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THE ARTIZAN

ENGINEERING JOURNAL

VOL 3 THIRD SERIES

VOL 23 OLD SERIES

A MONTHLY RECORD of the PROGRESS of CIVIL and MECHANICAL ENGINEERING

STEAM NAVIGATION SHIP BUILDING AND THE APPLICATION OF CHEMISTRY TO THE INDUSTRIAL ARTS

ESTABLISHED 1843.

EDITED BY W. SMITH C.E. F.G.S F.C.S, F.R.G.S &c.

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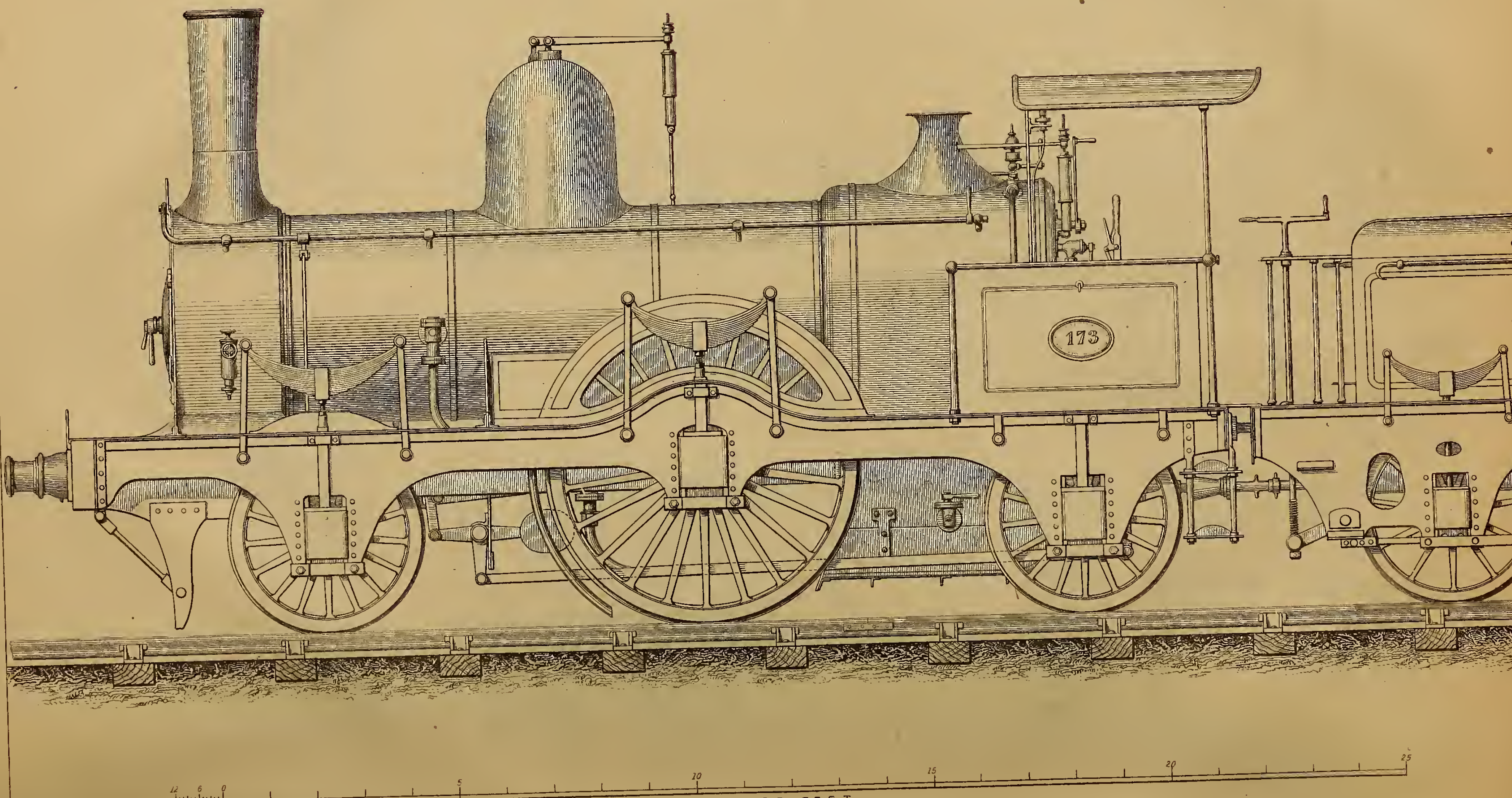
THE ARTIZAN JOURNAL, 1865.

LIST OF PLATES.

NEW EXPRESS ENGINE,

BY J. C. CRAVEN,

LOCOMOTIVE SUPERINTENDENT L. B & S. C. RY.




BAY of LIVERPOOL
COMPARISON OF THE SURVEYS OF
1690, 1760 & 1828
COURSE FROM SEA IN 1828
NEW CHANNEL
COURSE FROM SEA IN 1760
COURSE FROM SEA IN 1800
EDGE of HOYLE BANK IN 1690
THE BURBO SANDS
CROSBY CHANNEL
ALL DRY AT LOW WATER IN 1690
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ROCK LIGHT
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5 TO 7 FATHOMS IN 1690
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LEASOWE
COUNTY PALATINE OF CHESTER
SCALE OF MILES
LOW WATER SPRING TIDES IN 1828
DO 1690
DO 1760 ACCORDING TO EYES AND MACKENZIE
REMAINS OF SUBMARINE FOREST

THE ARTIZAN.

No. 25.—Vol. 3.—Third Series.

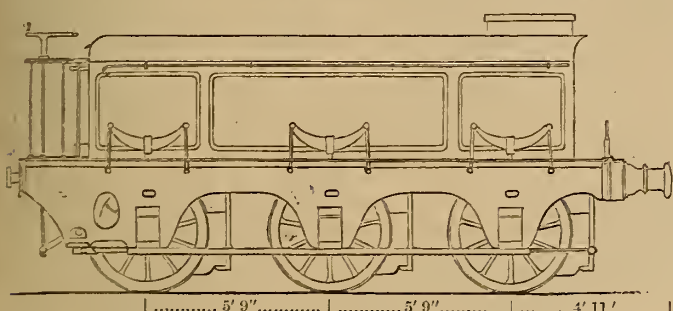
JANUARY 1st, 1865.

NEW EXPRESS ENGINES OF THE LONDON, BRIGHTON, AND SOUTH COAST RAILWAY.

By Mr. J. C. Craven, Locomotive Superintendent.

(Illustrated by Plate 272.)

The Plate and accompanying woodcut illustrate, in side elevation, the new Express Engines and Tenders (Nos. 172 and 173) completed during



the present year by Mr. Craven. We purpose giving, in our next a sectional view of the Engines, together with illustrations of the link motion, and when the full particulars as to dimensions, &c., will also be given.*

HISTORICAL AND DESCRIPTIVE SKETCH OF THE MERSEY DOCKS AND HARBOUR.

By J. J. Birckel.

(Illustrated by Plate 273.)†

Upon Plate 273 we have reproduced the surveys of that portion of the estuary of the Mersey, extending from its embouchure up to Stanley Point, on the Cheshire shore by Captain Denham in 1837, and by Lieut. Lord in 1852, for the especial purpose of enabling the reader to see how far the first named officer was correct in his predictions respecting Pluckington and Devil's Banks, and also to illustrate the removal of deposit which, after a lapse of fifteen years, had occurred within the region extending between Dingle Point and Garston.

It will be remembered that Captain Denham's chief anxiety concerning deposits opposite the face of the docks was the rapid and continuous growth of Pluckington Bank, and his argument respecting that subject was as follows:—

"Should the process of deposit not be arrested by a tide-guiding wall or by dredging, the spit of Devil's Bank and Pluckington Shelf will rapidly unite, and, on growing up towards low water level, a damming up of all that eastern branch of the ebb, and forcing through of a swatchway already begun at Garston, must take place. The whole column of ebb water will then sweep the Cheshire shore, leaving Pluckington to accumulate and spread across the Liverpool Docks in a ratio defying all sluicing."

Upon comparing the two surveys, it will be observed that what remains of Devil's Bank has shifted eastward, to the extent of reducing the tideway, between the main shore and that bank just opposite Dingle Point, from a quarter of a mile in width to about 220 yards; and the swatchway, also, of which he speaks had broken through, but at the same time had shifted considerably northward.

Again, upon comparing Lieut. Lord's survey with the one published upon Plate 269, it will be seen that Devil's Bank had further diminished in size according to this latter survey, whilst the Eastham Sands (which already in 1852 were growing northwards), had elongated into what is now termed the North Offing Bank, to such extent as to show indications of a tendency to unite with the Lancashire shore. Meanwhile, Pluckington has spread 400ft. into the river, as has already been shown.

In conclusion of our remarks upon the estuary proper, and in reference to the subject treated of in our last Paper, namely, Mr. Rennie's scheme, we should state that when the works now in progress of execution on the Lancashire shore, the northernmost docks, when completed according to design, will clearly face the open sea; and, remembering that the construction of the Canada Dock was already considered a hazardous experiment by masters of vessels, it is doubtful whether any further dock accommodation should be recommended and sought for in a northerly direction; for already, in the last proposed extension, Mr. Lyster, the present dock engineer, has had to recommend special provision against strong north-westerly gales, and we are informed by Mr. Fereday Smith that, with their river craft, the Bridgewater Trust have to enter and leave the Canada Dock at half tide during rough weather, the river being then still protected against *heavy swells* by the high elevation of Burbo Bank. It is not unlikely, therefore, that the very want of docks will ultimately lead to the construction of that south river wall so imperatively urged upon the Dock Committee by Admiral, then Capt., Denham some thirty years ago. The formation, however, of an artificial permanent shore, even as far as Formby Point, as shown in dotted outline upon the plate illustration, No. 270, in the shape of a substantial embankment, could not but be beneficial to the harbour, first, by still further extending a guiding action to the tide; and secondly, by preventing the abrasion of the low sandy shore, which, being nearly parallel to the direction of the current of flood, would be likely to furnish materials fostering deposits within the river.

We have thus traced the history of the tidal estuary as closely and as accurately as existing documents and known facts enable us to do; and having thus, by the natural sequence of events, drifted as it were into the bay outside, we shall now lay before our readers as many facts as are known concerning this important element of the port, viz., its sea approaches, in so far, at any rate, as they ma be instructive and useful to the engineer.

The earliest authentic surveys of this portion of the coast are those by Capt. Greenville Collins, published by him in his work entitled "The Coasting Pilot," and are reproduced here in the accompanying woodcuts; the first, dated 1687, formed part of a series comprising the Isle of Man, Carrickfergus, Dublin, Kinsale, and Cork, of which series he speaks as being "*the most usefullest and necessary part to navigation;*" the second, dated 1690, published originally on a much larger scale than the first, was styled "A new and exact Survey of the River Dee and Chester Water;" and seems to have been specially executed to facilitate the gathering of a large fleet of above 300 sail in those waters, for the purpose of conveying an army of 20,000 men, under King William III. and General Shomberg,

* The readers of The Artizan for the last few years back will remember the Plate given in our Volume for 1856, of the Pumping Engines at the Croydon Station, also designed by Mr. Craven.

† Charts in further illustration of this paper, will be published in subsequent numbers, as convenience will permit.

across to Ireland; for we find that on the 11th of June, 1690, the King embarked at Hoylake, and set sail with that fleet for Carrickfergus. Later surveys were those by Eyes and Mackenzie in 1760; by Capt. Thomas in 1813; by Giles in 1828; and after the permanent appointment of a marine surveyor to the port the surveys became more frequent and periodical, as will be seen in the sequel.

Little attention appears to have been paid to the mutations in the sea channels before Admiral Denham's laborious observations had demonstrated the necessity of watchfulness in these regions, as well as in the estuary above, and before he had advocated that necessity both in his communications to the British Association and to the Dock authorities; that spirit of vigilance, however, which he then endeavoured to foster, appears to have been caught by some, at any rate, of his associates and readers; and thus have the seeds which he cast upon these waters not failed to bear abundant fruit—wherefore, again we say that he is entitled to be considered one of the benefactors of this port.

Among those who have gratuitously devoted their time and attention to this subject we should mention, in the first instance, Mr. John Harrison who carried on a lengthy correspondence in the daily papers, and subsequently with the First Lord of the Admiralty, in which he endeavoured to combat the notion, somewhat hastily thrown out by Mr. Hills, that the changes in the bay have been inconsiderable. To him we are indebted for the diagram, Plate 273, in which the surveys of 1690, 1760, and 1828 are superimposed for facility of ascertaining, at a single glance, the amount of change in the position of the channels which had occurred during the periods intervening those surveys.

Of still greater usefulness, however, have been the labours of Mr. Joseph Boult, while acting as secretary to a Committee of the British Association appointed to investigate, during the years 1854 to 1856, the changes which had occurred within the channels of the Mersey during the fifty years preceding. We say his labours have been of greater usefulness, because, in the report which he handed to that Committee, he not only epitomised these changes in a clear and succinct manner, but to a great extent traced them to their proximate causes, and thus furnished a document which may, at any future time, serve as a guide to the engineer, if consulted respecting this or any other harbour similarly circumstanced. Harbour engineering, indeed, is but a science of present growth, which is far from having reached its manhood; and any document illustrative of the principles which ought to govern that science must be accepted by the profession generally as a valuable gift. We, therefore, reproduce that report here almost in its entirety, omitting such portions only as have been touched upon already in our previous papers, or which do not minister to the main objects of this work:—

Abstract of Mr. Boult's Report.

"The charts of the Mersey having been usually prepared when important changes had taken place in the channels, the investigations of those changes could not be arranged by epochs of time; and for this inquiry, therefore, the periods of the publication of those charts themselves have been adopted.

"For the purpose of this investigation, it may be conveniently assumed that the true mouth of the river are at the outward extremities of the sea channels. The streams of tide running inland through these sea channels unite into one between the North Dock Works at Liverpool and New Brighton, and, after passing the towns of Liverpool and Birkenhead, through a narrow gorge, which in places is as much as ten or eleven fathoms deep at low water of ordinary spring tides, this stream widens into a very extensive reservoir, sometimes called the upper estuary, from which, after sending an offshoot into the Weaver, it passes into the upper reaches of the river through the smaller gorge of Runcorn Gap, and its progress is finally barred by the Woolston Weir of the Mersey and Irwell navigation, four miles above Warrington.

"The phenomena of the outer estuary, or Liverpool Bay, which form the subject of this inquiry, may be considered separately and apart from those of the upper estuary, and the results of their separate investigations may be afterwards compared.

"The earliest authentic survey of Liverpool Bay, published within the period assigned to this inquiry, is that of Captain George Thomas, R.N., which was taken in 1813, and published in May, 1815; and the next authentic survey is that of Capt. H. M. Denham, R.N., in 1833, both of which were made by order of the Admiralty, in consequence of the great anxiety and alarm experienced by the local authorities, on account of the important changes which took place in the channels prior to each of the above dates. The changes of the later period continuing—for they, in fact, were only the precursors of the substitution of new outlets for the old ones—the surveys were repeated by Capt. Denham in 1835 and 1837.

"On comparing the charts of 1813 and 1833, it appears that at the former date the Northern Channel, which was previously divided into two portions called the Crosby and the Formby Channels, maintained an even course until it had passed Crosby Point, where it separated into two outlets; one over a bar, with from 1ft. to 8ft. of water, into the old Formby Channel, in which there were from $1\frac{3}{4}$ to 6 fathoms, and thence over another bar seaward, with from 1ft. to 8ft. of water. The other outlet, called the South Channel, was to the southward and westward, and passed between the Jordan and Great Burbo Banks, having a depth of from 2 to 6 fathoms, diminishing in a seaward bar to 7 ft. In this survey Formby Bank is insulated, and covered at four hours' flood.

"In 1833, twenty years later, Formby Bank had attached itself to the main shore; the old Formby Channel was almost land locked, and had no communication with the Crosby Channel except over a 6ft. bar between Jordan and Formby Banks. The depth of water on the seaward bar of this channel had increased in places to 13ft.

"The South Channel of Thomas's Survey appears, during the same period, to have shifted upwards of a mile to the southward and acquired nearly a true east and west bearing, and had a bar with 10ft. or 11ft. of water. It was called by Denham the New Channel.

"Between the Formby Channel and the New Channel another outlet was opened having a minimum depth of 2ft., and was called the Half-tide Swatchway, or Zebra Channel.

"Madwharf, a large bank adjoining Formby Point to the northward, had elongated upwards of 2,200 yards in that direction, and its area considerably enlarged. Many changes took place in the position and magnitude of the minor banks adjoining the seaward entrance of the Northern Channel, some of which, as the middle patch, nearly disappeared; whilst others enlarged their area, or sprang altogether into existence.

"A comparison of the survey of 1833 and those of 1835 and 1837 indicates differences chiefly consisting of the changes which accompanied the partly natural and partly artificial formation or readjustment of the new channels. These changes found their issue in the formation of that which is now known as the Victoria Channel.

"A similar examination of the Western Channel, divided into two portions called the Horse and Rock Channels, shows the following changes for the above-named period of twenty years.

"The banks north of the Rock Channel were enlarged and consolidated; the Brazil Bank and Burbo Sand were united to the Great Burbo Bank, and the patch which at the earlier date divided the Rock Channel at its junction with the river into two portions was itself divided, one piece being added to Burbo Sand and the other to the main shore. At the western extremity of the Rock Channel, near its junction with the Horse Channel, its width had been contracted about 400 yards, by accretions partly on the Dove Spit, but chiefly on the western point of Great Burbo, now called the North Spit. At the bar of the Rock Channel, Thomas gives soundings of 2ft. seaward and of 10ft. on the Liverpool side; in 1833, Denham gives 2ft. on the bar and 3ft. on the Liverpool side, showing a diminution of 7ft. in the latter.

"Hoylake formerly joined the Western Channel at the junction of the Horse and Rock Channels, and in 1689–90, the date of Collings's Survey, the depth in the lake ranged from $2\frac{1}{2}$ fathoms to 7 fathoms. One hundred

SURVEYS OF 1687 AND 1690, BY GRENVILLE COLLINS.

N.B.—The dotted lines show the outlines of 1690; the soundings indicate fathoms at low water spring tides.

and twenty-four years afterwards, Thomas records the range as reduced to from 1 to 4 fathoms; and twenty years later it appears, upon Denham's first chart, as closed by a bar, the pools on either side of the bar having been reduced in width to about one-half of that of the lake in 1813.

"Whilst these changes took place, the direction of the Horse Channel varied slightly by additions to the north-eastern extremity of East Hoyle Bank.

"From 1837 forward, the surveys of Liverpool Bay have been conducted by Lieut. Lord, R.N., late Marine Surveyor to the Dock Committee, and they were published in the years 1840, 1846, 1849, 1852, 1853, and 1854.

"On comparing the survey of 1840 with that of its immediate predecessor of 1837, it is found that the Northern Channel had undergone the following important change:—The length and direction of that portion of the Crosby Channel which lies between the Rock Lighthouse and the Crosby Light-vessel had been very slightly altered, and its area had remained very much the same as in 1837; but between the Crosby and Formby Light-vessels the direction of the Channel had undergone considerable alteration, the Formby vessel having in 1840 been moved nearly 600 yards westward, and its area increased from 15,600 yards to 17,500 yards.

"The change in the direction of the Victoria Channel had been very great, the Bell buoy which indicates its entrance from the sea having been moved in 1840 nearly 2000 yards to the north of its position in 1837, and the depth of water on the bar had been reduced from 12ft. and 13ft. to 10ft. and 11ft.

"Zebra Channel had been advanced to the westward of its former position, and had increased its minimum depth from 2ft. to 3ft. on the fairway track.

"Formby Bank had been slightly moved to the eastward, and had considerably elongated to the northward. On the whole, however, the volume of the bank appears to have been diminished nearly one-third; the cubic contents of the bank in 1837 having been nearly 10,000,000 yards, and in 1840 rather more than 6,500,000 yards.

"The area of Great Burbo Bank had been enlarged, and its volume increased from about 58,500,000 yards to about 62,000,000 yards.

"The Rock Channel had been reduced in length about 500 yards, and in average depth 1ft.; the depth of water on the bar reduced from 2ft. to 1ft., and the first sounding on the Liverpool side of the bar from 3ft. to 2ft. The sailing direction of the Horse Channel remained unaltered, but the North-west Light-vessel at the seaward entrance of the Channel had been removed in 1840 about 250 yards north of its position in 1837.

"The bar in Hoylake forming part of East Hoyle Bank had increased in area and grown up to 2ft. and 3ft. above low-water level; but notwithstanding this accession, the area and altitude of this bank had been diminished, and its volume reduced from nearly 81,250,000 yards to rather more than 73,500,000 yards.

"Between the years 1840 and 1846 considerable changes had occurred, though on the whole less remarkable than those which took place between 1837 and 1840.

"That portion of the Crosby Channel which lies between the Rock Lighthouse and the Crosby Light-vessel had not undergone much change. Its direction had been so altered as to necessitate the removal of the light-vessel nearly 200 yards to the eastward; the average depth had remained nearly stationary at 30ft. That portion between the Crosby and Formby Light-vessels had undergone greater change. Its length had been increased about 400 yards, and its average depth reduced to 26ft. Notwithstanding the change in the position of the Crosby Light-vessel above mentioned, and the removal of the Formby Light-vessel nearly 400 yards to the northward, the direction of the Channel in 1846 was parallel to its direction in 1840.

"The direction of the Victoria Channel had been altered by the amount indicated by the change in the position of the Formby Light-vessel above mentioned, and by the removal of the Bell buoy about 500 yards westward. The average depth of water on the bar had increased from 11ft. to 12ft.

"In the Zebra Channel the minimum depth had increased from 3ft. to 6ft.

"The area of Formby Bank had been slightly enlarged, and the elevation considerably increased; a slight elongation northwards had taken place, and its volume had increased from 6,500,000 yards in 1840, to 13,000,000 yards in 1846.

"The area of Great Burbo Bank apparently remained unaltered as a whole, though there occurred considerable local changes. Its elevation had been reduced, and its volume, which was 62,000,000 yards in 1840, was computed in 1846 at 59,750,000 yards.

"The Rock Channel had recovered 300 yards of its length, but the average depth had remained stationary. In the Horse Channel, East Hoyle Bank had advanced towards the north-east, and the North-west Light-vessel had been moored about 300 yards to the westward; the volume of East Hoyle Bank had been reduced from upwards of 73,500,000 yards to less than 72,000,000 yards.

"The chart of 1852 shows that considerable and important changes had taken place since the survey of 1846, with which that of 1849 may be considered in the main identical. The following comparison, therefore, is instituted between the surveys of 1846 and 1852, a period of six years:—

"The principal changes in that portion of the Crosby Channel between the Rock Lighthouse and the Crosby Light-vessel were:—Its elongation, and the consequent removal of the light-vessel about 2,000 yards north-westwardly of its position in 1846; the diminution of its average depth from 30ft. to 29ft., and the diminution of its average area from 18,840 yards to 17,500 yards. Its direction had also been slightly altered, as indicated by the change in the position of the light-vessel—a change which appears to have been occasioned by the growth of a large elbow upon Great Burbo Bank. In that portion of this channel extending between the Crosby and Formby Light-vessels a change of direction had taken place, necessitating the removal of the Formby Light-vessel 750 yards north-westwardly, and an increase of the average depth from 26ft. to 28ft.

"The position of the Victoria Channel had undergone a change necessitating the removal of the Bell buoy about 1,000 yards to the southward, or nearly midway between its positions in 1840 and 1837.

"The Formby Bank had been enlarged by the accession of the Jordan Bank, and by its own increased elevation. In 1846, the volume of the former was about 13,000,000 yards, and that of the latter 1,500,000 yards, making a total of 14,500,000 yards, which in 1852 was estimated at 15,750,000 yards.

"Taylor Bank and Jordan Flats, the former of which had no existence in 1833, while the latter was of very minor importance, had not only united in 1849, but in 1852 had largely increased in volume, and in the same period had moved into close proximity with the united Formby and Jordan Banks.

"The Great Burbo Bank had undergone material alterations since 1846, one of which was the extraordinary growth of the north-east angle in Crosby Channel before mentioned; but the most important change was its increase of bulk, arising partly from enlarged area, but principally from increased elevation, extending over the whole of the bank. In 1846, its volume had been computed at 59,750,000 yards; in 1852 it had increased to 69,500,000 yards.

"In 1852, the Rock Channel had again undergone a slight elongation, and its average depth had been reduced from 14ft. to 13ft.

"East Hoyle Bank had also acquired a considerable increase of bulk, arising from additional elevation; its volume, which in 1846 had been 72,000,000 yards, was now computed at 84,500,000 yards.

"The surveys of 1853 and 1854 were only partial, and indicated no material changes.

"In recording the foregoing observations on the changes in the bay, the earliest survey within the period of inquiry has been assumed as the starting-point, and succeeding phenomena are noted in chronological sequence. It is now proposed to retrace the inquiry, in order, as far as practicable, to reduce effects to their proximate causes, important facilities being derived from the less imperfect data of the more recent periods.

"On comparing the surveys of 1854 and 1852, it was observed that the changes were almost entirely confined to the increased tortuousness of the Victoria Channel, the silting up of the Zebra Channel, the opening of the Queen's Channel, intermediate between the Zebra and the Victoria, and the contraction of the eastern portion of the Rock Channel, with a consequent diminution of its average area. During this period there was no abstraction of the tidal space in the river for dock purposes, and consequently no reduction from *that* cause of the scour; while in 1852 the rainfall was about 50 per cent. above the average.

"It may be observed that, as the influence of freshes in a tidal river is greatest when the ebb is low, their effects in the Mersey will be more apparent in the Northern Channel and its branches than in the western channel, because the direction of the latter is almost at right angles to the course of the river, whilst that of the former is almost in a direct line with it; the bar which crosses the Western Channel at its junction with the river will also tend to weaken the scour of the water when the tide is low.

"It appears then that the freshes of 1852, in passing down the Northern Channel, were deflected by Taylor's Bank and Jordan Flats on to the north-east elbow of Great Burbo, itself of recent formation; after passing that elbow the ebb took the direction due to this modified impetus down Crosby Channel, passed over the shoals between the Zebra and Victoria Channels, and opened up the swatchway, now known as the Queen's Channel. The channel thus initiated by the freshes of 1852 was deepened by the continued action of the ebb-tide throughout that year and the following, until in 1854 we find the Queen's Channel formed; and the Zebra silting up from the loss of the water which then passed by the New Channel. On the Victoria bar, also, these freshes had effected a slightly increased depth of water.

"The contraction of the Rock Channel may be due to the drift of sand promoted by the N.W. wind, and the loss in depth which occurred during the period 1846–49 appears to indicate that the abstraction of the tidal area, which was greatest during that period, has been prejudicial to this channel. The surveys since 1833 indicate a progressive though irregular tendency towards the silting up of this channel; and there are facts which render it probable that the effects of diminished scour should first be manifested there.

"The tidal establishment is earlier at the North-west Light-ship, or entrance of the Western Channel, than it is at the Bell buoy, or entrance of the Northern Channel. Though the difference is very slight, it is sufficient to give a bias to the stream of tide, as is shown by the experience of bathers on the shore just above the junction of the Rock Channel with the river, who find that, with a young flood, there is a current out again to sea by the Northern Channel.

"The same also appears from the experiments of Mr. Enfield Fletcher, C.E., and others, with floats. These were liberated at Wallasey Pool on the ebb tide, for the purpose of ascertaining in what time the water from the pool would reach the Victoria bar; but all the floats without exception went down the Rock Channel, and grounded upon Dove Spit. This bias with the ebb would, however, be confined to the upper stratum of the water, the impetus of the current to sea naturally giving to the main bulk the more direct course by the Northern Channel, in preference to the almost right-angled deflection down the Western Channel. Whilst the Rock Channel has been losing depth, the depth of water in the Northern Channel, considered in its whole length from the Rock Lighthouse to the Bell buoy, is almost undiminished since 1833. The loss on the Victoria bar may be due to the diversion of the stream formerly by the Zebra, now by the Queen's Channel. But it is difficult to assign any cause to the elevation of the banks and of the bottom of the Rock Channel, other than the loss of scour at the first of the ebb, and the influence of the prevailing winds in drifting sand from the coast.

"It appears that between 1846 and 1849, during which the enclosure walls were in progress of construction, there was no alteration in the direction of any of the channels; and that between 1849 and 1852, these works being still in progress, the direction of the Victoria Channel was so altered that the Bell buoy was removed about 1,000 yards westwards of its position in 1846; and that in the upper portion of the Northern Channel there had been no changes in the fairway track beyond those consequent upon the elongation of the part between the Rock Lighthouse and Crosby Light-vessel.

"The change in the Victoria Channel is probably due to the lengthening of the Crosby Channel, which has been attributed to the growth of the sandbanks; and it does not appear that the extension of the dock walls had so far been productive of much effect on the direction of the sea channels.

"As respects the Rock Channel, the influence of the new north wall in Bootle Bay is very likely to aggravate the tendency to silting up, since that wall will, in all probability, impede the advance of the flood tide through that channel by substituting for a shelving shore a nearly perpendicular face almost at right angles to the course of the flood.

"Between 1833 and 1837 was perfected that remarkable change in the northern outlet of the Mersey of which Capt. Denham has recorded so many particulars in his work on the Mersey and the Dee, and in communications to the Association. But there is such a complete dearth of observations upon the changes which preceded the opening of this new outlet in 1833, and upon the meteorological phenomena by which it was preceded or accompanied, that the result of any detailed inquiry must necessarily be very precarious. The same observations apply to periods immediately subsequent and precedent to Capt. Thomas's Survey in 1813. The general features of the consolidation and enlargement of the principal sandbanks, and of the eastern shore of the estuary, may be observed upon this survey, and also upon all the authentic surveys since that of Capt. Collins in 1690. It is also remarkable that the low water margin of the eastern shore appears to have advanced westward to an extent fully equal to one-half the width of the Northern Channel as laid down by Collins, or 1,000 yards."

The only comments which we desire to make upon this report have reference to the Rock and Horse Channels.

The cause of their deterioration has very properly been attributed, in part at any rate, to the retarding influence upon the column of flood through the Rock Channel by the north river wall; but now that the Victoria and Queen's Channels have fairly established themselves, while Burbo Bank has continued to grow westward, and East Hoyle Bank has considerably spread northward, we apprehend that the flood tide will rather court these latter channels in preference to the former, seeing that the deposits named cannot but act as effective retarding causes to its flow in that direction.

On the other hand, it is self-evident that the greater the velocity of ebb, and that is the object which has been aimed at inside the estuary, the less chance is there that the ebb tide will turn abruptly at a right angle into the Rock Channel; and the more will it persevere, by virtue of its impetus, in the more easy, if not shorter, course which it has worked out for itself.

In our opinion, therefore, the Rock and Horse Channels may be considered as eventually doomed, notwithstanding any Parliamentary enactments for their preservation; and, moreover, we apprehend nothing but good results from this event, since it is preferable, by far, to direct all the available scouring power into one channel only, in order fully to realise its benefits, rather than divide it into a number of small streams, and waste it in detail—on that well-known principle, which holds good in practical science as well as in social life, that *union gives power*.

TABLE D.—Crosby Channel Rock Lighthouse to Crosby Light-vessel.

Date of Survey.	Surveyor's Name.	Length of Channel.	No. 1. Depth.	No. 1. Average Area.	No. 2. Depth.	No. 2. Average Area.	No. 3. Depth.	No. 3. Average Area.	No. 4. Depth.	No. 4. Average Area.	No. 5. Depth.	No. 5. Average Area.	No. 6. Depth.	No. 6. Average Area.	No. 7. Depth.	No. 7. Average Area.	No. 8. Depth.	No. 8. Average Area.	No. 9. Depth.	No. 9. Average Area.	Average Depth.	Average area of the whole.	Remarks.	
		Yds.		Yds.	Ft.	Yds.	Ft.	Yds.	Ft.	Yds.	Ft.	Yds.	Ft.	Yds.	Ft.	Yds.	Ft.	Yds.	Ft.	Yds.	Ft.	Yds.		
1837	Capt. Denham	6500	...	15,460	35	19,252	33	22,778	32	21,233	29	19,333	24	19,077	31	14,885	......	....	......	....	31	18,860	On the average of the first seven columns.	
1840	Lieut. Lord ...	6700	...	18,221	31	17,150	31	17,300	30	19,218	28	20,000	28	18,584	28	13,360	......	....	......	....	30	18,019		
1846	" ...	6750	...	17,225	31	17,665	34	20,103	32	20,790	27	18,973	25	19,968	27	17,147	......	....	......	....	30	18,839	Ft.	Yds.
1852	" ...	8700	...	17,213	31	17,087	31	19,673	30	16,357	26	17,628	23	19,952	26	16,600	28	16,817	31	18,160	29	17,502	29	17,506
1854	" ...	8700	...	16,543	33	16,750	33	19,001	30	15,405	27	17,567	22	20,788	24	18,470	28	18,387	28	18,332	29	16,923	29	17,779

TABLE E.—Crosby Channel—Crosby Light-vessel to Formby Light-vessel.

Date of Survey.	Surveyor's Name.	Length of Channel.	Depth.	Average Area.	No. 1. Depth.	No. 1. Average Area.	No. 2. Depth.	No. 2. Average Area.	No. 3. Depth.	No. 3. Average Area.	No. 4. Depth.	No. 4. Average Area.	No. 5. Depth.	No. 5. Average Area.	No. 6. Depth.	No. 6. Average Area.	No. 7. Depth.	No. 7. Average Area.	Average Depth.	Average Area of the whole.	Remarks.	
		Yds.	Ft.	Yds.	Ft.	Yds.	Ft.	Yds.	F.	Yds.	Ft.	Yds.	Ft.	Yds.	Ft.	Yds.	Ft.	Yds.	Ft.	Yds.		
1837	Capt. Denham..	5860	29	17,356	31	17,300	29	15,650	26	15,770	26	17,273	24	14,783	23	12,832	......	....	27	15,601	On adding columns 8 and 9, Table D.	
1840	Lieut. Lord	5800	29	17,796	30	17,508	29	17,837	29	17,020	29	19,028	3	17,759	24	15,981	......	....	27	17,537		
1846	"	6200	28·5	18,143	29	19,900	33	18,167	30	17,916	28	19,650	24	21,237	23	17,350	24	16,900	26	18,599	Ft. 28	Yds. 16,748
1853	"	4800	28·6	17,126	....	....	......	....	29	16,850	31	17,062	27	19,100	24	15,200	28	13,140	28	16,151	28	16,733
1854	" . ..	4800	28·7	17,302	....	....	......	....	29	18,647	35	16,900	29	17,852	23	17,217	26	9,800	28	16,083		

The two columns in brackets show the average from Rock Light to Formby Vessel.

TABLE F.—Rock Channel—Rock Light to Dove Spit.

Date of Survey.	Surveyor's Name.	Length of Channel.	No. 1.	No. 2.		No. 3.		No. 4.		No. 5.		No. 6.		No. 7.		No. 8.		No. 9.		No. 10.		Average Depth.	Average of the whole Nine Columns.
				Depth.	Average Area.	Depth.	Average Area.	Depth.	Average Area.	Depth.	Average Area.	Depth.	Average Area.	Depth.	Average Area.	Depth.	Average Area.	Depth.	Average Area.	Depth.	Average Area.		
		Yds.		Ft.	Yds.	Ft.	Yds.	Ft.	Yds.	Ft.	Yds.	Ft.	Yds.	Ft.	Yds.	Ft.	Yds.	Ft.	Yds.	Ft.	Yds.	Ft.	Yds.
1837	Capt. Denham	10,000	Nil	2	193	3	650	14	1,500	14	1,660	18	3,100	14	5,243	17	6,519	13	5,950	18	6,067	12·5	3,431
1840	Lieut. Lord ...	9,500	,,	1	42	2	367	16	1,740	13	2,227	12	2,762	11	3,802	11	5,033	15	5,070	18	4,583	11·5	2,847
1846	,, ...	9,800	,,	1	110	2·5	521	14	1,749	13	2,840	13	3,893	13	4,233	12	5,360	13	4,917	19	2,600	11	2,914
1852	,, ...	10,000	,,	1	47	2	367	15	1,650	11	1,950	12	3,570	12	3,890	12	4,567	15	4,735	17	4,467	11	2,805
1854	,, ...	10,000	,,	1	42	2	222	15	1,223	13	1,717	11	2,730	11	3,800	12	4,258	15	4,875	17	4,475	11	2,594

Remarks.—In making an average of the whole Channel, the first column, which represents a cross section where the Channel is dry, has been omitted. The above Tables represent cross sections in the respective channels in the right angles to the Fairway Track, and at intervals of 1,000 yards, commencing in Tables D and F, on a plane passing through the Rock Light, and in Table E on a plane through Crosby Vessel. Length of Channel in yards, Depth in feet, Average Area in yards.
Datum.—Low water, ordinary spring tides.

TABLE G.—Average Volume of the Banks.

Date of Survey.	Surveyor's Name.	Gt. Burbo, Burgill, and Nth. Bank.	Formby.	Taylor's.	Jordan's.	Madwharf.	Middle.	Little Burbo.	Outlying.	Total.	East Hoyle.
1837	Capt. Denham	58,543,257	9,929,400	....	238,333	6,510,000	97,750	859,333	360,367	76,268,740	81,219,333
1840	Lieut. Lord ...	62,010,225	6,668,417	91,667	231,667	6,510,000	From a wash to 9ft. below low water...	A wash 2ft. below low water	....	75,511,976	73,623,283
1846	,, ...	59,795,536	12,993,750	390,250	1,512,833	5,720,250	3ft. to 12ft. below low water	By a wash to 9ft. below low water...	....	80,412,619	71,943,259
1852	,, ...	69,578,770	11,079,600	4,404,800	4,720,000	6,350,067	A wash 3ft. below low water...........	By a wash to 7ft. below low water...	....	96,133,237	84,579,450
1854	,, ...	99,396,034	11,079,600	4,502,400	4,121,025	6,350,067	A wash 3ft. below low water...........	2ft. to 6ft. below low water	....	95,449,128	84,579,450

This table represents the comparative growth of the several banks above low water of spring tides, and represents only approximately their absolute size.
Datum.—Low water of ordinary spring tides.

(To be continued.)

ON THE PARABOLIC CONSTRUCTION OF SHIPS.

By J. W. Nystrom.

Mr. Nystrom, at a recent meeting of the Franklin Institute, stated that he had received the following communication from Trieste:—

"After having perused your treatise on the Parabolic Construction of Ships, your Pocket-book of Mechanics, 9th edition, and a lecture on the Parabolic Construction, published in the 'Journal of the Franklin Institute' (republished in The Artizan for July, 1864, in London), I take the liberty of sending you the theories that sustain Chapman's hypothesis, in which you have not succeeded; with the hope that you will correct your theory, based on wrong hypothesis, before going forward with your treatise, now in progress, and that it really will be brought to perfection; and should these proofs be accepted, I may avail myself of another opportunity to forward some more extensive details on the Parabolic Construction, communicated to my family in the year 1806, from Chapman himself (sending a work entitled, 'Försök till en Theoretisk Afhandling att gifva ett Linie skepp dess råtta storlek och form. Likaledes för Fregatter och mindre Bevårade Fartyg of F. H. af Chapman Carlscrona, 1806,') which was the result of labours of the latter years of Chapman's life, that he dedicated it, as his testament or memorial of what he had been able to contribute to it, to all enlightened admirers of this noble science.

"In case you would be so very kind as to answer this letter, I beg you to have the kindness, if you do not publish the theoretic part of the Parabolic System in your progressional work, to make me acquainted with it, in order that I may be able to know if I have something still to learn of it.

"Yours, &c.,
"Anthony Panfilli, Trieste.

"Mr. John W. Nystrom, C.E."

I have received half a dozen letters of this kind from shipbuilders in Europe, which all seem to agree that I am wrong in my Parabolic Construction; but they do not state why or wherein I am wrong, only refer me to Chapman's formulas. I have answered several communications, and requested them to explain why or wherein I am wrong; and if any light is obtained on the subject, I shall not fail to communicate the same to the Franklin Institute. In the meantime, I shall go on, uninterrupted, with my work on the Parabolic Construction, as I am under the impression that they only suppose I am wrong merely because my hypotheses differ from those of Chapman. I may consider myself a pupil of Chapman's school, because it is on his Parabolic method I have started, and progressed as explained in The Artizan and in the lecture at the Polytechnic College, Philadelphia. The first part of that lecture, which explains the inefficiency of Chapman's hypothesis, has not yet been published, but the following is an extract of the same:—

Extracts from the first part of the Lecture on the Parabolic Construction, at the Polytechnic College, Philadelphia, February 11, 1864.

"It is proposed to explain to you, this evening, a new method of constructing ships, called the Parabolic Construction. It is so called because it is based on the formula for a parabola, whereby all the lines in a ship can be constructed.

"The Parabolic system of constructing ships was originated by the celebrated Swedish naval architect, Chapman, nearly a century ago, at which period it was well received among shipbuilders; but on account of its then incomplete form, restricting constructors to particular shapes, it was gradually abrogated, until no trace could be found of it, even in works on shipbuilding. Mr. Chapman hit upon the fortunate idea that the cross sections of the displacement of a vessel ought to follow a certain progression, in order to present the least possible resistance when moving through the water. He collected a great many drawings of ships of known good and bad performances, and made the following investigation. On each drawing he transformed the cross sections of the displacement into rectangles of the same breadth as the greatest beam of the load water line, of the vessel; placed their upper edges in the plan of the load water line, by which he found that the under edges of the rectangles formed a bottom, the curve of which were parabolas in ships of known good performances.

"Let Fig. 1 represent a ship with the load water line, W, dead flat cross section $a \ominus b$, formed into the rectangle $a\ b\ c\ d$, and $i\ o\ i$ another cross section formed into a rectangle $e\ f\ g\ h$, so that the breadth $e\ f$ is equal to $a\ b$; then the line $k\ l\ m$, Fig. 1, forming the bottom of the rectangles, should be a parabola with the vertex at k, and $k\ o$ the axis of the abscissa.

"Mr. Chapman found that the parabola so obtained did not terminate at the stem n, but fell a little short at m. The deviation $m\ n$ was very small in vessels of his days, but in modern vessels it is more considerable, showing that there must be a point of inflection p in the curve. However erroneously we may set out in quest of an object, experience generally leads us towards correct scientific principles. In the case before us, experience has increased the deviation $m\ n$, and we know that inasmuch as nature admits of no physical by-laws, the curve cannot be a plain parabola. It is this increasing deviation $m\ n$ which has led me to investigate the subject more carefully; starting on the principle that the

FIG: 1.

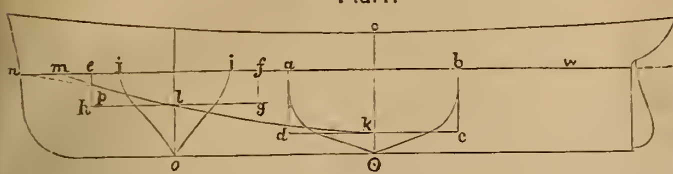
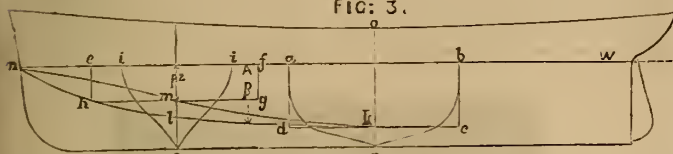


FIG: 3.



resistance to a body in motion in a fluid, is a function of the square of the sine of the angle of incidence to the motion. Let $a\ b\ c\ d$, Fig. 2, be a body in motion in a fluid, in the direction $a\ c$; then the resistance to that body is found by experiments to be nearly as the square of the sine of the angle v; the beam $b\ d$ being constant.

"From this it appears that the proper progression of the cross sections should be as the square of the ordinates in a parabola.

"Let Fig. 3 represent a vessel with the dead flat Θ and stem n. Draw the cross section $a\ \Theta\ b$ and the rectangle $a\ b\ c\ d$, as before described; draw a parabola $k\ l\ n$ of any desired order, terminating at the stem; then the proper progression of the cross sections should be as the square of the ordinates β. Let $b = 1$, then the ordinates β will be fractions of b, and the square β^2 multiplied by the area of the dead flat cross section Θ, would give the proper area of the ordinate cross section θ, or $\theta = \Theta\ \beta^2$, Fig. 3. The line $k\ m\ n$ should then indicate the proper progression of the ordinate to cross sections θ. The areas $e\ f\ g\ h = i\ o\ i$."

Here the lecture was continued on the properties and formulæ for the parabola, which it is not necessary to repeat on this occasion. Arrived to the following formulæ, it referred to the rectangular co-ordinates half length and breadth of the vessel:—

$$(a\ b) = b\left(1 - \frac{y^n}{l}\right) \quad (1)$$

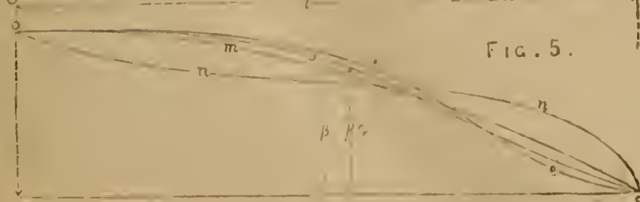
$$(a\ \theta) = \Theta\left(1 - \frac{y^n}{l}\right)^2 \quad (2)$$

"The formula (1) gives the plain parabola $o\ \beta\ s$, Fig. 4, and formula (2)

FIG. 2.

FIG. 4.

FIG. 5.



the parabolic cyma $o\ o\ s$, of which the latter indicates the proper progress of the ordinate cross section of the displacement of a vessel, and agrees with vessels constructed for speed of the present day, while old vessels come nearer to the plain parabola $o\ \beta\ s$, as constructed by Chapman.

"I have investigated the progression of the cross sections in a great many vessels, from most parts of the world, as will be seen in a treatise on the parabolic construction of ships now in progress. Many American vessels agree perfectly with formula (2), of which the U. S. frigate *Niagara*, constructed by the late Mr. Steers, is one. The formula (1), which embodies Chapman's method, is therefore not applicable in modern shipbuilding, which I think is the reason why the original parabolic system has not been more generally adopted. It is not always necessary to pay the greatest attention to speed, as there are many other circumstances of greater importance, namely, freight, shallow water, location of metacentre and centre of gravity of the vessel; for which it becomes necessary to arrange the parabolic construction of ships, so that it will accommodate itself to all the requirements, as well as to the taste of the shipbuilder. This can be accomplished by raising the ordinate β to any arbitrary power, which we will designate with the letter q, and call it the power of the exponent n, when the final formula will appear:—

$$\beta = b\left(1 - \frac{y^n}{l^n}\right)^q \quad (3)"$$

This is the general formula for the parabolic construction. The balance of the lecture has appeared in the "Journal of the Franklin Institute."

It does not appear that Chapman attempted to form the water-lines and frames of a vessel by the parabolic method. He says the area of the cross sections can be approximated by a parabola, placing the vertex at the keel, which cannot give a proper shape to the frame. Inasmuch as the displacement of a vessel is the integral of the areas of the water lines and cross sections, and that those areas are integrals of the ordinates in the frames and water lines, they are all convertible into one another by a common formula, which is the formula (3), and which formula embodies Chapman's system completely; simply by placing $q = 1$. But, by so doing, the constructor is restricted to a stiff and obstinate guide, which will not yield to his taste, and we have the result before us; namely, the shipbuilder assumes his independence. It would be futile to attempt to introduce a system of constructing ships that would not accommodate itself to the taste of the constructor. By Chapman's system, when the length, breadth, depth, and the displacement are given, then the sharpness of the vessel is obdurately fixed; while by an arbitrary value of q the sharpness and ease of the lines can vary considerably, and accommodate itself to the taste of the architect.

Suppose the area, length, and breadth of the load water line of a vessel are given, which is substantially the same as if the displacement, dead flat, cross section, and length were given; then Chapman's method will produce the fixed line, say, $o\ m\ s$, Fig. 5, while the formula (3) will produce any variety of lines, as $o\ o\ s$, or $o\ e\ e\ s$, or if we wish to go to the extreme the wrong way, we can produce the line $o\ n\ n\ s$; in fact, the formula (3) can manipulate the displacement the same as one can work a lump of soft clay in his hands. What more is wanted? This is a property of my parabolic system which does not appear to have been appreciated by my correspondents on the subject; but when once fairly laid before them, I am assured they will be the first to appreciate and acknowledge its utility.

This formula (3) is not limited only to shipbuilding, but is applicable to a great variety of physical laws. It embraces all properties of heat, such as the pressure and temperature of steam, the law of dilatation, total and specific heat in matter. I prefer to use this formula for the rude and empirical mode of interpolation, and most invariably succeed in bringing it in.

ON THE ACTION OF OIL WELLS.

By PROFESSOR E. W. EVANS, MARIETTA COLLEGE.*

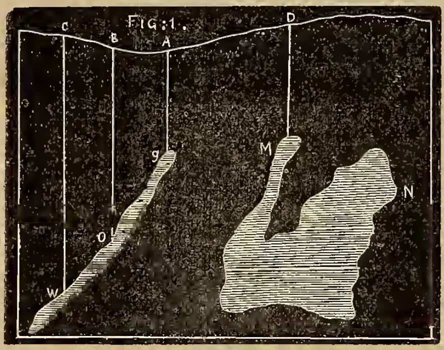
The phenomena exhibited by oil wells suggest various problems, the discussion of which may be of scientific as well as practical interest. The facts on which the following remarks are based have been collected chiefly from the history of different wells in the coal regions of Southern Ohio and West Virginia.

It seems certain that the principal supplies of petroleum are not diffused between the planes of stratification, but are collected in cavities more or less sunken in the strata, whence it is less liable to be carried away by running water. Professor E. B. Andrews has shown, that it is common to find large quantities in places where there are marks of disturbance and displacement of the rocks. The cavities have probably been caused sometimes by uplifts and sometimes by erosion and the dissolving action of

* From the American "Journal of Science and Arts."

water; but whatever may be their origin, they are not usually of great horizontal extent. It is seldom that two neighbouring wells strike oil at the same depth, whether the strata be horizontal or dipping. It is one chance out of many to strike oil at all, even in neighbourhoods where it exists in abundance. The drill, as it enters the cavity, sinks variously from four or five inches to as many feet, sometimes sticking fast, as if between the oblique sides of a narrow fissure. But there are facts connected with the history of oil wells, particularly their intermittent action and their interference with one another, which serve to show the existence, in many cases, of systems of these cavities connected together by channels of communication more or less free, running sometimes along the strata and sometimes across them. The productiveness of a well depends on its entering either one of the main reservoirs or some of its important connections.

Let us begin with the most simple case, that of a single or isolated oil cavity; of which a cross section is represented by *g w*, fig. 1. Every



collection of oil is accompanied with varying quantities of gas and water, the gas occupying of course the top of the cavity and the water the bottom, according to the order of their specific gravities. First suppose that a well is bored at A, so as to enter the gas. Being in a high state of tension the gas escapes, sometimes with explosive violence, carrying out with it whatever water there may be collected in the boring. If water enters the cavity freely, as is usually the case, the oil, floating on its surface, is soon driven upward to the mouth (*i.e.*, lower end) of the tube; it may then be pumped out till the line of division between it and the water rises to the mouth of the tube; after which, mixed oil and water will be drawn. But it often happens that the water rises faster than it can be thus exhausted, and the oil, driven into the top of the cavity, is lost, until the water is reduced by machinery of greater working power. But as it cannot be reduced below the mouth of the tube, unmixed oil cannot again be obtained from the well. In all wells from which the gas has escaped, there is ultimately a saving of work if the oil is pumped out as rapidly as possible before the intrusion of water. Secondly, suppose that the boring is at B and enters the oil. In this case, the oil rises in the tube to a height depending on the tension of the gas above it; a mode of action which is illustrated by the familiar apparatus called the fountain with condensed air. Sometimes it is thrown into the air a distance of 30ft. or 40ft., and large quantities wasted. If the oil continues to be ejected till its surface in the cavity descends to the mouth of the tube, the fact first becomes known by a gurgling and spurting action, and the gas, or the greater portion of it, escapes, after which the pump becomes necessary, and the same series of actions take place as in the first case. But if the gas reaches its equilibrium with the hydrostatic pressure before the oil is reduced so low, we may then pump out the oil till the water rises to the mouth of the tube, after which we shall obtain mixed oil and water as before, till the whole supply of oil is exhausted, provided the pump is of sufficient working power to prevent interruptions by the too rapid rise of the water.

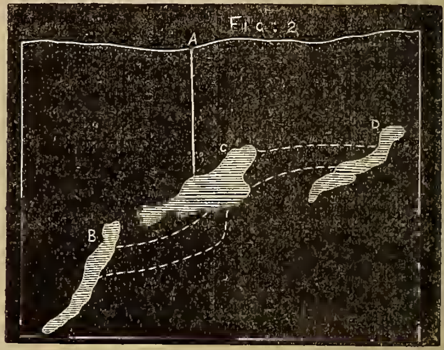
Next suppose that the boring is at C and enters the water. If the gas has sufficient tension, water is raised, until its surface in the cavity descends to the mouth of the tube, then mixed oil and water is obtained, then pure oil, after which the same circumstances exist as in the second case. It must not be inferred, however, that when the water is not thrown to the surface there is no oil. It may happen that the pressure of the gas will raise a column of water only part of the way up the boring, and yet the well be found productive. Hence no considerable quantity of water should be passed without ascertaining by reducing it with the pump whether there is oil confined above it in some side chamber. The Shattuck well on the Little Kanawha had to be drained of water with a steam pump for two weeks before oil was obtained; but after that it yielded abundantly.

Some varieties of action are to be accounted for on the supposition that there are, in the same cavity, different collections of gas separated by a partition descending from the top. Such a cavity is represented by MN, fig. 1. A well enters the gas chamber M. The gas escapes with violence, and yet the oil immediately begins to flow in a continuous stream over the top of the boring, and is perhaps projected in the form of a jet to a great height, by the pressure of the gas in another chamber N, of the same cavity.

It is evident that if a second well be sunk so as to enter the gas in the chamber N, the oil in M will immediately sink to the level of that in N, and be lost to the first well, a mode of interference which sometimes occurs, when two wells are quite near together.

Thus far have I have considered only isolated oil cavities, or those which, when exhausted, are not replenished to any considerable extent from other sources. In general these run their course in a short time, and yet they sometimes yield very large quantities of oil.

There is a second class of wells, in general more productive, which exhibit the same phenomena at first, but as often as they are exhausted are replenished again, and repeat a certain series of actions indefinitely, and with remarkable regularity of time. This is to be explained by supposing that they are connected with other reservoirs by slight channels of communication, whose capacity for replenishing is less than that of the tube for exhausting. Let C, fig. 2, be an oil cavity having connections with



two other cavities, B and D. Suppose that a well A enters the oil in C. After this well has thrown out oil, and, perhaps, afterwards water, by force of the condensed gas, it comes to a stop. Then owing to the diminished tension of the gas in the large space in C, the gas and oil in B and D force slight passages, represented by the dotted lines, into C, until the gas in this cavity again becomes sufficiently compressed to raise oil and water successively; after which the well comes to another stop until it is replenished with oil and gas as before; and the same process is repeated an indefinite number of times. The Newton well, on a branch of the Little Muskingum, a few miles from Marietta, repeats this process (with some escape of gas) at regular intervals of about half-an-hour, expelling about a barrel of oil each time. A noteworthy fact connected with this well is that when it stops it is necessary to pump out a little water in order to start it again; then the oil issues spontaneously. This is to be explained as follows. The pressure of the gas is not quite sufficient to raise the water to the surface; but the position of the mouth of the tube is such that a few strokes of the pump suffice to reduce the surface of the water in the cavity below that point. Now a column of oil will be raised by a given pressure so much higher than a column of water as its specific gravity is less. In this case it is raised not far from a fourth higher (the specific gravity of the oil being ·816); and the difference is sufficient to make it flow over the top of the tube. Examples of this kind are common.

The well in the figure is represented as having but a few connections, sufficient, perhaps, for the purpose of illustration; but it is probable that these lines of slow communication are usually numerous: the gas and oil, like the water, forcing their way in through a multitude of pores and slight crevices, until a state of equilibrium is gradually reached or approximated to, as mercury forces its way in through the pores of wood into the exhausted receiver of an air pump. Sometimes it happens that the cavity is filled with sediment of clay and sand by these little streams, and the well becomes inactive.

The class of wells here described may be distinguished from others as intermittent wells. The finding of one of these may be regarded as a certain sign that there are numbers of oil cavities near together in the same locality. Especially if it yields copiously for months in succession, as often happens, without any material diminution in quantity, or increase of the intervals between the successive yields, the rocks in its neighbourhood may be presumed to contain rich supplies of oil that may be directly reached.

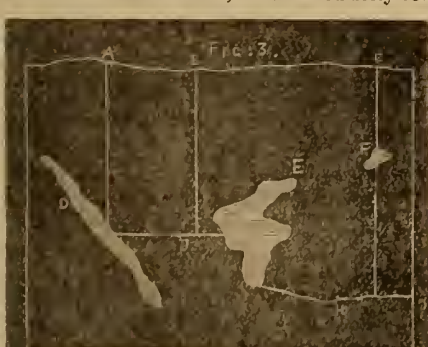
On Oil Creek in Pennsylvania the greatest quantities of oil are found in the same horizontal stratum of sandstone. It would seem that this rock is very porous, and perforated like a honeycomb with numerous cells and fissures containing petroleum. The history of many of the wells is as follows. When oil is entered, the gas begins to raise it up over the top of the boring, increasing gradually in force until it projects it into the air, often to a height of 40ft. or 50ft., then alternately diminishing and increasing in force at regular intervals, but without any cessation in the flow for a long time. These variations in the force of the gas (the "breathings of the earth," as they are called) are to be explained on the same principle as before, by supposing that as the tension of the gas is relaxed by the removal of oil, the gas and oil from other cavities around rush in through the pores and slight fissures till a certain maximum tension is reached, and the influx ceases; then by the expansion of the gas already in the chamber the oil continues to come up, but with a diminishing flow, until a relative vacuum is again created; after which the influx is renewed and gradually increases as at the beginning. These regular alternations vary in different wells from two or three times a day to as many times an hour; the intervals, however, gradually increasing in length as the supply of oil is diminished, unless, as sometimes happens, new communications are forced, and the well, deriving new supplies, starts off again with a new period. It often happens that the same well has two periods—one of variation in the flow, and another of cessation, consequent on the escape of gas.

A more uniform flow may be secured by making the orifice at the mouth of the tube smaller. This is often desirable in order to prevent the escape of gas by the exhaustion of the oil in the cavity down to the bottom of the boring. Sometimes such a quantity will thus rush out, before the oil raised up by the water closes the passage again, as not only to render the pump necessary after that to raise oil, but also to diminish materially the influx of oil from other cavities by reducing the pressure of the gas in them. Another expedient sometimes resorted to, when the spontaneous flow of oil becomes slight, is to stop up the boring till another "head of gas," as it is called, accumulates. But the stoppage should not be continued long; for instances are known where the gas has in consequence forced a way from its new channels in other directions, and found vent in other wells.

It is not an uncommon thing for intermittent wells to throw out at first 300 or 400 barrels a day, or to yield in all as much as 20,000 barrels. They sometimes run two or three years before exhaustion. The productiveness of the Lewellyn well on the Little Kanawha greatly exceeded these figures.

It is evident that if a second well were sunk so as to enter the cavity B or D, fig. 2, the well C would lose one portion of its supply of gas and oil, and be to this extent interfered with. Sometimes a very productive well thus cuts off the main supplies of a number of less considerable ones in its neighbourhood, or, if the first sunk, it is itself tapped by them.

But some of the most marked cases of interference that are known, show the existence of a third class of oil cavities, connected with one another by perfectly free channels of communication, so that when the equilibrium between them is disturbed, it is immediately restored. Fig. 3



will serve to illustrate. A well, A, enters the cavity D, finding oil. Another well B is bored so as to enter an open channel *g* between the two cavities D and E. This will drain oil from A; but if, as in the figure, its mouth is lower than that of A, it can be made a valuable auxiliary to it when the rising water drives the oil into the upper part of the cavity; for it can be used to reduce the water, and thus to keep the oil within reach of A.

Again, a third well C is bored, and passes through a strong current of water, a cross section of which is represented by F. It finally descends to a fissure H, which communicates freely with E, and consequently also with D, and interferes with both the other wells by letting in such a head of water as to drive the oil in both cavities above the mouths of the tubes. Pumping the water out of all these simultaneously might bring the oil down again within reach of that tube at least which enters at the highest point. A better expedient is to stop up tightly the space on the outside of the tube in the well C, just below the stream of water F. This is often effected by lowering a leather bag filled with dry seeds to the required depth. As water penetrates it, the seeds swell and close the passage.

On the Little Muskingum there are four or five wells (from 100ft. to 200ft. apart), so connected together as to illustrate both modes of interference shown by fig. 3. Had the well B entered the gas in E, it would have interfered with A by causing the escape of this gas; a case analogous to that mentioned before, where there were supposed to be two gas chambers in the top of the same cavity. After this the irruption of the water from C would have temporarily assisted B by raising the oil in E to the mouth of the tube.

Examples differing in details might be multiplied indefinitely. I have aimed only to point out in a general manner the different modes of action, and the hypotheses on which they are to be explained.

In the foregoing illustrations the quantity of gas has been supposed considerable. In many cases, however, it is so slight that the pump has to be used throughout. Yet wells of this kind often partake of the intermittent character to some extent. As it is not usual to work them at night, they begin each day with a new accumulation, which gives them a certain regularity of daily action often considered mysterious. There is a well a few miles from Marietta which yields oil only for a short time in the morning; when neglected till that time is passed, it is unproductive for the day. This is owing to the proximity of another well, which drains it of its water in the daytime, but by resting at night allows it to be replenished. Wells of small supply often require a certain interval of rest to be replenished, but never exceed a certain amount, however that interval may be extended—the column of oil having reached its maximum height by pneumatic or hydrostatic pressure.

Oil wells commonly vary in depth from 100ft. to 800ft. The deepest are as apt to raise oil to the surface as the shallowest. This indicates a greater compression of the gas at the greater depth, owing doubtless to its connection with higher columns of water. The activity of some wells is increased by rains; others, with less gas, are rendered unproductive till the water can be reduced. It must not be assumed, however, that their connection with subterranean currents is immediate and unobstructed. I know of no instance where there is reason to suppose that the oil is raised to the surface by the direct pressure of a stream of water whose head is higher than the issue, as the jets of Artesian wells are said to be produced. In spouting wells, the presence of gas as the immediate agent becomes known, not only from their variable action, but also from the actual escape of gas, and consequent cessation of flow whenever the oil is reduced to a certain level. If collections of oil had direct and free connection with strong currents of water, the mechanical agency of these currents would bear them rapidly away.

As it is, minute quantities come to the surface with the springs, showing a very slow process of drainage. As an index of the location of oil cavities this sign is not reliable; for that which issues may have been carried by the streamlets many miles from its source. Gas springs are less deceptive signs; for the gas being more buoyant than the oil, and not liable to be carried along by descending currents, is not likely to wander so far before it issues. But the "show of oil" increases in value as a sign with the depth at which it is found. Especially is the finding of large quantities of imprisoned gas, though no oil may be present, regarded as a good indication that there is oil near.

THE CONNECTION AND WORKING OF RAILWAY CARRIAGES, &c.

Railway accidents and their prevention is a subject upon which much attention is now deservedly concentrated; and we find that many simple and efficient plans are being submitted to meet the various circumstances under which railway accidents take place. Amongst some of the causes may be mentioned the breaking of railway wheels or axles, and the cases where the engine, or engine and tender, with the carriages, leaves the rails. With a view to provide for such contingencies, Mr. Chamberlayne, of Cranbury Park, near Winchester, has invented the following contrivances:—

CHAMBERLAYNE'S IMPROVEMENTS IN THE CONSTRUCTION AND MODE OF CONNECTING AND WORKING RAILWAY CARRIAGES, TRUCKS, AND WAGGONS.

The object of this contrivance is to construct the buffing parts of a railway carriage or truck, so that whilst the necessary amount of elasticity or yielding action is obtained, a means of supporting the end of one carriage is also provided; so that in case of a wheel, or one or more pairs of wheels, or one or more of the axles breaking, such carriage or truck would be supported, and the passengers or goods remain uninjured. This is effected in the following manner:—At both ends of each carriage or truck one male and one female projecting piece or continuation of the buffing bar are provided, th two male projections being at the diagonal corners, and the two femal projections at the other diagonal corners of each carriage or truck, so tha when any carriage similarly fitted is brought up to it for the purpose o being coupled to form part of a train, the male projection of one carriage fits into the female projection of the next carriage, irrespective of which end of the carriage is presented for that purpose; and both the male and female projections being compressible, or sliding in and out under increased pressure, the requisite yielding amount of buffing, or ability of receiving concussion, is afforded, whilst the extent to which the male projection enters into the female portion of the apparatus enables any carriage which may break down to be supported between the preceding and following carriage of the train, the male and female projections being formed of sufficient strength for that purpose. The spring may either be a spiral spring placed before or behind the end frame-piece of the carriage, and be directly acted upon; or may be elliptic, flat, or of any other form, placed in any convenient position within the under carriage or frame, and be operated upon by means of a rod.

The buffer rods of the buffing apparatus, in accordance with this invention, may, instead of being formed solid, be made hollow, and serve as tubes through which may be led signal wires, or rods, or other means of communicating between the guard or guards and engine driver, or the passengers and engine driver, or the passengers and guards. (Figs. 3 and 4.)

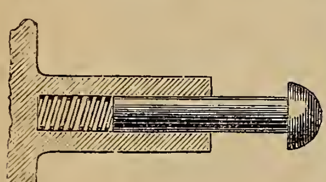


FIG: 2.

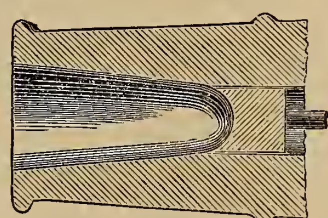


FIG: 1.

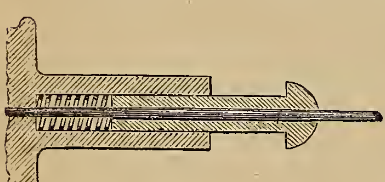


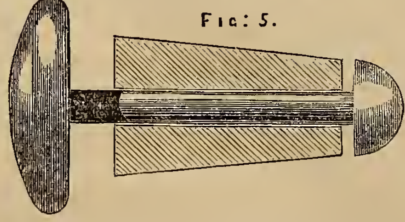
FIG: 3.


FIG: 4.

Fig. 1 is a horizontal section of the female buffer head, or projection from the buffer board, or end frame of the carriage. Fig. 2 is a horizontal section of a form of male buffer, which may be of wrought iron, and securely bolted to the end frame or buffer board of the carriage, having a buffer pin of wrought iron or steel, and a spiral spring introduced in the hollow cylinder behind the buffer pin or piston; and, although the end of the cylinder of the main buffer head is here shown as closed, and a short spiral spring applied, yet the buffer pin may pass through the male buffer head, and an elliptic or other spring may be applied behind the buffer, or within the under carriage or frame.

For the purpose of adapting carriages fitted with this kind of buffer to be coupled and run in combination with carriages fitted with the ordinary buffers, conical plugs are inserted into the hollow of the female buffer heads of one of the forms shown in Figs. 5 and 7. In the former figure the cavity of the buffer head is fitted tight with a conical plugpiece, bored through the line of its longitudinal axis to allow of the buffer pin playing there-through, the outer end of this pin being fitted with a buffer similar

FIG: 5.



to the ordinary buffers, the inner end of the pin being acted upon by a spring, as before described. In Fig. 7 the plug is shown as being a solid wood plug, free to move backwards and forwards in the cavity, whilst it is made sufficiently long to project and come in contact with the ordinary buffer head of the next carriage; and for adapting the male buffer head, the buffer pin or piston is withdrawn and replaced by a pin or piston having at its outer extremity, as shown in Fig. 6, a buffer head, or buffing piece, similar to those in ordinary use.

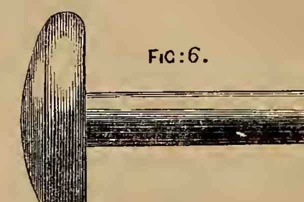


FIG: 6.

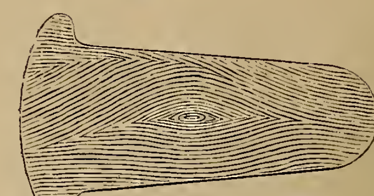
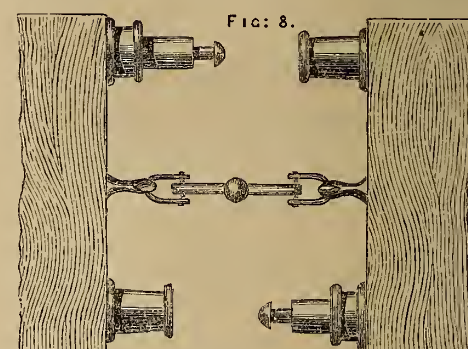


FIG: 7.

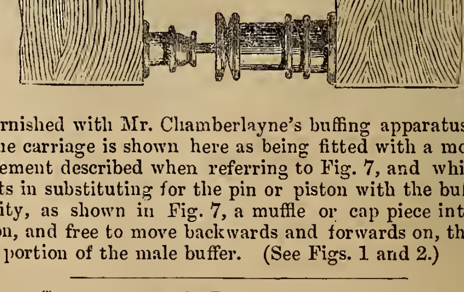
Fig. 8 is a plan view in outline, and to a reduced scale, of the lower body or frame of a portion of two railway carriages or waggons fitted with buffers according to this invention, but which are not coupled up close;

FIG: 8.



and Fig. 9 shows a portion of a third railway carriage, fitted with buffers of the ordinary description. This figure is intended to illustrate the way in which carriages fitted with the ordinary buffing arrangement are adapted

FIG: 9.



to those furnished with Mr. Chamberlayne's buffing apparatus. The male buffer of one carriage is shown here as being fitted with a modification of the arrangement described when referring to Fig. 7, and which modification consists in substituting for the pin or piston with the buffing piece at its extremity, as shown in Fig. 7, a muffle or cap piece intended to be placed upon, and free to move backwards and forwards on, the projecting cylindrical portion of the male buffer. (See Figs. 1 and 2.)

Chamberlayne's Railway Safety Hooks.

The object of this invention is to enable carriages composing a railway train, or the engine and carriages to become detached, when from any accidental cause the engine or any of the carriages leave the rails and endanger the safety of the remainder of the carriages and their passengers or contents. For the ordinary form of hook, as employed for connecting the side chains and screw couplings, the inventor substitutes an L shaped hook, having a hinged piece, or moveable point, held in its position of rest by a hinged spring, clip piece, or stop. The hook is fitted with a link of flat section and suitable width, which will rest securely within the L hook, if pulled and drawn in a straight line, or within certain limits of angular divergence. The moveable point, forming the third side of the hook, is held securely in its place, and cannot be opened by the vibration or motion of the link within the hook, nor otherwise than by the disengagement of the stopper from the point thereof, forcibly, either by hand or by the line of draught, or pull upon the link being changed from the right line to an angular direction to the right or left as the case may be. The divergence from the straight line of draught requisite for the purpose of opening the point of the hook will be in the direction of the point of the hook; this will cause the inner edge of one side of the link to come in contact with the back part of the hook, whilst the outer edge of the opposite side of the link presses against, in a corresponding degree, and opens or disengages, the spring stop piece from the end of the hinged point of the hook, which is pressed open or forced back by the inner side or edge of the link, and thus the link, being set free from the hook, is drawn therefrom, and the connection between the carriages severed by the obliquity of the draught; the width of the link forming the one end of a right angled lever, the length of the link forming the other; the inner edge of one side of the link being the fulcrum, whilst the outer edge of the opposite side, the point of the lever. In attaching or hooking on the links, they are passed over the hinged point of the hook, which are thereupon turned up or made to form the third side thereof; and, thereupon, for the purpose of securing it in its place, the moveable stop piece is brought on to the point, and the spring is made to maintain it in its proper position.

Instead, however, of a single L hook, a double L hook, made in one piece, may be employed; and instead of the spring stop or stopper pieces being acted upon by a flat link, a T headed connecting bolt or an intermediate link with a T head may be substituted; and the facility of effecting the disengagement by either a right or left hand movement, instead of by a movement in one of those directions only, may thus be secured.

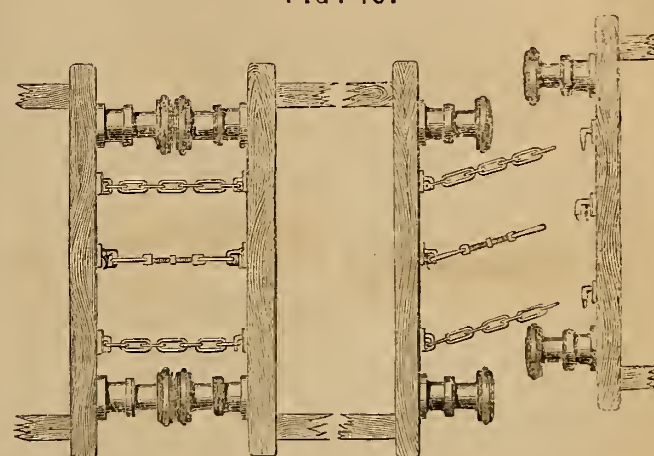
In applying hooks and coupling links to the ends of railway carriages, they may either be welded on to the ends of the draw-bars, or may be attached thereto by a cotter, pin or key; in which case the hooks may be made to reverse from right to left, or left to right, for the convenience of arranging the proper coupling up of the carriages, and to prevent the necessity for their being turned round or reversed.

Figs. 1 and 2 are longitudinal views and cross sections of two descriptions of the L hook, with the flat link shown broken; Fig. 3 shows a similar kind of hook, in which the hinged spring is dispensed with. In Fig. 4 the stop piece and hinged spring are shown in a horizontal instead of vertical position. Fig. 5 represents an elevation and plan of the flat coupling link. Figs. 6, 7, and 8 are front and side elevations and plan of an arrangement, in which a T hook, with stopping pieces, is substituted for the L hook.

In all these figures, the hooks are shown as secured by plates, and incapable of having their position changed without unscrewing or unbolting them from the end frame or buffer board. Instead of this arrangement, the shank may be formed square, and be fitted so as to slide in the plate to a limited extent, to enable the direction of the hook to be reversed, if necessary. Such a mode of reversing a single L hook is shown in Fig. 9, being a plan view and cross section of a reversible hook.

Fig. 10 exhibits a skeleton plan view of the extremities of portions of three carriages fitted with some of the forms of coupling apparatus illustrated in the engravings given below. The foremost and the middle carriages are shown as being in line, while the third following is supposed to be in the position it would assume when from any accidental cause it has

Fig. 10.



been thrown off the rails. These views are, of course, somewhat exaggerated, for the purpose of showing the action more thoroughly; but the parts of the coupling apparatus should be so proportioned and arranged that the departure of any one carriage so coupled from the rails to the extent of the flanges of the wheels passing from the inner to the outer edge of the rail, or a distance equal thereto, may be sufficient to disengage that carriage from the next adjoining.

Fig. 1.

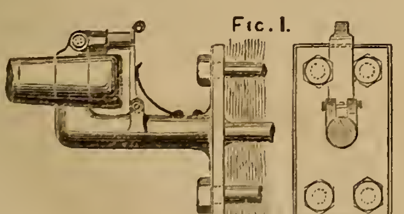


Fig. 6.

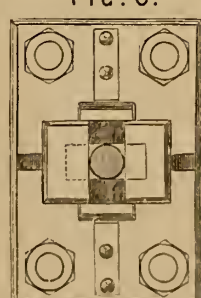


Fig. 7. Fig. 4.

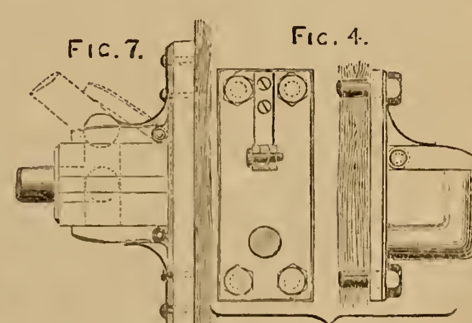


Fig. 2.

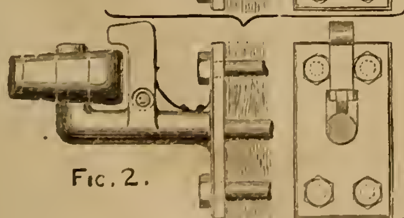


Fig. 8.

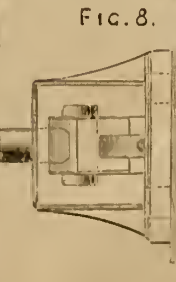


Fig. 9

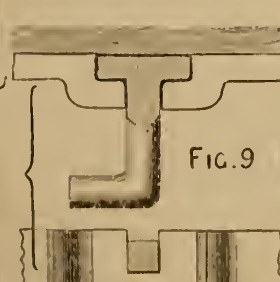
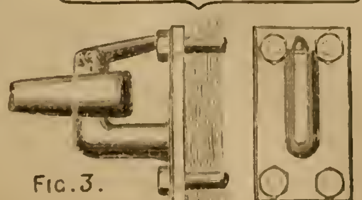


Fig. 3.



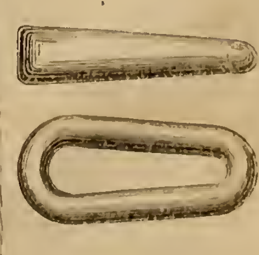


Fig. 5.

INSTITUTION OF CIVIL ENGINEERS.

ON THE DECAY OF MATERIALS IN TROPICAL CLIMATES.

By Mr. William J. W. Heath, Assoc. Inst. C.E.

During a residence in Ceylon, extending over a period of seven years, while engaged on the railway, Mr. Heath's attention had been directed to those materials which were most used in the construction of permanent buildings. The habitations of the lower class of natives were formed of a rude framework of stout bamboos, the sides and roof consisting of reeds, closed in with the interwoven leaves of the cocoa-nut palm, the latter being washed over with the slimy juice of a native fruit, which, when dry, resembled copal varnish. In the huts built of "wattle and dab," the framework was made of roughly squared jungle trees, the space between being filled, and both the inside and the outside of the hut being covered, with clay and sand well kneaded, afterwards plastered over with earth thrown up by the white ants, mixed with a powerful binding substance produced by the ants. Superior houses were built of "cabook," a soft kind of rock, found at a few feet below the surface. This material had the appearance of a coarse sponge, the interstices being filled with soft clay. Before being used the blocks should be exposed to the rain, to allow some of the clay to be washed out. Cabook required to be protected from the weather, but if covered with a thin coating of lime plaster, it would last for years. Hard kinds of stone were not much used, owing to the expense of working them; and rubble masonry was not approved, as there was difficulty in obtaining even beds and good bond. Bricks as a rule were so badly burnt, and the clay was so badly pugged, that brickwork in exposed situations and unprotected would perish very rapidly. It was advisable that it should in all cases be well plastered with lime mortar. Two or three coats of boiled linseed oil would preserve brickwork without hiding it, but the expense prevented its general use. Coal tar was an excellent preservative, but on account of its unsightly appearance it could not be often employed. Lime was generally made by calcining white coral. When taken from the kiln it was in a fine white powder, fit for immediate use, after being mixed with twice its own bulk of sand and water. It set so rapidly that, in the Public Works Department, it was the practice to keep the lime under water for two days before using it. This had the effect of making it longer in setting, but it was more easily worked, and eventually made better work, equal, in fact, to the best blue lias lime. Well-seasoned timber, with free ventilation, would endure for many years, if the white ants were kept away, without any precautions being taken to preserve it. In exposed situations, and where subject to the attacks of the white ant, Stockholm tar was the best preservative; while creosoted timber was free from their ravages. In sea water, and even in fresh water lakes and canals, timber was speedily attacked by worms, notwithstanding that it might be painted, oiled, or tarred.

Iron exposed to the influence of the varying weather speedily oxidised, but oil, applied hot, was a good preventive. Coal tar was, however, the best covering, applied either cold or hot, or before or after oxidation had commenced. Ordinary galvanised sheet iron did not last many years, unless protected with good red lead paint, frequently renewed; but zinc would last for many years, with little or no decay.

In the course of the discussion it was stated that, on the Great Indian Peninsula Railway, Baltic sleepers, both creosoted and Kyanised, and native jungle wood sleepers, had been used; but after thirteen years' experience, those which had failed were being replaced with teak and iron sleepers. The native woods were so hard and close grained, that they could not be impregnated with any preservative substance. The keys were a source of great trouble in warm and variable climates. Those of wood had not been found efficient in India, and endeavours were now being made to devise a substitute. Ironwork of all kinds should be thoroughly cleansed, dried by heat, and then dipped in hot linseed oil, before being exported from this country.

It was contended that it was impossible to predicate what timber would sustain, for while yellow pine had been known to last sound, as railway sleepers, for twenty-five years, in other cases it had decayed in five or six years. This frequently happened also with hard tropical woods, without there being any apparently assignable cause for this difference in the rate of decay. Hence, in the tropics, iron was nearly the only material that could be employed, especially for sleepers, with anything like certainty as to the results. No doubt iron made a rigid permanent way, unsuitable for the high speeds common in this country, although possibly this might be partially obviated, by a more perfect manner of securing the rails on the sleepers; but in tropical climates the use of iron was almost a necessity, and there a speed of from 25 to 30 miles per hour was a maximum. Greaves's cast-iron bowl sleepers had been laid for eighteen years on the Egyptian railway, and made a good and substantial road. The objection that they were liable to break, particularly along the centre line, might be met by making them stronger; and it was remarked that on the Dom Pedro Segundo Railway, Rio Janeiro, the bowl sleepers had been in use for eleven years, and only one sleeper per mile had required to be renewed.

On the East India line, of more than 1,000 miles in length, the sleepers were principally of sâl timber, but there were others of creosoted fir and of iron. Although there were many different kinds of suitable native woods, there was difficulty in obtaining large quantities of any other than sâl, which, when cut out of large timber and well seasoned, was very durable. Recently, in opening a part of the line near Calcutta, sâl sleepers had been found in a good state of preservation after having been laid twelve years. In other parts of the line, creosoted sleepers were in a serviceable condition after being in use ten years. Teak was, perhaps, the best of all Indian woods, but the cost precluded its use for sleepers, as it would amount to fifteen shillings per sleeper. Flat iron sleepers had been unsuccessful, but cast-iron bowl sleepers seemed to promise better results, although at present they had not been sufficiently long in use to enable a definite opinion to be pronounced. The breakage, so far, had been serious, amounting to about 20 per cent., but this might be obviated in future by making them stronger, as had been suggested. The use of iron was desirable, on account of the difficulty of obtaining large supplies of timber sleepers, and the uncertainty as to their quality.

Although the decay of materials in Ceylon was unquestionably influenced by the alternating effects of heat and moisture, yet it was believed to be principally due to the use of inferior materials. In the upper districts of India, there were brick and stone buildings of great antiquity, in fact anterior to historic periods. Sâl timber was hard, durable, and abundant in the central forests, and along the base of the Himalayas, and had been generally employed by the Public Works Department; but owing to the great demand of late years, it was now hardly possible to obtain it well seasoned. Teak was also becoming scarce: that which grew in the province of Burmah was of large size and very useful for shipbuilding; while when cultivated in a drier range and upon rocky ground, it was as hard as ebony, or iron wood, though of small scantling and of crooked form.

It was noticed as remarkable, that the observations in one Paper were repeated in the other, and that the means of preservation which had been suggested as applicable in Brazil, were likewise recommended for Ceylon. There were, however, some points of difference—especially as to the use of galvanised iron. The author of the first communication, speaking apparently from opinion rather than from experience, advised its use, while the author of the second, on the contrary, thought that galvanising alone, without painting or tarring, was not adequate to protect iron in such climates. As corroborative of the remark, that the loss of weight in iron from oxidation was less in Ceylon than in England, in an equal period of time, it was mentioned that out of a quantity of rails, which had been manufactured at the same time and at the same place, some were lying for many months unused in Ceylon, and others in South Wales, when the loss of weight by rust was found to be largely in excess at the latter place. Where there was great heat, combined with excessive moisture, it was imagined that the effect upon materials, particularly timber, could not be otherwise than serious. While, in the first instance, it might be prudent to import timber artificially prepared, owing to the absence of available data as to the character of the native materials, yet it was believed, as the qualities of the different kinds of native woods became better known, as well as the proper time to fell them, and to prepare them by shed-drying, or otherwise, and as a more ready access was obtained to the forests, native woods might ultimately be used with advantage and economy. In fact, a specimen of native Brazilian wood had been exhibited, which had endured for two hundred and fifty years. The alleged excessive wear of the rails and tires in Pernambuco must be explained upon other grounds than the heat. Perhaps the fact that the rails were not "fished" until after a portion of the line had been opened for traffic, that there were considerable curves on the line, and that the road was not laid in that perfect manner which was possible in this country, added to the great atmospheric alternations, might be sufficient to account for it.

It was remarked that, in using unprepared wood, no doubt it was desirable to select that part which was hard, as the pores being filled with ligneous matter, such timber did not so freely absorb moisture. But for creosoting purposes the reverse was the case, for it was impossible to make heart wood absorb 10lbs. of oil per cubic foot, as was sometimes required. The great value of creosoting was that it enabled young wood to be used, as then the pores being filled with a bituminous asphaltic mastic, the wood so treated was perfectly waterproof, and harder than heart wood. The reason why the half-round sleepers on the Pernambuco line were more durable than those of square form, was believed to be due to all the young wood being retained in the former. Recent experiments in the harbour of Ostend showed that wood prepared with corrosive sublimate, or with sulphate of zinc or copper, was only partially protected against the worm, but when creosoted the worm would not touch it. It was advisable that piles in sea water should not be squared, but used round, with as much young wood as possible.

Respecting the ravages of the white ant, there were many structures in Brazil not so affected; and as regarded railway sleepers, the frequent shaking and vibration would, it was considered, render them tolerably safe. In that country porous and open-grained timber seemed most subject to these attacks; but in Australia the hardest kinds were first attacked. This was especially the case with iron-bark timber, the density of which was so great as to cause it to sink in water, and in tenacity and resistance to strain it approached rough cast iron. White ants were effectually destroyed by oil of creosote, and anything of a bitter taste injected into the fibre, or even a small quantity of turpentine, would prevent their attacks. In some parts of India white ants were very destructive, and 10 per cent. of some stacks of sleepers had been decayed at the heart in from six to eight months. The black ants of the West Indies were also more destructive in hard than in soft wood. Some descriptions of wood there were neither affected by the teredo navalis, nor by the black ant, and when used for piles had never been known to decay.

With regard to stone, it had been found that the application of linseed oil not only acted as a preservative, but it rendered soft stone in the course of a short time very hard. In Jamaica the bricks were well made, and of good materials; and some buildings there had stood from time immemorial, without exhibiting any signs of decay. Mortar, both there and at the Cape, was made of shell lime, and even when mixed with sea sand it was hard and durable. In India, the addition to the lime of about 5 per cent. of jaggery, coarse native sugar, caused the mortar to set well, and to be very durable. At the Cape the bricks were not good, and owing to the exudation of phosphate of soda after the work was finished, it was advisable to plaster all brickwork. In India the telegraph posts were, to a large extent, of stone obtained from Agra, and the rapid decay of timber, when used for that purpose, had greatly retarded telegraphic extension in that country. The difficulty was now being met, by making the lower part of the posts of iron, into which wooden posts were inserted.

Respecting the statement, that the only examples of iron bridges in the province of Pernambuco were those belonging to the railway, and that of St.

Isabel, completed in 1863, it was remarked that, about twenty years ago, a French engineer, M. Vauthier, when Engineer-in-chief to the province, designed and erected a suspension bridge on one of the main roads, about nine miles from the city, across the River Capibaribe, at the village of Caxangá. The roadway, which was 100ft. long by 20ft. wide, was suspended from a pair of iron wire ropes on each side of the bridge, by vertical rods of wrought iron, the attachment of the rods to the ropes being by means of strong wrought iron plates, embracing both ropes. Each rope was in four separate pieces, and consisted of a mass of wires simply laid together, and bound at intervals. The rocking standards were of cast iron, in three pieces, and the platform was of wood. All the work was executed in the country, including the casting of the standards, but the wire was purchased in England. The ropes, as well as the cast and wrought iron work, were still sound. The cost had amounted to between £5,000 and £6,000.

DESCRIPTION OF THE GREAT GRIMSBY (ROYAL) DOCKS; WITH A DETAILED ACCOUNT OF THE ENCLOSED LAND, ENTRANCE LOCK, DOCK WALLS, &c.

By Mr. E. H. Clark.

The author stated that the old dock, formed from a natural creek, measuring in extent about 19 acres, was comparatively useless, by its shallowness, and by the narrowness of the entrance channel. When the means of carrying out an extensive water commerce at the port of Grimsby were contemplated, the Manchester, Sheffield, and Lincolnshire Railway Company, who had become the proprietors of the Old Haven and Dock, presented an extensive project to Parliament, designed by the late Mr. J. M. Rendel (Past President Inst. C.E.), which was sanctioned in the year 1845, and had since been completed. It comprised the formation of an entirely new dock, the entrances of which lay beyond the limits of low water, the new works being advanced into the River Humber for a distance of three-quarters of a mile, and embracing an enclosure of 138 acres of land reclaimed from the river. The works of this enclosure were commenced in the spring of 1846. They comprehended the construction of wharves, embankments, and a cofferdam, together nearly 1½ mile in length. The cofferdam was remarkable for its magnitude, exposed position, and independent stability. Considerable difficulties were encountered in several places in obtaining a firm foundation for the wharves and embankments: but these were successfully overcome through the exertions of the late Mr. Adam Smith (M. Inst. C. E.), the Resident Engineer, principally by loading the soft ground with chalk stone. The enclosure was completed by the end of the year 1848, when the interior works were commenced. These comprised the construction of a dock of 25 acres, with a depth of 6ft. at low water, and of 25ft. 6in. at high water, ordinary spring tides; of two entrance locks to the dock, the larger one being 300ft. in length between the pen gates, and 70ft. in width, and the smaller one 200ft. in length by 45ft. in width; and of a tidal basin of 13 acres, enclosed by timber piers, with an entrance 260ft. in width. There were also extensive timber ponds, a graving dock with a width of entrance of 70ft., and on the quays, which were 3,600ft. in length, transit sheds and bonding warehouses, granaries and cotton sheds, cattle pens and coal spouts, with a railway passenger station, and branch railways through the warehouses, besides a small dock, for fishing craft, 6 acres in extent, and having an entrance 20ft. in width, with the usual appurtenances connected with that trade.

The contractors for the cofferdam were Messrs. Linn, of Liverpool, and for the dock works, Messrs. Hutchings, Brown, and Wright.

The cofferdam* was 1,500ft. in length, and consisted of two circular arcs, with a straight return on the west side, the versed sine of the curved portion being one-fifth of the span. It was situated where the average velocity of the River Humber was 5 miles per hour, and the rise of tide was 25ft. There were three parallel rows of whole timber sheet piles, of Memel fir, averaging 60ft., 47ft., and 37ft. in length respectively. The piles were driven in bays of 10ft., and there was a space of 7ft. between the outer and the middle rows, and of 6ft. between the middle and the inner rows. Clay puddle was filled in between the rows. The tie bolts connecting the rows of piles were arranged so as to break joint, to prevent a run of water directly through the dam. The chief novelty was, however, in the counterforts, or supports, placed at intervals of 25ft. along the whole length of the dam, and extending for 18ft. in depth, so as virtually to give the cofferdam a base of 32ft. in width. The counterforts were composed of whole timber sheet piles, and were firmly attached to the dam, by wales and struts. The total quantity of timber used in the dam amounted to 709,000 cubic feet, and its construction occupied two years and a half.

The wharf extended from the old dock entrance to the west end of the cofferdam, a length of 2,431ft. and from the east end of the cofferdam eastward from a length of 1,208ft., where it was joined by an embankment 1,800ft. in length. The wharf was constructed of a single row of whole timber sheet piles, with a dry rubble wall of chalk stone at the back, in the centre of which there was a puddle wall.

The embankment was composed of the stiff clay thrown up from the foreshore, and was faced with chalk stone on the seaward side, which had a slope of 5 to 1, while on the inland side the slope was 2 to 1.

The two entrance locks were separated by a pier of Masonry 70ft. in width. Each lock was provided with two pairs of pen gates and one pair of flood gates. The ground over the whole area of the locks, centre pier, and wing walls, was excavated to a depth of 8ft. below the cill of the larger lock, and bearing piles were driven in rows, 5ft. apart from centre to centre, and in some places 4ft. apart from centre to centre, over this area. A pile was considered to be sufficiently driven, when it did not move more than one quarter of an inch with a blow of a ram weighing 1 ton, and falling through 12ft. The heads of the piles were then cut to a uniform level, the ground was removed to a depth of 2ft. below this level, and this space was filled up with concrete. Whole timbers, so connected as to form continuous ties across the locks and centre pier, were then laid transversely, in parallel rows, on the bearing piles. Other similar timbers were laid at right angles to the transverse bearers, concrete being filled into the upper surface of these longitudinal bearers, which were then covered with planking, to serve as a bed for the masonry. Upwards of 254,000 cubic feet of timber, in addition to the sheet piles, were thus employed.

The masonry of the pointing cells, gate tables, inverts, aprons, platforms, square quoins and culverts, were of Bramley Fall stone; the hollow quoins were of stone from the Calverley Wood quarries; while the backing to the walls was of chalk stone, hammer dressed, laid in regular courses, and well bonded with the ashlar. The inverts and platforms for the gates were wholly of stone; the cills were straight, and the joints of the Masonry radiated horizontally and vertically, corresponding to the radius of the inverts. There were three main culverts, one in the centre pier and one in each wall of the larger and smaller locks, communicating with the dock, with branches and outlets to these culverts, for filling and emptying the locks, for scouring the entrance channel, and for clearing the gate tables.

From the treacherous nature of the ground on the site of the proposed dock walls, and from the necessity of obtaining good foundations for the granaries and transit sheds, Mr. Rendel decided to form the walls of piers, varying from 40ft. to 80ft. in length, and generally about 6ft. thick, built of chalk rubble masonry, faced with ashlar, the space between the piers being arched over with brickwork. The backing of the walls consisted of a slope from the back part of the arch to the dock bottom, with a batter of 2½ to 1, composed of puddled clay, faced with rough chalk stone.

Blue lias lime, from Lyme Regis, was used in the preparation of the mortar. It cost, delivered at Grimsby, 10*s.* 6*d.* per ton. The mortar was of two kinds' the proportions of that employed for pointing and facework were, ten parts of slacked lime, eight parts of screened sand, one part of forge ashes, and one part of pozzuolana. The other, used chiefly for the backing of walls and buildings, was composed of sixteen parts of slacked lime, twenty parts of screened sand, three parts of forge ashes, and one part of pozzuolana. The cost of the former was about 16*s.*, and of the latter about 12*s.* per cubic yard.

The gates were of timber, chiefly of oak from the Black Forest, but teak and mahogany had been used. They were regular trussed girders, each pair of bars being trussed by wrought iron straining rods. Each leaf of the gates for the 70ft. locks weighed about 75 tons, and when completed, in 1850, they were considered to be the largest timber lock gates ever made. It having been found on trial, when the large gates were being erected, that the ordinary roller, fixed on the outside, was out of the vertical plane passing through the centre of gravity of the gate, causing the gate when moved to twist considerably, it was determined to have two rollers, one on each side of the gate, but both to travel on the same path. The inner one was necessarily of smaller diameter than the outside one, and a cast iron box was provided for the inside roller to fall into, when the gates were closed. There was a false door at the back of this box, and when any hard substance was forced against this door, a bar at the back was broken. During the twelve years these rollers had been in use, these bars had only required to be replaced about twelve times in the three pairs of gates. The gudgeon, on which the heel posts of the gates revolved, was of solid cast iron, and the cup which fitted into the horn of the heel post was of the same material, but in the top of the cup there was a piece of brass of a converse shape. The pointing cills of the gates were straight, and corresponded with the bottom bars of the gates. They were protected by cast iron face-plates, jointed and planed so as to form a perfectly water-tight joint. The cost of a pair of gates for the larger lock, 70ft. wide, was £2,300, exclusive of the machinery for working them. This was the first instance of the application of Sir W. G. Armstrong's hydraulic machinery for opening and closing lock gates, and its cost for the six pairs of gates in both locks was about £4,000, including foundations and cast iron pits for the chains to work in. Two men only were required to work the gates of both locks, which could be opened in two minutes and a half, and the machinery, which had now been in use for ten years, had required very few repairs, and had answered admirably.

The piers forming the boundaries of the tidal basin were of open timber work, constructed in bays of piles in clusters, each bay being 25ft. apart. The whole of the timber had been thoroughly creosoted, at the rate of 15 gallons of oil per load of timber. The channel from the mouth of the basin to the entrance locks averaged 260ft. in width, and was kept to the level of the lock cills by frequent scouring, and by occasional dredging. Immediately outside the tidal piers the channel was 3ft. below the level of the larger lock cills, and the scour of the tides past the pier heads had gradually deepened the channel, since the construction of the dock works, from 3ft. to 4ft. In addition to the means provided for sluicing the silty deposit from the channel of the tidal basin, the back water from the country, which originally flowed into the old dock channel, was now diverted into the tidal basin.

A graving dock had been constructed since the opening of the new docks, with a width of entrance of 70ft., the cill being laid at the level of 6ft. above the cill of the larger rock, giving an average depth of water of 19ft. 6in. The length of the dock for keel was 350ft., the width of the floor was 52ft., and at the level of the coping 96ft., tapering to 84ft. at the ends. The area of the dock was surrounded by a row of Memel fir sheet piles; and rows of piles were driven in the centre line of the dock, to support the weight of the ships when blocked. The ground within this area was removed to a depth of 6ft., and was replaced by concrete. The inverts and gate tables were of Bramley Fall stone, and the joints were radiated both vertically and horizontally. The floor was curved, instead of concave or flat, as was the usual plan; thus giving greater space for the workmen, and allowing of better ventilation round the sides of the vessel. The sides of the dock were in nine steps, each step being 3ft. in height, with a

* A "Description of the Cofferdam at Great Grimsby," by C. Neate, M. Inst. C.E., is given in the Minutes of Proceedings, Inst. C.E., vol. ix., page 1.

width of tread of 3ft. The graving dock was supplied with water direct from the Royal dock, and was drained to the level of low water into the tideway; but as the floor of the dock was 3ft. below the level of low water of ordinary spring tides, a depth of water of from 3ft. to 4ft. had to be removed by pumping. This was effected by a centrifugal pump, supplied by Messrs. Simpson, fixed in a well adjoining the dock, and its cost complete, including pipes and erection, was £413. These pumps were deemed to be very suitable for the drainage of graving docks, as they were not liable to become choked, like valve pumps, from the chips and rubbish which found their way into the well. The gates were of oak timber, and were similar to those of the locks, 70ft. wide. They were, however, worked by powerful double-purchase crabs, instead of by hydraulic machinery, as, being so seldom used in comparison with lock gates, it was considered that this plan would be less expensive. The total cost of the graving dock, including the engine house and well, but not the engine and pumps, was £32,000. It was designed by Mr. Adam Smith, and was constructed, under the superintendence of the author, by Mr. J. Taylor.

Two lines of railway, laid on a timber staging, ran into the dock, having coal spouts at their extremities. These spouts, or wrought iron shoots, were fitted with hinged joints, and were capable of being raised or lowered, by winches, to the height of the deck of the vessel. There were doors in the bottoms of the coal wagons, and breakage of the coal was in a great measure prevented, by a door being fixed inside the spouts, hinged to one of its sides, and connected by a chain with a winch above, by which the rate of the coals entering the vessel was entirely under control. The wagons, when emptied, descended by their own gravity down the return line. About 400 tons of coal per day could be loaded at each spout.

A tower, having a total height of 300ft., was erected, and in this, at a height of 200ft., a wrought iron tank was fixed, capable of holding 33,000 gallons, for the purpose of serving as an accumulator of water pressure, for working the machinery of the lock gates and cranes, and of supplying fresh water to the shipping. The water was forced into the tank by two pumps, each 10in. in diameter, worked by a duplicate horizontal engine of 25 H.P. The engines, pumps, pipes, and machinery were supplied by Sir G. W. Armstrong.

In concluding the Paper, the author remarked that he had observed for several years past, that there was a gradual wasting away of the promontory on the Yorkshire coast, opposite to Grimsby, known as the Spurn Point. On the maintenance of this Point depended, he believed, the existence of Grimsby as a port. About eight or nine years back, when the sea threatened to make a breach between the Spurn Point and the mainland, Mr. Rendel directed the attention of the Government to the matter, and the foreshore of this neck of land was then protected, by depositing on it large quantities of chalk stone. Since then nothing had been done, and it was now to be feared, unless immediate steps were taken, that a permanent breach might be made, and the channel of the River Humber might be diverted from the Lincolnshire coast, and form for itself a new outlet into the North Sea, when the channel opposite the Grimsby Docks would probably be silted up.

DESCRIPTION OF THE RIVER TEES, AND OF THE WORKS UPON IT CONNECTED WITH THE NAVIGATION.

By Mr. Joseph Taylor, Assoc. Inst. C.E.

After describing the course of the river, from its rise in the south-eastern flank of Cross Fell, in the Goredale series of carboniferous limestones, and the geological features of the country through which it passed, the author alluded to the works above Darlington for supplying that town, as well as Stockton-on-Tees and Middlesbro', with water. But neither at these works, nor elsewhere, so far as the author was aware, had any gaugings been taken, with sufficient accuracy, to be of value. The tide flowed as far as Yarm, and the river was navigable to that town for small vessels. At Stockton-on-Tees, 7 miles further, the river assumed considerable dimensions, and vessels of from 200 to 300 tons burthen came up to its quays. Thence to Middlesbro' 5 miles, its course was very tortuous, and immediately below, after making a sudden bend to the north-east, it opened into a wide estuary, upwards of 3 miles in width from shore to shore; but of this a large area was only covered to the depth of a few inches at high water. The bar buoy was about 8 miles below Middlesbro'. The total length of the course of the Tees was between 70 and 80 miles, and its basin contained an area of about 750 square miles.

Under an Act obtained in the year 1808, a cut was made from the east side of the river near Stockton, through a neck of land, to Portrack. This channel was 220 yards in length, and it shortened the course of the river about 2½ miles, producing a scour by which the depth of water at Stockton Quay was increased from 9ft. to 11ft. The cost of this work was upwards of £12,000. A second cut was completed in 1830, from Blue House Point to near Newport. This was 1,100 yards in length, and cost about £26,000. About the same time, the construction of timber jetties, or groynes, at right angles to the stream was commenced. Their total number at present was forty-three, and they varied in length from 40ft. to upwards of 2,000ft.

Allusion was then made to the staithes for shipping coal, erected on the bank of the river at Middlesbro'; and it was stated that, owing to the shipping berths at the staithes having become filled up, a ship of the usual draught of water could with difficulty be unloaded. In 1842, therefore, a dock was constructed, and the staithes were abandoned.

Having noticed the principal works connected with the navigation, the author next referred to their effect on the channel of the river. The first cut, of 1808, appeared to have been well devised, for it contributed to the removal of a shoal lying a little higher up the river, and produced an increased depth of water of 2ft. at Stockton Quay. The expediency of the second cut was more doubtful, as it destroyed a broad reach of the river, thus depriving the channel below of an important reservoir of tidal water. The combined effect of the timber groynes and of the two artificial channels had been to reduce the river between Stockton and Newport to a nearly uniform width, straight, and narrow, through which the ebb tide flowed with considerable velocity. As the tide was suddenly checked at the eastern extremity of the second cut by the greater width of the channel, the tendency was for all matters held in suspension to be deposited, thus forming shoals, and filling up the bed of the river. As this was constantly recurring, the system of groynes had been continued lower down, with a view to secure deep water, and when the wider channel was reached, it became more difficult to deal with it.

The works had caused the silting-up of the north shore of Bamblet's Bight, which must have been contemplated; but they also led to the filling up of the shipping berths at Middlesbro', which could not have been intended. In 1852, the control of the river was assumed by the present Thames Conservancy Commission. For some years previous, the river below Middlesbro' had been in a very bad state, and was continually getting worse. It was evident, by letters from shipowners, as given in Mr. Bald's report to the Admiralty in 1851, and was corroborated by the personal experience of the author, that the channel changed very much every spring tide, by the operation of the jetties below Cargo Fleet, and that it ran almost dry at low water near the ninth buoy. In fact, the effect of the groynes had been to advance the foreshore to their extremities, and in many cases the width of the original channel in the Tees had been reduced one-half, by which a large body of tidal water had been excluded, reducing the velocity of the ebb tides, and diminishing the scouring force, with a corresponding result in the lower reaches of the river. In 1821, previous to the construction of any of these works, the least depth of water between Cargo Fleet and the ninth buoy anchorage was 6ft., excepting upon the Mussel scarf shoal, since removed by dredging: and which it was estimated by Mr. Bald, in his report to the Admiralty, might have been then effected for £350, while the cost of the jetties, which did not remove it, must have been considerably greater. The works in the upper part of the river had therefore reduced the depth in the channel below Middlesbro' 4ft., and the deep water anchorage berths had also been considerably diminished. It was not doubted that the channel of the river between Stockton and Middlesbro' had been made more direct, and the depth more uniform, by the construction of the various works; but the author was of opinion that better results would have been obtained by a judicious system of dredging, and that the disastrous effects upon the lower reaches of the river might have been avoided. The author believed, as a general principle, that the operation of dredging, by lowering the bed of a river, and thus increasing the tidal flow, was acting in unison with the natural scouring forces; whilst contracting the channel, by jetties or groynes, shut out a corresponding amount of tidal water, and weakened the scouring force of the ebb tide.

In conclusion, it was stated that the new Commissioners had principally directed their attention to dredging the channel, and to form groynes or training walls of refuse slag from the iron works, either at half tide level or at low water mark, in place of the old timber jetties, by which the depth of the channel had been increased to upwards of 4ft. at low water. A breakwater, also of iron slag, was now in process of construction near the mouth of the Tees, on the southern shore, extending for a distance of about 4,300 yards; and it was intended to form another pier from the north shore for a length of about 2,000 yards. The ends of these two piers would curve seawards, leaving an entrance channel of 600 yards in width. It was hoped that by the construction of these piers, a safe and sheltered harbour of refuge would be created at the mouth of the Tees. The depth on the bar at low water spring tides was about 11ft., and at high water 27ft., being a greater depth than existed on the bars of the Tyne, the Wear, or the Clyde.

SOCIETY OF ARTS.

ON THE RECENT PROGRESS AND PRESENT STATE OF INDUSTRY IN IRELAND: AND THE DUBLIN INTERNATIONAL EXHIBITION OF 1865.

By Sir Robert Kane, F.R.S., President of Queen's College, Cork, and Director of the Museum of Irish Industry, Dublin.

At the request of the Executive Committee of the Industrial Exhibition, which is to be held in Dublin in the summer of next year, I have undertaken to bring under your notice this evening some explanation of the circumstances under which that Exhibition has been undertaken, and the arrangements which have been made to secure its success, together with such notice of the present position of Ireland, in an industrial point of view, as may enable the members and visitors of this Society, representing as they do so fully the industrial intelligence and commercial energy of this country, to judge whether the objects for which we in Ireland are now labouring are worthy of that sympathy and co-operation which I trust we shall be able to obtain. Almost simultaneously with the earliest efforts of this Society, to realise, by means of exhibitions, the actual position of British industry, similar exertions were made by those in Ireland, who were anxious to direct the energies of that country to the permanent and solid advantages of industrial pursuits. Amongst the means employed for that useful purpose, exhibitions of manufactures held a prominent place; these, although necessarily of a local and limited character, obtained a large amount of popularity and success. All such exhibitions, however, whether held here or in Dublin, could be considered but as the faint glimmerings of dawn heralding the full refulgence of the day when under the august Prince, whose loss the friends of intellectual and industrial progress will always deplore, the Exhibition of 1851 was inaugurated, and that unparalleled review of the aggregated productive forces of the world was opened to the assembled nations. The impetus thus given led to a greater development being allowed to the Exhibitions which took place in

Ireland immediately after, as in Cork in 1852, and especially in Dublin in 1853. The objects were no longer limited to Irish manfactures, as they had previously been, but the British and foreign manufacturers were iuvited to render the Exhibition in Dubliu, as in London, really international. The Dublin Exhibition of 1853, for which a building admirable in its adaptation had been provided by the liberal enterprise of Mr. Dargan, was remarkable for the introduction of Fine Arts as a leading department, and was honoured by the presence and approval of her Majesty the Queen and her illustrious Consort.

The great International Exhibition of 1862, which, after the interval of eleven years, had renewed with still greater richness and completeness of illustration the glories of 1851, had naturally suggested that after a similar interval an International Exhibition should be held in Dublin. It may be stated that an Exhibition has this year been held at Dubliu and attained considerable popularity. Being limited, with the exception of machinery, to the display of objects of Irish manufactnre, this Exhibition was on too small a scale to represent in any degree the progress which foreign and domestic industry has made within the last ten years.

The opportunity of which it is now proposed to make use, in order to organise in Dnblin an International Exhibition, which shall be the worthy successor of the great successes of 1851, of 1853, and of 1862, has arisen from the fact that a number of gentlemen, of whom it is ouly necessary to mention the names of the Duke of Leinster, of Mr. Guinness, and of Mr. Dargan, possessing at once the inclination and the power, have nndertaken to provide for the citizens of Dublin a great winter garden aud buildings containing concert and lecture rooms, supplying, but on a smaller scale, the resources and enjoyments of the Crystal Palace at Sydenham. An independent Executive Committee having been formed to organise and carry out an International Exhibition, the Directors of the Winter Garden have most liberally placed their fine buildings altogether at the disposal of the Committee for that purpose, and the Executive Committee have gladly availed themselves of this truly patriotic proposal. The Exhibition will, therefore, be organised under extremely favourable conditions, as all that in other previous occasions had entailed the greatest amount of expense, of responsibility, and of risk, will have been spontaneously and all but gratuitously provided, whilst the authority and direction are preserved entirely in the hauds of the Executive Committee. The great advantage which will thus naturally result to exhibitors in the arrangement of their articles will be easily understood, and it has been arranged that all funds arising from the receipts above the payments of the expenses incidental to the Exhibition, shall be vested in a Committee of noblemen and gentlemen, under whose direction the excess shall be applied to public purposes for the advancement of Arts and Sciences in Ireland.

Such being the circnmstances nnder which the proposed Exhibition is to take place, I shall very briefly notice the positiou which the buildiug occupies. It is situated on the south side of Dublin, and in what may be considered the most fashionable quarter of the city; close to the terminus of the railway which leads to the most beautiful mountain scenery of Wicklow. The extent of space accommodation available may be fouud in detail by reference to plans which are in the office of this Society, but I need only say that the accommodation already at their disposal is very large, and there are, as I believe, now present, gentlemen representing the Committee of Advice and the Executive Committee who will be able, and I am sure willing, to supply information as to the details of space, much more precisely than I could attempt to do. The principal portions of the Exhibition will be located in the Great Conservatories of the Winter Garden—constructions in glass and iron rivalling the Crystal Palace itself in elegance of design, although of course much inferior in extent, and affording advantages as to supply of light and means of display which could not be surpassed.

Under those favourable circumstances it may be hoped that, not merely on public grounds, but even on the lower but more directly practical basis of individual advantage, we may hope for the co-operation of the manufacturers of Great Britain, who cannot fail to derive material benefit from bringing the products of their factories and workshops under the immediate cognizance of the Irish people. The Executive Committee have good grounds for expectation that the industrial resources and products of our Colonies and of the European Continental States, with scarcely an exception, will be adequately represented on that occasion. Gentlemen of great activity and intelligence have visited, on the part of the Executive Committee, the governmental authorities and the industrial centres of the Continental States; they have been uniformly received in a most friendly spirit, and have received promises of active co-operation. We shall thus have brought before the inhabitants of Ireland the most beautiful and perfect productions of the industrial enterprise and artistic genius of Italy, of France, of Germany, and of Belgium. We shall have, as I expect, very efficient evidences of what Ireland itself can do in the manufactures; and it is to be hoped that the British mannfacturers, even satiated as they may well be with triumphs already gained, and somewhat fatigued from the exertions by which that success was earned, will still not allow an International Industrial Exhibition to take place without Great Britain being properly represented, the more when that Exhibition will be held under the august sanction of Her Majesty the Queen, who has most graciously been pleased to become its patron, and when the Executive Committee have reason to expect that the Exhibition will be hououred by the presence of their Royal Highnesses tho Prince and Princess of Wales.

Among the elements of success to which the Executive Committee attach the greatest value, must be considered the support and co-operation which has been received from the Council and officers of this society. By their assistance a London Committee of Advice has been formed, which has contributed materially to our success. The all-pervading and well-earned influence of the Society of Arts throughout the manufacturing world secures to its recommendation, or as I may say, to its endorsement, an attention that no other body could command; whilst the accumulated experience of its officers in everything connected with the organisation and management of Industrial Exhibitions has even already proved of the utmost value. The members of the Executive Committee are therefore anxious that I shonld express how deeply they feel the beuefits of the advice and assistance they have received from this Society.

Whilst makiug the arrangemeuts which I have endeavoured to describe for procuring a full and satisfactory representation of the natural resources and industrial progress of our colonies and of foreign states, the Executive Committee has had its attention naturally directed to the position which the productions of their own country should occupy in the Exhibitiou. Two courses were open to them—the one, of carrying ont the principle of geographical classification, which will be adopted as regards the colonies and foreign countries, and thus to arrange the mauufactures of Great Britain and of Ireland separately; or on the other hand, to merge all separate insular existence, and exhibit under one head the iudustrial productions of the United Kingdom. Although the former plan might have tended to conciliate to the undertaking a good deal of local feelings and honest prejudices, the Executive Committee have decided upon adopting the other course, and propose to arrange that all natural and manufactured products of Irelaud shall fall into their respective positions as elements of the great total of British industry, extending to the results of iudustry—that fusion of interests and of objects which has already made so much progress in the political and social relations of those two countries.

In taking this course, however, the Committee are quite seusible of the risk that the iudustrial productious of Ireland—which are so limited in amouut and in variety, as compared with those of Great Britain—might easily be lost sight of, and pass unnoticed in the immeusity of the results displayed by her more fortunate sister; aud that, although acting upon the purest motives, and taking a course which I am sure will be found to be correct, they might be the inuocent means of an injustice being done to the manufacturers of their native land. This it is desirable to prevent; and hence I feel it my duty in this paper which may be considered as in some degree a foreshadowing of the Exhibition which is to come, to supply a notice of the present coudition of manufacturing industry in Ireland—not attempting to go into details, or to meution every department, but ouly such as may furnish an idea of what is being done, aud what we may hope to be able to do in the way of successful manufactures.

Every person is familiar with the fact that, whilst in this country the great development of manufactures forms the characteristic of social organisatiou and the foundation of its political strength, in Ireland the manufacturing indnstry has not attained any similar extension, and that agriculture, generally speaking of an imperfect kiud, forms the principal meaus of occupatiou and of existence to the people. Hence the terrible results which followed from the potato disease, and consequent famine in the years 1845–46, by which no less than a million and a half of population were destroyed, and which, followed by a coutiuuous stream of emigration, numbering not less than 80,000 a year, reduced the population of Ireland from 8,175,124 in 1841, to 5,798,967 in 1861. I do not feel called upon, or indeed here even authorised, to express an opinion as to how far this great diminution of population is to be regarded as a national misfortune or the reverse; it is impossible, however, uot to recognise that, under at least two points of view, society has benefited by the changes thereby introduced—Firstly, the establishment of the Incnmbered Estates Court, by which the position of landed property has been simplified, and tho introduction of an improved system of agriculture facilitated. Secondly, the rate of wages has been very materially increased, and payments in money generally substituted for a complex system of allowances, which practically left to the agricultural labourer little beyond the mere permission to live.

A population thus specially devoted to agriculture in its simplest form can turn only with difficulty, and under great stimulus, to manufacting operations, so much more complex in their nature, and requiring so much more of intellectual exertion for their successful prosecution. In fact, even in England the first introduction of the staple manufactures had been mainly due to the successive waves of foreign population, Flemings, Germans, and French, who, retiring from the political and religious persecutions to which they were exposed in their respective countries, sought the safety and refuge which England alone, then even as now, presents to all that peaceably land upon her shores. To the philologist a curious study is afforded in the technical expressions still employed in the every-day language of the English workman in various manufactures, marking the foreign origin of those trades and even the time and circumstauce of their importation.

Similarly in Ireland we were indebted principally to strangers for the introduction of those branches of manufacture which were subsequently carried on with most success; and in many cases the names most eminent, even at the present day, among our mercantile community, mark unmistakeably the historical events which had deprived their native countries of the ancestors of such worthy sons.

The absence from Ireland of any abundant deposits of bituminous coal, such as occur in this island, and on which gift of nature has been built up the colossal fabric of England's industrial power, necessarily prevents the establishment in that country of those branches of trade in which the cost of fuel forms any very large proportion of the total cost of production. Hence, although possessing in abundance deposits of the richest iron ores, we have not had any successful establishment of iron smelting in recent times. The iron ores, however, both as earthy carbonate and as hematite, are now largely exported from Ireland to this country to supply the enormously increased demand. Similarly, although large quantities of copper ore are raised in Ireland, principally in the southern counties of Cork and Waterford, the ore is shipped to Swansea to be smelted, as the large proportion of fuel which is required in smelting copper would render the process in Ireland too costly to be profitably carried on.

In the case of the ores of lead and silver, however, the proportion of fuel necessary is not so large, and not merely are all the lead and silver ores raised in Ireland smelted in the vicinity of Dublin, but a large quantity of foreign ores of those metals are imported for Irish smelting works, the produce from which is highly esteemed, not merely in the local but in the British markets. I believe that this department of mineral industry will be found very efficiently represented by Irish smelters in the coming Exhibition.

Although the smelting of iron ores and the actual manufacture of iron is now carried on in Ireland, yet there is a very large amount of trade in the making of machinery, especially for the linen manufacture, of steam engines and water-wheels, and of late years of iron ships. This latter business has already assumed large proportions. The Messrs. Harland and Wolff, of Belfast, have built in the last ten years twenty vessels, of an aggregate tonnage of 36,913 tons, giving employment to about 1,200 men. The establisnment of Messrs. Malcolmson, at Waterford, is similarly active, and employs about 300 men, turning out annually, at least, one first-class steamer, mostly about 2,500 tons burden each, and engaged in transatlantic voyages. The establishment of Mr. Pike, in Cork, is equally successful; whilst that of Messrs. Walpole, Webb, and Bewley, of Dublin, although only two years in existence, already gives employment to about 600 hands, and has completed five vessels, of which one of 1,434 tons burden, the *Knight Commander*, was almost the only ship that rode out uninjured the terrific cyclone that recently caused such frightful calamity at Calcutta. I mention these particulars to illustrate how much of industrial activity there already exists in Ireland, and how marked the extension of that activity in certain departments has lately become.

A very large branch of mining industry in Ireland, that of iron pyrites or sulphur ore, becomes the basis of an extensive series of chemical manufactures, which, however, are limited, just as in the case of iron smelting, to those branches in which the cost of fuel does not form a preponderate proportion of the total cost of manufacture. In Dublin, Cork, and Belfast large quantities of sulphuric acid, of chloride of lime, sulphate of soda, magnesia, &c., are made; the important branch of alkali making, as caustic and carbonate of soda, however, is not, as I believe, carried in Ireland beyond the manufacture of sulphate of soda.

In mentioning the absence in Ireland of deposits of bituminous coal of industrial importance, it is, perhaps, proper to mention that several extensive coal fields, yielding, however, principally anthracite coal, exist in the interior of that country, and are worked with success and profit. Their produce is, however, not so well fitted for manufacturing purposes, and is all employed for domestic purposes in their localities.

I cannot pass from the subject of Irish fuel without reference to what constitutes so important a feature in the Irish scenery and the agriculture of Ireland, the Irish peat-bogs. The reclamation of those great tracts of land to the uses of agriculture, and the employment of those stores of peat to the purposes of fuel, have occupied, and very properly, a very large amount of attention; but, whilst recognising fully the importance of the subject, it will be seen that the progress of society and of the industrial arts in later years has divested the question of much of the paramount importance that formerly belonged to it. In regard to the restoration of the peat bogs to agricultural purposes, the first and necessary element must be a perfect drainage, a measure of truly national importance, indispensable for the proper cultivation of even the best land, and, in considering which, the improvement of mere peat mosses cannot be held the primary object. But now that by the researches of Liebig, of Lawes, and others, the true principles of the growth of agricultural crops are understood, it is well known that even thoroughly drained peat will not supply the materials required for the production of food, and that the cost of supplying those materials, in the form of manures, if applied to the same area of land of more suitable constitution, will yield greater and more profitable returns. Hence, where ordinary farm land can be obtained, its improvement is preferable, as a field for the employment of labour and of capital, to the reclamation of peat bogs.

Similarly, the altered circumstances of the country have deprived the question regarding peat as a fuel of much of the importance that formerly was attached to it. The facilities for internal intercourse afforded by the railway system which Ireland already possesses, and which tends every year to expand, together with the low rates of freight, which allows the introduction of sea-borne coal at moderate prices, all tend to limit the area within which peat as a fuel can be advantageously employed, and to confine its use to the vicinity of the bogs and to the agricultural population. The heating power of peat being, even when best prepared and driest, not more than two-thirds of that of coal, together with the greater cost of transport of a bulkier and less valuable article, place a limit to its economy which will determine practically the area within which it can be employed. The various plans proposed from time to time for the preparation of compressed peat have, therefore, been found not to possess the pecuniary advantages which had been at first expected from them, although eminently successful in so far as producing a compact, convenient, and agreeable fuel, which, in some respects, may deserve a preference over coal, although it cannot do so for general manufacturing purposes.

The soil and climate of Ireland have always been favourable to the growth of wool, especially of the longer stapled kind, and at an early period the quantities of Irish wool exported to England were considered to interfere so much with the interest of English wool growers as to lead to some harsh fiscal regulations. Owing to various circumstances of the country and of the times, the woollen trade of Ireland had declined very much indeed, until within the last few years, when it began to revive, and it is now every year rapidly expanding in extent of business and in the variety of articles made. Thus in Dublin, in Cork, in Waterford, and in various inland towns, woollen and worsted mills that had been abandoned had resumed work, mills already in action have augmented their number of looms and spindles, and new mills are being erected. This great improvement is partly due to the fact that the diminished supply of cotton has produced a general increase of activity in the woollen trade, and also to the excellent character which Irish-made woollen goods have acquired in the English markets, being practically free from those sophisticatious that are but too commonly in use. The actual expansion of this branch of industry within ten years is shown by the fact that the number of woollen and worsted mills in Ireland had increased from nine in 1851 to forty-three in 1863, being nearly 463 per cent.

The cotton manufacture exists in Ireland, but to a limited extent, and latterly, since the diminution of the supply of cotton, many mills have been altered from cotton to flax spinning and weaving, in order to meet the increased demand for linen goods. This has been the case to a great extent with the factories of Messrs. Pim, at Dublin, and of Messrs. Malcomson, near Waterford. The latter, belonging to the same enterprising family which I have mentioned already in reference to the building of iron ships, is one of the most completely organised manufacturing establishments with which I am acquainted. It contains 31,000 spindles and 950 power-looms, with all the necessary machinery required for the spinning and weaving department. Being to a great extent isolated from other works they are obliged to depend on themselves, in many cases, for the construction and repairs of machinery, and hence there is attached to the mill a foundry and mechanics' shop, where machinery equal to any made in the best English workshops is constructed. The total number of hands employed by the Messrs. Malcolmson, in their various works, may be taken as averaging about 3,000.

The mixed woollen and silken tissues, which are known as poplins, or tabinets, have been considered as peculiarly an Irish fabric, but the manufacture was first introduced into that country at the beginning of the eighteenth century, by some Huguenot refugees. This branch of trade had of late years considerably declined, until the recent commercial treaty with France, which opened up the markets of that great country, where the rich tissues of the Irish looms were extremely popular. Since that time the poplin trade has been very active, every competent hand being fully employed until within the last three months, when a reaction appears to have occurred, which has somewhat diminished the demand. This interesting branch of trade gives employment, principally in Dublin, to more than 1,200 persons, of whom about one-fourth are employed by the Messrs. Pim, a firm active in all that tends to promote intellectual cultivation and industrial habits, giving, in their various departments of business, occupation to over 1,000 hands, and providing not merely for the material wants of those in their employment, but practically evincing most praiseworthy interest in their moral and social life. By the example of such employers, labour is truly dignified, and leaders of industry vindicate their right to the high position which, in this country, has been so justly conceded to them.

Of all branches of industry, however, that which is of most importance to Ireland, from the amount of capital it represents, and the number of persons to whom it gives occupation, is the linen trade. I am indebted to the kindness of Mr. M'Ilwrath, secretary to the linen trade of Belfast, for much valuable information on that subject, and also to Mr. M'Call, of Lisburn, for many interesting particulars, of which I shall endeavour to lay before the Society such general heads as our limited time may allow.

The linen trade of which Belfast has been long the established head-quarters in Ireland had been rather falling off in amount, until the interruption of the supply of cotton by the American war called it into immensely increased activity. The contrast in this regard is well shown by the following figures:—In 1859 there were in Ireland 82 flax-spinning mills, containing 651,872 spindles, of which 91,230 were unemployed; whilst in 1864 there were 74 spinning mills with 650,744 spindles, of which but 8,860 were unemployed, whilst 50,638 additional spindles were in May last about being set to work. Further, in addition to the above there were employed in 1864, 14,648 spindles occupied in making thread, and five mills were in course of erection to contain 45,000 spindles. In regard to power-loom factories for linen, a similar remarkable increase is shown for the same period. Thus, in 1859, there were 28 factories with 3,633 looms, of which 509 were unemployed: whilst in 1864 there are 42 factories with 8,187 looms, of which but 258 are unemployed; 1,685 additional looms were about being set to work at the date of the return in May last. The introduction of the factory system into the linen trade, and especially the power-loom, is comparatively modern, the first spinning mills for flax in Ireland having been established about 1828, previously to which time cotton spinning was much more extensively carried on in Belfast that it has since been.

The great extension of trade and the benefit to the operative classes which followed this change, may be illustrated by the following fact:—When spinning and weaving were done by hand, the firm of Richardsons, of Lisburn, turned out from 15,000 to 20,000 pieces of goods in twelve months; that firm can now deliver 250,000 pieces of bleached goods in the same time.

As to wages in the old day of spinning on the domestic wheel, the earnings were from 2*s.* 6*d.* to 4*s.* weekly, whilst at present in spinning mills the ordinary work-women make from 3*s.* 6*d.* to 6*s.* per week, and superior hands from 6*s.* to 8*s.* The best hand-loom weaver can only make 6*s.* per week, out of which he has to pay charges which leave him only 5*s.*, whereas an expert girl, who can attend to two power-looms, can make 10*s.* per week clear. Thus the earnings of individuals have been materially increased by the introduction of steam machinery in the linen trade; and in regard to the total amount of employment, there were, ten years ago, 17,000 persons employed in this trade in and about Belfast, whereas in the present year the number employed in the mills is 25,000, exclusive of the vast number of outsiders who indirectly derive their subsistence from that branch of manufacture.

Coupled with this development of the linen trade there has taken place a great increase in the quantity of flax cultivation in Ireland. During the Crimean war, when the Baltic trade was subjected to certain impediments, the quantity of land under flax was increased, and amounted, in 1853, to 174,579 acres, but on the restoration of peace, the Baltic trade being resumed, the demand for home-grown flax diminished, and the cultivation fell off to 91,646 acres in 1858. Since that time it has progressively increased, and has now assumed proportions entirely unprecedented, the quantity in 1863 having been 214,099 acres, and in the present year having increased to 301,942 acres, which at an average of 35 stone of clean scutched flax to the acre, gives the produce of fibre at 10,567,970 stones, or 66,050 tons; and at an average price of 7*s.* 6*d.* per stone, the total value of the crop of the present year, is £3,962,989. This great increase of production is accompanied of course with corresponding increase of the export trade.

The total value of linens exported from the United Kingdom has nearly doubled within the last three years, having been £8,469,036 in 1863, against £5,193,347 in 1861.

A corresponding increase has taken place in the branches of steam engine and machine making connected with the linen trade. The foundries and workshops occupied in that way have fairly doubled in extent of business and number of hands employed, while wages have increased the last two years from 10 to 15 per cent. Simultaneously, the general trade of Belfast has increased to such a degree, that in the year 1863 the imports amounted to £8,505,991, and the exports to £10,472,598. The tonnage of the port in 1861 was 920,800 tons, and the revenue £40,600, whilst in 1800 the tonnage of Belfast had been but 54,200 tons, and the revenue collected but £2,740.

Closely connected with the linen and cotton manufactures are the important industries to which the refuse and worn-out remains of textile fabrics are devoted, the manufacture of paper and pasteboard. This branch of trade is extensively carried on in Ireland, especially in the neighbourhood of Dublin. The quantity of paper manufactured annually at the time the duty was repealed, was between 9,000,000lbs. and 10,000,000lbs. The advantage afforded to the introduction of foreign-made paper by the late commercial tariff has depressed the condition of the paper trade in Ireland, as it has done in this country; but it may be hoped that the relaxation of the export duty on rags, which has lately been made in the Treaty of Commerce between France and Switzerland, will mitigate, after some time, the disadvantage under which the British maker is now placed. In regard to specially Irish interests, I may mention that the lower price of straw in Ireland has led to a very extensive manufacture of the low-class paper containing that material, and that a large proportion of the cheap literature of London is printed on Irish manufactured paper.

A very large source of employment is afforded throughout Ireland, especially in the northern districts, in the sewed muslin trade, which occupies, it is estimated, over 300,000 females. The products of this industry are generally sent into commerce as Scotch, the greater number of the firms giving out the work being of that country. Indeed, this class of occupation is curiously cosmopolite, and illustrates the tendency of industry to overcome the distinctions of country and of race. Thus in the trade of shirt-making, by which considerable employment is given in Ireland, I have been informed that for some large houses the shirts are cut out and sewn in Ireland, are then sent to Scotland to be washed, thence they pass on to London to be made up and prepared for sale. Most of the shirts, however, manufactured in that way are intended for exportation.

Minor industries of that class are, I am happy to say, being introduced and extending themselves in Ireland. Thus the making of ladies' corsets and crinolines was commenced in Dublin by the enterprise of Mr. Crotty, some few years back, and his firm now employs 700 girls, who earn from 5*s.* 6*d.* to 10*s.* per week, producing at the rate of about £60,000 worth of corsets per year, all of which, as I believe, are exported to this country. For it is a remarkable, and I believe a healthy characteristic of Irish manufactures, as they are now carried on, that they do not depend for their success on any excitement of misdirected though honest patriotism or protection. In fact, the prejudice is entirely the other way, and the Irish manufacturer meets much more ready customers abroad than he can find at home. This, however, is not peculiar to Ireland. Similar feelings are met with in every country; and it is most creditable, that in every branch their products find a welcome reception both in Great Britain and in foreign countries, grounded on the confidence which has been established in the honesty of the materials and the excellence of their make.

It would be unsuitable if, in speaking of Irish manufactures, I omitted noticing what had been long considered the staple manufactures of that country—porter and whisky. Of the latter, the production and consumption has of late years very much declined, the quantity of Irish made spirits entered for consumption having fallen off from 8,136,362 gallons in 1853 to 3,898,268 gallons in 1863. This enormous decrease is due partly to the increase of duty, but I believe in a greater degree to the improved habits of the people. A large increase in the production of ale and porter is shown by the returns of malt on which duty was paid, which rose from 1,376,148 bushels in 1855, to 2,234,947 bushels in 1863. This increase, however, is in great part represented by the development which the export trade in porter has received.

Those remarks will serve to illustrate in some degree the position which the Irish manufactures may be expected to take in the approaching Exhibtion, and although, with the exception of the linen trade, not comparable in extent with the same branches of industry as carried on here, yet it will, I believe, be found that what is done is done well, and will establish their right to an honourable companionship with their fellow-labourers in Great Britain.

I am indebted to my friend, Mr. Barrington, who, I hope, will have the honour, as Lord Mayor of Dublin in the coming year, to receive in a manner worthy of the city and of the great manufacturing firm which he so efficiently represents, some details as to the position of the soap and candle trade which is carried on to a considerable extent in Ireland, especially in Dublin; about 230 tons of hard soap and 40,000 dozen pounds of candles being made weekly. This manufacture, which has been said to constitute a test for the civilisation of a country, is steadily progressing in Ireland.

Under these circumstances, I trust that the manufacturers of Great Britain will not hesitate to lend their assistance towards rendering the Exhibition a sufficient representation of the productive power of our common country. Now that the intervening channel has been practically bridged by the splendid steamers which give to the passage more than the security and almost the comfort of the railway train, the journey from London to Dublin occupies but a portion of a day, we may by our uniting on the common ground of industrial fellowship, contribute to cement that union by which the greatness and the tranquillity of the empire are secured. The position and the prospects of Ireland have been represented in very desponding colours. Her woes and losses have been eloquently traced to commercial jealousy and political misgovernment, and there has been but too much foundation for that charge. We have, as I hope, however, passed from the crimes and errors of an ignorant and bigoted age into a time when the blessings of education have taught all classes the true road to national prosperity, and when a more enlightened and tolerant spirit governs the relations as well of nations as of individuals. Scarcely beginning to recover from the fearful visitation of the potato famine, Ireland has had to pass during the last five years through a succession of wet seasons and bad harvests, entailing an annual loss estimated by the highest authority, Judge Longfield, at five millions annually, or twenty-five millions in the five years. No wonder, then, that her agricultural capital has not augmented during that time; that the quantity of live stock has not been multiplied; that the area under cereal crops has not increased. But, with all this, even with the emigration of a class which it would be desirable, if possible, to keep at home, the amount of crime has been diminished by one-half, and of pauperism to six-tenths within the last ten years, whilst wages have risen as well in agricultural as manufacturing districts to a point practically equal to the cost of labour in this country.

Our visitors next year need not imagine that in crossing a narrow channel of the sea they will pass into a wilderness, where agriculture is abandoned and trade extinct, among a population lawless and pauperised, abject and ignorant, whose only signs of national activity are outbursts of political and sectarian strife, miserably caricaturing that grand struggle which settled the constitution of this country a century and a half ago. Under a surface scum of passion and discontent, which represents the former Ireland, and is every day melting away, the humanising influences of education, and of equal laws, have called forth a new and a better Ireland, a population intelligent and moral, peaceful and provident, able and willing for any work that may be set before them, and seeking such work even in the most distant portions of the globe. Such a people require only fair and considerate guidance and example to constitute themselves admirable materials for industrial enterprise, and prove themselves worthy to participate in the prosperity and power of this great empire. I regard, as highly conducive to that great end, that our British neighbours, especially those who are themselves engaged in industrial pursuits, should know more of Ireland and of its people; that they should learn to judge of the people and of the country as they now are, and not by the newspaper exaggerations, or stories of a by-gone time. Such means of calm and dispassionate judgment will be afforded by the the opportunity of the Exhibition next year; and—as I believe the result will be to elevate the position of Ireland and of its people in the opinion of those who are most competent to decide, as well as most interested in the result—I do trust and expect that England and Scotland, as well as more distant foreign countries, will be well represented as visitors and co-operators in the approaching Exhibition.

SMITHFIELD CLUB SHOW.

One of the chief novelties exhibited at the late Show was the new Double Expansive Portable Engine, introduced by Mr. E. E. Allen, of Parliament-street, in which, as the name implies, the steam is used twice over, not being discharged from the cylinder until it is fully expanded, nearly or quite to the atmospheric pressure. The chief peculiarity lies in the cylinder, which is double the ordinary length, but divided by a partition in the centre. The piston is, as it were, also divided into two parts or plates; one plate (with metallic packing on edge) working in each division of the cylinder, but connected together by a trunk, which passes and works through the division in the cylinder, which division has also metallic packing let into it. The steam first acts upon the annular space of each piston plate alternately; and after one stroke is completed it passes through the valve to the ends of the cylinder, acting upon the whole area of the piston plates alternately, and so, by its expansive force, producing the return stroke. When fully expanded, the steam is discharged in the ordinary way. The high pressure steam acting upon a small area of piston does not cause any injurious strain upon the working parts of the engine, although the cylinders are considerably larger than those of ordinary engines of the same power. As the thrust on the crank is made up of the high pressure steam on the annular space of one piston plate, and the expanding steam on the whole area of the other piston plate, force is given out to the fly-wheel during the *whole stroke*, although the steam is expanded to the atmospheric pressure; thus a light fly-wheel suffices. The valve which is cast in one piece, and is driven by one ordinary eccentric and rod, is packed at the back, and so relieved of steam pressure, in the ordinary mode of marine engine valves, and that reduces friction, and consequently the wear and tear of the valve facings. The cylinders are steam jacketed, as well as the valve boxes, the boilers and jackets being felted and lagged.

Several of these engines are now at work. One at the new Government Offices, in Downing-street, Whitehall, is of 8 horse-power, and is employed in driving eight sets of stone-sawing frames. Its consumption of fuel is 4cwt. of common (Cannel coal) gas coke per day of fourteen hours, and at this rate of consumption it has been at work since the beginning of October, 1862.

Another engine (a 10-horse) is employed on the estate of R. S. Holford, Esq., M.P., at Westonbirt, near Tetbury; and here the consumption is 40lbs. to 47lbs. per hour, or under 4cwt. per day of ten hours.

A marked feature in these engines is the ease with which their boilers are fired, the boilers being nearly double the size of ordinary portable engine boilers, when compared with the amount of steam they have to generate.

A third engine has just been started at Boston, Lincolnshire, and has worked at the rate of 14lbs. of coal per horse-power for four hours, the boiler being fed with cold water. This consumption for a farm engine of 8 horse-power, working eight hours, would amount to only 2cwt. per day.

Besides portable engines, some large fixed engines, upon Mr. Allen's system, have been constructed and working for some time.

TWIN SCREW PROPELLED BROADSIDE BATTERY SHIPS.

We have already expressed our opinion favourably as to the advantages of this system of propulsion, more especially as applied to war vessels constructed in the manner proposed by Captain Symonds, R.N. One of the features most deserving of notice in Captain Symonds' plan is that which we remember being mentioned and illustrated in a paper read by him at the Royal United Service Institution, in March, 1862, given in The Artizan volume for 1863, and which consists in forming twin screw propelled broadside battery ships with a domed central battery amidships. This feature was also more recently dwelt upon by Captain Symonds at the last meeting of the Institution of Naval Architects (*vide* The Artizan, June, 1864). In either addition to the broadside armament, the rounded ends of the battery are armed with guns, the whole of them to be used as bow and stern chasers, firing in line with the keel; or say two as bow and stern chasers, and the others, by shifting their position (spare ports being provided for the purpose), to be used as broadside guns.

Although our own Admiralty do not as yet appear to have determined to adopt the plan submitted to them by Captain Symonds, we find the Dutch Government have lately had completed for them a twin screw gunboat constructed, as regards the provisions for her fighting qualities and arrangements upon a plan which appears to us identical with that before referred to as having been submitted by Captain Symonds.

This vessel, the *Handig Flug*, has been constructed by Messrs. J. and W. Dudgeon, for his Netherlands Majesty for service on the rivers of Borneo and Java. She has a mean draught of 3ft. of water, having a length between perpendiculars of 100ft., a beam of 17ft., and a depth of 6ft. 6in. Her tonnage is 138 tons, builders' measurement. She is built entirely of steel plates. This cupola battery occupies 61ft. in length in the central part of the vessel, the entire space being covered in with a central grating longitudinally for ventilation, and is capped with a "pilot house" 5ft. in diameter It is fitted with six gunports, three forward and three aft, one at each end and in a line with the keel, and the others on the bows and quarters. In addition, there is breast high, round this cupola, pierced holes with brass slide covers for rifles. The *Handig Flug* made her trial trip at the measured mile in Long Reach on the 23rd ult., when the average of the six runs made gave the vessel a speed of 10 knots. Some interesting experiments in manœuvering the vessel were also made:—Reversing the action of the engines, the complete circle was made to starboard in 2min. 47sec. and the circle to port in 3min. In going ahead at full speed the course of the vessel was reversed by the altered action of the screws in one minute. The engines, also by Messrs. Dudgeon, averaged 220 revolutions throughout the trial, with a pressure of steam on the boilers of 30lbs., and a vacuum of 24in.

We look forward to the time as not being far distant, we trust, when we shall see the twin screw system applied to armoured war ships of large tonnage and deeper draught, constructed upon the plan advocated by Captain Symonds, as the twin screw system is now applied successfully to *commercial* steamers of considerably larger tonnage and deeper draught than those to which the system was at first applied, and to which alone it was then considered by some to be adapted.

REVIEWS AND NOTICES OF NEW BOOKS.

George and Robert Stephenson. By Samuel Smiles. 8vo. New Edition Revised. London: John Murray. 1864. 388 pp.

This volume, which is a new edition of the "Story of the Life of George Stephenson," with the addition of a memoir of Robert Stephenson, is deserving of considerable attention. While exhibiting, in a very concise form, the facts relating to the rise and progress of the undertakings with which the name of Stephenson is indissolubly connected, yet being so pleasantly relieved by the freedom of the composition, there is not the least tediousness about it.

In the present edition the author has also introduced such corrections as were formerly observed, so that it is perfect and accurate up to the present time. The illustrations, also, are executed in a superior style; the production altogether reflecting much credit on both author and publisher.

Brindley and the Early Engineers. By Samuel Smiles. 8vo. London: John Murray. 320 pp.

This work is an abstract principally of Mr. Smiles' "Lives of the Engineers," and presents, in a very compact and useful form, many incidents of great interest not only to the scientific world, but also to the community at large. Accounts are given of the extensive drainage works of Vermuyden, the cutting of the New River by Myddelton, with the principal achievements of Brindley, Perry, and other engineers of their time.

Those interested in the progress of civilization and social economy should not be without this work.

Hurst's Architectural Surveyor's Handbook. By John Thomas Hurst, C.E. London: E. & F. N. Spon. 1864.

A useful pocket or office book for those connected with the building trade, either as architects or contractors. Uniform with Mole's worthy "Pocketbook for Engineers," it is easily portable. It contains numerous practical formulæ and tables relating to estimates, the setting out of work, &c.

NOTICES TO CORRESPONDENTS.

R. H. P.—The reply to your question will be found on page 187 of The Artizan volume for 1863, in the "Notices to Correspondents," in answer to "R. E.;" and, we may add, it is not usual in practice to include the atmospheric pressure in calculations on steam. Thus, if the pressure at which an engine works is stated to be 15lbs., this figure represents only the *over pressure*, the aggregate pressure of steam and atmosphere combined being, in that case, 29·706, or about 30lb. It is obvious that by the rise of the temperature of the steam, its pressure, and consequently its density will be increased—or, in other words, the volume of the steam will be reduced to minor proportions. Thus, to refer to the example you quote:—Supposing a cubic foot of water, if transformed into steam at a pressure of 25lbs., would occupy a volume of 996 cubic feet, this volume will be gradually reduced by the increase of the temperature and pressure of, say, 40lbs. (= 25·3lbs. – the atmosphere) the same *quantity* of steam will not occupy more than 640 cubic feet. Want of space prevents us entering more fully into the matter in our present number, your note coming to hand but a few hours previous to going to press. As to your other query, we have written you by post.

W. H. W. (Constantinople).—Remittance, 13*s.* 6*d.* received.

Aliquis.—(1). Send us your address, and we will forward you the printed specification, which will give you the most complete information upon the subject of your inquiry. (2). We cannot do better than refer you to Bourne's Treatise. (London: Longman. 1862.)

Constant Reader.—In our leader of June, 1862, a cupola, as constructed on Captain Coles's design, is alluded to, while the illustration in our issue of February, 1863, shows Ericssons's *original* plan, as submitted to the Emperor of the French in 1854. This illustration is a reproduction of a drawing supplied to us by Capt. Ericsson. The required information on the number of ironclads, &c., you will find in the Blue Book, issued by the Admiralty; also, we should think, in the statistical abstracts published annually by Capt. Graham, the Superintendent of the Statistical Department Board of Trade.

PRICES CURRENT OF THE LONDON METAL MARKET.

	Dec. 3.			Dec. 10.			Dec. 17.			Dec. 24.		
	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
COPPER.												
Best, selected, per ton	92	0	0	92	0	0	92	0	0	92	0	0
Tough cake, do.	87	0	0	89	0	0	88	0	0	88	0	0
Copper wire, per lb....	0	1	0	0	1	0	0	1	0	0	1	0
„ tubes, do.	0	1	1	0	1	1	0	1	1	0	1	1
Sheathing, per ton	98	0	0	98	0	0	98	0	0	98	0	0
Bottoms, do.	105	0	0	104	0	0	104	0	0	104	0	0
IRON.												
Bars, Welsh, in London, per ton	7	15	0	7	12	6	7	12	6	7	12	6
Nail rods, do....	8	15	0	8	10	0	8	10	0	8	10	0
„ Stafford in London, do.	9	7	6	9	2	6	9	2	6	9	2	6
Bars, do.	9	0	0	9	0	0	9	0	0	9	0	0
Hoops, do.	10	0	0	9	17	6	9	17	6	9	17	6
Sheets, single, do.	11	0	0	10	12	6	10	12	6	10	12	6
Pig, No. 1, in Wales, do.	4	10	0	4	10	0	4	10	0	4	10	0
„ in Clyde, do.	2	11	3	2	11	6	2	11	0	2	10	0
LEAD.												
English pig, ordinary soft, per ton ...	20	10	0	20	10	0	20	10	0	20	10	0
„ sheet, do.	21	0	0	21	0	0	21	0	0	21	0	0
„ red lead, do.	22	0	0	22	0	0	22	0	0	22	0	0
„ white, do.	26	0	0	26	0	0	26	0	0	26	0	0
Spanish, do.	19	10	0	19	10	0	19	10	0	19	10	0
BRASS.												
Sheets, per lb.	0	0	9½	0	0	9½	0	0	9½	0	0	9½
Wire, do.	0	0	9	0	0	9	0	0	9	0	0	9
Tubes, do.	0	0	9¾	0	0	9¾	0	0	9¾	0	0	9¾
FOREIGN STEEL.												
Swedish, in kegs (rolled)	15	10	0	15	10	0	15	10	0	15	10	0
„ (hammered)	16	0	0	16	0	0	16	0	0	16	0	0
English, Spring	19	0	0	19	0	0	19	0	0	19	0	0
Bessemer's Engineers' Tool	44	0	0	44	0	0	44	0	0	44	0	0
TIN PLATES.												
IC Charcoal, 1st quality, per box	1	8	0	1	7	0	1	7	0	1	7	0
IX „ „ „	1	14	0	1	13	0	1	13	0	1	13	0
IC „ 2nd quality, „	1	6	0	1	5	0	1	5	0	1	5	0
IC Coke, per box	1	3	0	1	2	6	1	1	9	1	1	9
IX „ „	1	9	0	1	8	6	1	7	9	1	7	9

The Winan's Yacht.—Since the notice of this vessel in our June number of last year, good progress has been made with her construction, the hull being in a forward state, but a considerable amount of rivetting and fitting to the deck houses, bulk-heads, &c., remains to be done. The engines, by Messrs. Jackson and Watkins, of the Canal Iron Works, Poplar, are on board, and present an appearance of extraordinary solidity combined with high finish. In the early spring a series of experimental trials will be made, which are looked forward to with considerable interest by shipbuilders and engineers, and the results of which we purpose giving in our columns.

RECENT LEGAL DECISIONS
AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

UNDER this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least —less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

LIMITED LIABILITY AS CONTRIBUTORIES.—The Lords Justices have affirmed the decision of the Master of the Rolls, in *re* the Exhall Coal Mining Company, holding that when a person applies to a company for a certain number of shares, but before registration or anything done to fix his liability in respect of his application, he expresses a wish to diminish the number of shares, and the company assent to this proposal, there is nothing to prevent the alteration of the original transaction. The mere fact of the acceptance of the shares first applied for, and payment of first deposit or call on them, do not make the original contract so irrevocable as that both parties cannot dissolve it.

DETTERS *v.* TOWNSEND.—BILLS OF EXCHANGE.—It has been held by the Court of Queen's Bench, that where a holder of an over-due bill has commenced an action upon it against the acceptor, and has subsequently endorsed the bill away, the indorsee is entitled to sue the acceptor in a second action, although he took the bill with notice that the first action was still pending. The defendant's remedy against the first action, after the commencement of the second, is by application to the Judge at Chambers to stay the proceedings in the first.

CUNNINGHAM *v.* COLLINS.—Vice-Chancellor Wood decided on the 20th ult. a question that had been before him for some time respecting the validity of Cunningham's patent for reefing sails without sending the sailors aloft to man the yards. The patent consists in a plan for lowering the yard in such a way that the sail winds round it as on a drum. The sailors, therefore, reef or unreef by simply lowering or hoisting the yard, and this can be done from the deck. The defendant, a Mr. Collins, urged that the principle was not novel, and, if it was, his process was substantially different; but the Vice-Chancellor decided against him on both pleas, and confirmed the validity of the patent.

SALVAGE FOR THE "GREAT EASTERN."—The American Courts have just given a decision against the late management and in favour of Mr. H. E. Towle, an American engineer, who was a passenger in the ship from New York in September, 1861, when her rudder-post, in may be remembered, was twisted off, and she was left to the mercy of the waves. After her captain and crew had all failed to regain the control of the rudder, Mr. Towle volunteered his services, and succeeded in saving both ship and crew, passengers and cargo; but the managers or owners refused to recognise or reward his services because he was a passenger and had an an interest in saving the ship as a means of saving himself. The American Courts have awarded Mr. H. E. Towle 15,000 dollars out of the result of an arrest at New York.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

HOT-BLAST OVEN.—Mr. H. E. Clifton, of St. Louis, Missouri, U.S., has invented an improved arrangement for hot-blast ovens, by means of which great economy is effected, and a very regular blast is obtained. He employs a series of double pipes one within the other, the consequence being that the cold air passes over twice the heating surface usual. Mr. Clifton prefers to use fire-clay tubes instead of metal, the former being much less liable to injury from the expansion and contraction from change of temperature. Each pair of pipes is capable of being brought into use or thrown out by simply turning a tap.

STEEL WIRE ROPE.—Some important experiments have been made with galvanised steel wire-ropes at the Dock Testing Works, Birkenhead. The testing was at the instance of Messrs. Jones, Quiggin, and Co., the eminent iron shipbuilders, who are building a monster composite ship, the largest ever built in the Mersey. Being naturally anxious to have everything of the best and strongest for this vessel, they determined that the strength of all her materials should be thoroughly tested. For this purpose surplus pieces were cut from the wire rigging now in course of being manufactured for the vessel at Messrs. Garnock, Bibby, and Co.'s ropeworks. The testing showed the following extraordinary results:—4¼in. steel wire rope, 57 tons 1 cwt., the Admiralty test for charcoal wire of this size being 24 tons 8 cwts.; 3¼in. steel wire rope, 24 tons 6 cwts., Admiralty test for charcoal wire of this size 13 tons 10 cwts.; 2¾in. steel wire-rope, 19 tons 0 cwts., Admiralty test for charcoal wire of this size 8 tons 11 cwts. The experiments were under the inspection of Mr. M'Donald, superintendent of the Birkenhead Testing Works.

A REMARKABLE STEAM-BOILER has been patented by Mr. E. N. Dickerson, New York. One of these boilers has exhibited such results as to astonish the practical men who witnessed the trial. The *Providence Journal* says:—The boilers stand on the dock without any chimney whatever, so that the only draught was that which was produced inside of the boilers themselves, which usually would not serve to make steam in less than two or three hours of firing. In these boilers, however, steam was produced in seventeen minutes from the time the fire was lighted; and in half an hour the pressure was about seventy pounds to the inch. The safety-valve was then opened and the steam blown off at a pressure varying from seventy to thirty pounds to the inch. At the pressure of thirty pounds the safety-valve was blocked open, but the steam could not be blown down below that point, although the safety-valve is about twice as large in proportion to the grate surface, as is usual, and the fire was made of ordinary cord-wood burning without any chimney. Instead of blowing off water from the open valve, as boilers usually do, nothing but pure steam could be seen, thus showing that no heat is lost by working water; and the products of combustion as they pass from the boiler tubes are so cooled that persons were walking on the perforated plate through which the hot gases were escaping without burning shoes or clothing, and the hand could be held at the aperture of the tube without any inconvenience whatever. Before the boilers were fired up they were subjected to a cold water pressure of more than a hundred pounds to the inch, which they endured without complaining. The boilers are less than half the usual size, and yet they make pure steam without any "steam chimney," in less than a quarter of the time usually required and in far greater quantities, from the same weight of fuel, than any other boiler ever constructed can do.

MOULDS FOR CASTING METAL.—Mr. H. Cochrane, of the Ormesby Ironworks, has patented an invention which has for its object the formation of permanent moulds for casting iron and other metals, that shall not act injuriously on the casting by chilling the surfaces of the same, or by engendering gases. For this purpose he makes such moulds of a composition consisting of fire-clay mixed with black-lead or plumbago, or of fire-clay mixed with black-lead and silicon, or of black-lead mixed with silicon; the composition which he has found suitable for the purpose being one-third of black-lead mixed with two-thirds of fire-clay, with a small proportion of silicon, but he in no way limits himself to these proportions. The moulds, when made, are, by preference, dried gradually at a moderate heat.

ENORMOUS WEIGHBRIDGE.—A new weighbridge has been placed by the Manchester markets committee, in Liverpool-road. The platform is 16ft. 6in. long, and 9ft. wide, in one solid casting, and the machine is adjusted to weigh from 2lb. to 70 tons. It has been tested up to 50 tons. The transferring lever is 25ft. 6in. long, and is made upon a new principle, as applied to weighbridges, being constructed of wrought iron boiler plates riveted together in the proper form, after the manner of the modern tubular bridges. Its strength was demonstrated when the machine was tested with 50 tons, which remained on the platform forty-three hours, and the deflection of the lever at that period was very slightly over the eighth of an inch at the middle of its length. The weighbridge was made for the markets committee by Mr. Thomas Steen, of Burnley. The foundations are cased with a space between each to lessen vibration from passing carriages, and, together with the machine-house, were erected from plans and under the direction of Mr. Lynde, the city surveyor.

COLOUR: THE TROCHEIDOSCOPE.—With reference to a notice of the meeting of the Liverpool Architectural Society, Mr. G. A. Audsley writes:—"The general principles on which my instrument is constructed are the same as those on which the instruments invented by Mr. Rose some years ago, the common 'Colour Top,' and the 'Trocheidoscope' of Mr. Goodchild are arranged. All I can claim for my machine is, that by adopting a vertical position for my revolving discs, &c., instead of the usual horizontal one, and by a very brilliant mode of illumination, I render the effects of colour visible at a great distance, and to any number of persons at a time. I have also introduced a series of compound motions, by which I obtain some striking effects as well as continuity. Although I may have done a little towards the development of a very useful and interesting class of instrument, I lay claim to no credit connected with it, much less to being its inventor."

ELECTRICITY APPLIED TO ORGANS.—Mr. Barker, organ-builder, Paris, is said to be the inventor of a mode of applying electricity in the construction of great organs, so that the largest organ may be played as easily as the piano, and the pipes may be distributed anywhere through a church. This invention is now being applied to a great organ in course of construction for the church of St. Augustin, in Paris.

ALUMINIUM BRONZE BEARINGS.—It appears that in an extensive factory in New York aluminium bronze has been successfully applied as the bearing of a small mandril, which runs 7,000 revolutions per minute, every bearing previously tried having entirely failed. The aluminium bronze used was made from 90 parts of copper with 10 parts of aluminium, and the *Scientific American* remarks that propeller shafts and boxes troubled with chronic heating might be cured by this metal. Boxes for fan blowers particularly, the shafts of which run from 3,500 to 4,500 revolutions per minute, might be easily lined with this metal. It is pronounced by those who have used it to be a superior composition for all journals at great velocities.

AN IRON LETTER.—A letter which is remarkable both as a documentary curiosity and as a specimen of manufacturing skill was recently received by the *Birmingham Journal*. It is written on iron rolled so thin that the sheet is only twice the weight of a similar sheet of ordinary note paper. The letter is dated, "South Pittsburg (Pennsylvania), November 6th. 1864," and says:—"In the number of your paper, dated October 1st, 1864, there is an article setting forth that John Brown and Co., of the Atlas Works, Sheffield, had succeeded in rolling a plate of iron 13½in. thick. I believe that to be the thickest plate ever rolled. I send you this specimen of iron made at the Sligo Ironworks, Pittsburgh, Pennsylvania, as the thinnest iron ever rolled in the world up to this time, which iron I challenge all England to surpass for strength and tenuity. This, I believe, will be the first iron letter that ever crossed the Atlantic ocean.—Yours, &c., JOHN C. EVANS." The iron is said to be of exceedingly fine quality, and the sheet by far the thinnest ever seen in this country. The letter will be deposited in the Museum of the Midland Institute. Tested by one of Holtzappfel's gauges, the thickness of the sheet is found to be one-thousandth part of an inch! A sheet of Belgian iron, supposed hitherto to be the thinnest yet rolled, is the six hundred and sixty-sixth part of an inch thick; and the thickness of an ordinary sheet of note paper is about the four-hundredth part of an inch.

THE MONT CENIS TUNNEL.—In a highly interesting article by Emile Level, in the last number of the "Revue Contemporaine," are some curious details about the piercing of the tunnel between Modane and Bardonèche. It is well known that the whole length of the tunnel, when completed, will be 12,220 metres. The machine used for the purpose is M. Sommelier's perforator, set in motion by compressed air. It consists of a piston working horizontally in a cylinder, and carrying a chisel fixed upon it like a bayonet, which at each stroke dashes with violence against the rock to be pierced. Each time the chisel recoils, it turns round in the hole, and as the latter is sunk deeper and deeper, the frame or shield which carries not one, but nine perforators, advances in proportion. While the chisel is doing its work with extraordinary rapidity, a copper tube, of a small diameter, keeps squirting water into the hole, by which means all the rubbish is washed out. Behind the shield there is a tender which, by the aid of a pump set in motion by compressed air, feeds all these tubes with water. The noise caused by the simultaneous striking of all the chisels against the rock is absolutely deafening, enhanced as it is by the echo of the tunnel. All at once the noise ceases, the shield recedes behind it, and the surface of the rock is perceived riddled with eighty holes, varying in depth between 80 and 90 centimetres. These holes are now charged with cartridges, slow matches burning at the rate of 60 centimetres per minute are inserted, and the workmen retire in haste. The explosion seems to shake the mountain to its foundation; when all is over, the ground is found covered with fragments of the rock, and an advance equal to the depth of the holes has been obtained. On the Bardonèche side this year the average advance per month has been 50 metres; on the Mondane side it has not exceeded 38 metres per month, owing to the greater hardness of the rock on that side; there still remains the length of about 8,250 metres to be got through. When completed the tunnel will have required the piercing of 1,220,000 holes, 5,500 kilogrammes of gunpowder, 1,550,000 metres of slow match; and the number of bayonets rendered unserviceable will amount to 2,450,000.

The Council of the British Association have resolved that the next congress shall be held on Wednesday, September 6th, 1865, at Birmingham, as settled by the vote at Bath.

The Pneumatic Loom.—Mr. T. Page, C.E., reports on a new system of weaving by compressed air in the pneumatic loom. The improvement will affect the working of nearly 500,000 power-looms, the labour of more than 775,000 persons and the manufacture of about 1,200,000,000lb. of cotton alone. The principle upon which the new loom acts is that of discharging a jet of compressed air from the valves of the shuttle-box, upon the end of the shuttle, at each pick or stroke, and thus substituting for the imperfect motion of the "picker" the pneumatic principle, simply applied. The working velocities will be in proportion of 240 strokes by the new machine per minute, to 180 strokes of the old in the same time. This improvement applied to the whole of the power-looms of the United Kingdom would represent a total increase of 1,400,000,000 yards over the produce of the same number of existing machines.

Portable Steam Cranes.—Messrs. Taylor and Co., of the Britannia Ironworks, Birkenhead, have commenced the erection of two of their largest portable steam cranes alongside No. 2 dock at Chatham-yard, to be used in lifting the six-inch and other armour plates for encasing the sides of the *Bellerophon*, 14, 1,000 horse-power, iron-clad frigate, under construction in that dock. Each crane is capable of lifting a weight of twenty tons, but in order to prevent accidents fifteen tons will be the maximum weight they will be used to raise. Four of the smaller steam cranes manufactured by Messrs. Taylor are also in use alongside the Bellerophon dock.

Import of Cotton.—In the first three quarters of the present year raw cotton of the enormous value of £56,334,266 has been imported into this country, an amount equal to the sum paid for the cotton import of the entire year 1863, and far exceeding the value of the cotton import of any previous year. The value of the cotton import of the year 1860 was but £35,756,889, and the quantity received for that sum exceeded 12,000,000cwt. Only half that quantity has been received in the first nine months of 1864 for the far larger sum first mentioned. The quantity received in the first ten months of the year was 3.076,073cwt., in 1862; 4,226,127cwt. in 1863; and 6,146,796cwt. in 1864. In the first ten months of 1862 India sent us 2,190,604cwt., and Egypt 429,464cwt.; 1863, India, 2,611,985cwt., and Egypt 661,104cwt.; 1864, India 3,355,747cwt., and Egypt 892,419cwt.

Ammonia in Fires.—*Galignani's Messenger* states that an apothecary at Nantes has just discovered, by the merest accident, that ammonia will put out fires. He happened to have about seventy litres of benzine in his cellar, and his boy, in going down carelessly with a light, had set fire to it. Assistance was speedily at hand, and pail after pail of water was being poured into the cellar without producing any effect, when the apothecary himself took up a pail which was standing neglected in a corner, and emptied the contents into the cellar. To his astonishment the flames were quenched as if by magic, and upon examination he found that the pail which belonged to his laboratory had contained a quantity of liquid ammonia. The result is easy to explain on scientific principles—for ammonia, which consists of 82 parts of nitrogen and 18 of hydrogen is easily decomposed by heat, and the nitrogen thus set free in the midst of a conflagration must infallibly put out the flames. A large supply of liquid ammonia properly administered would be the promptest fire extinguisher.

Bursting of a Reservoir in Cumberland.—On the 1st ult., a catastrophe occurred at the seaport of Harrington, Cumberland, similar in some respects to that at Sheffield in the early part of last year, though upon a much smaller scale, and unattended with any loss of life. About eleven o'clock on that day a reservoir, three acres in extent, situated at a short distance from Harrington, burst, and deluged the main street with a wide stream described as some 4ft. or 5ft. in depth, which rushed down the street with a loud roar, the main body of water finally emptying itself into the harbour. The reservoir was one recently constructed to supply the new ironworks of Messrs. Bain, Blair, and Patterson. It was constructed in a valley, the adjacent hills forming two sides, and the low end being shut in by an embankment about 300ft. in length and 20ft. high. This bank was 5ft. thick at the top, and it gradually spread out towards the base, sloping on either side. The sides were formed of battered earth and clay, a section of clay puddle being placed in the middle. It was about ten months since the construction of this reservoir commenced, and it was almost completed when this catastrophe occurred. The recent heavy rains had filled it, and the bye-fall which carries the overflow into a beck and so into the harbour, proved inadequate to carry off the surplus water, which flowed over the side of the embankment, and, it is conjectured, washed away the earth on the outer side, and so gradually diminished the thickness of the embankment at one place until it was incapable of resisting the pressure from within, and finally the water burst through, making a chasm some 10ft. wide.

Industrial Exhibition for Reading.—A public meeting has been held in the Town Hall, Reading, when resolutions in favour of holding a working class industrial exhibition in the Town Hall in June next, and of raising a guarantee fund for the purpose, were unanimously passed.

A Ladder.—A ladder has been invented and patented by Mr. Henry Druce, of Oxford. It is constructed on the telescopic principle, and consists of a series of pieces or lengths, each of which forms a single and distinct ladder of itself. These ladders are made to slide one into another, so that the ladder can be extended to any length, according to the convenience of the person using it, and the number of pieces of which it is composed. When closed up it is about 6ft. long.

The Utilization of Sewage.—A number of noblemen, including the Dukes of Sutherland, Marlborough, Wellington, Rutland, and Manchester, have appended their names to the following resolution:—"That the pollution of rivers, by house sewage and by other matters, is a serious evil, affecting most injuriously the health and wealth of the population. We, the undersigned, are therefore anxious that the sewage of towns should generally, so far as possible, be utilised on our respective estates." The Earl of Clarendon and Lord Ebury signed the resolution in the following form—this was the form in which it was first agreed to, but it was inadvertently altered in being copied:—"That the pollution of rivers by house sewage, and by other matters, is a serious evil, affecting most injuriously the health and wealth of the population. We, the undersigned, are therefore anxious that the sewage of towns should be utilised on our respective estates, and generally so far as possible."

NAVAL ENGINEERING.

Twin Screws.—The trial of the *Rattlesnake*, twin-screw steamship, took place on the Thames on the 10th ult., and was attended with the most complete success, and was a further illustration of the value of the twin screw system which will undoubtedly prove a most valuable auxiliary for war purposes, and especially so for all ships whose armament is carried on the broadside, the twin screws giving vessels a power of revolving nearly, if not quite, equal to that of the turret or cupola. In addition to this one great advantage in its application to ships of war, the twin-screw principle also enables any vessel whether engaged in the pursuit of war or commerce, to carry a great weight with large engine-power at a lighter draught of water than can be attained under any other arrangement of a ship's propelling power. The *Rattlesnake* is a vessel of 200ft. in length, iron built, with a beam of 25ft. and a depth of hold 13½ft., and her tonnage, builders' measurement, of 615. She is fitted with engines of 200 horse-power, collectively, with a diameter of cylinders of 34in. and a 21in. stroke, the screws having a diameter of 9ft. and a pitch of 17ft. 6in. She is a fine clipper-looking craft, with two masts; schooner rigged, and two funnels, and is, in fact, almost a copy of the now celebrated *Talahassee*, excepting that the *Rattlesnake* is fitted with a poop, and a deck-house amidships, which the *Talahassee* was not built with. Messrs. John and W. Dudgeon, of Cubitt-town yard and the Sun engineering works, are the builders of both the ship's hull and her engines. The ship left Tilbury Pier at noon, and started on her voyage down the river at half speed, which a few minutes afterwards was increased to full speed, the tide being just after high water, with the wind fresh, easterly, and consequently meeting the ship full on her course down. The vessel soon began to give evidence of her great speed, passing every other steamer going the same way as herself. The Mucking Light was passed at 12h. 21m., the Chapman Light at 12h. 40m., Southend pier at 12h. 53m., the Nore lightship at 1h. 7m., and the Mouse lightship, the eastern extremity of the run, at 1h. 33m. In passing by the measured mile in the Lower Hope the distance was gone over in 3min. 37sec., which gave the ship a speed of 16·590 knots, the wind at the time freshening, and therefore giving proportionate resistance to the vessel's progress through the water. Passing the measured mile on the Maplin Sands the time was again taken and the ship's speed was found to be slightly increasing over the rate at which she ran past the mile in the Lower Hope. The distance between the Nore and the Mouse light vessels was accomplished in 26min., and this gave the *Rattlesnake* a speed of over 17 knots. It was merely a trial of engines and speed of the ship, all experiments in making the circles and revolving under steam being unnecessary, owing to the results gained on former trials of vessels fitted with twin screws, and which have been fully reported in The Artizan, as they have occurred. Soon after passing the Mouse light, the *Rattlesnake's* course was reversed, and her head laid for the Thames on her return to Tilbury. The distance between the Mouse and the Nore being run over against the tide in 30min. 10sec. The distance between the two light vessels is exactly 7½ knots and 100 yards.

Trial Trip of the "Valiant."—The iron-clad war steamer *Valiant*, 24, 4,063 tons, 800 horse-power, was taken on the 15th ult. for a trial in order to test the working of her machinery during several hours' full steaming, previously to entering upon her speed trials at the Maplin Sands. The *Valiant* is fitted with a pair of horizontal engines of 800 horse-power (nominal), of the double piston-rod class, and are similar, excepting in a few minor improvements, to those fitted on board the *Royal Oak*, the *Royal Alfred*, the *Zealous*, and others of the squadron of iron-cased ships by the same makers, Messrs. Maudslay, Sons, and Field. The cylinders are 82in. in diameter, with a length of stroke of 4ft., by which from 55 to 60 revolutions per minute are obtainable. The cylinders are encased in steam jackets, supplied with steam direct from the boilers, the slide-valves, which are double ported, being worked by double eccentrics and link motion. The expansion-valves are constructed on the revolving equilibrium principle, and are worked by wheelwork from the main crank shaft of the engines, the alteration of the range of expansion being effected by long sockets with spiral grooves, in the manner introduced by Messrs. Maudslay and Co. for steam engines in the early stage of screw propulsion. The screw is fitted with two blades of the Griffiths form, on the improved plan introduced by Messrs. Maudslay, by which the pitch can be readily altered when required from a minimum of 22ft. 6in. to 27ft. 6in. The boilers are of the ordinary tubular construction, with return tubes over the fireplaces, and are placed in the wings of the vessel, with the stoking-room amidships; the six boilers are heated by means of 24 furnaces, ranged 12 on either side of the stokehole. In addition to the large engines there are a pair of auxiliary engines, of 40 horse-power, with cylinders of 15in. in diameter, and a length of stroke of 14in. These auxiliary engines work two horizontal double-acting pumps of 7½in. in diameter, connected directly with the piston-rods of the engines, for the purpose of extinguishing fires. Connected with the pumps are ranges of pipes, with the necessary branches, traversing every part of the ship, so that a fire, wherever it might break out, can be readily extinguished. The auxiliary engines also drive two of Lloyd's silent fans, each of 3ft. 6in. in diameter, for ventilating the vessel, either by forcing a current of air into the different cabins, or by exhausting them and blowing into the coal-boxes, as may be required, the amount of ventilation being regulated by sliding-valves placed in each cabin, as well as in the different water-tight compartments of the frigate. The same engines also drive a fan for heating the cupola furnace, placed at the forward end of the stokehole, for preparing the molten iron for the Martin shells, and also to work an apparatus for raising the ashes to the upper deck. During the trial the engines worked with great regularity.

Unshipping and Raising Screw Propeller.—An invention has been patented by Captain W. K. Hall, C.B., commanding the Chatham steam reserve in the Medway, for the more speedy shipment and unshipment and the raising of screw propellers. It is expected to prove of great benefit in supplying a want which has long been experienced in the royal navy, as well as in the mercantile marine. Hitherto it has been found necessary to construct our vessels of war with a screw well to enable the screw propeller to be lifted to the deck for repair. By the adoption of Captain Hall's invention, however, this is no longer required, as by means of a system of chains and davits the screw can be easily lifted and disconnected from the threaded rods, the disconnection being effected by the removal of the "cotters" which hold the parts together. The davits are so arranged that should it be found convenient to remove one of the screw blades, or alter the pitch of the screw, there is no necessity for placing the screw on deck, as the required alteration can be effected in a simple and ingenious manner. The advantages of Captain Hall's invention are that screw propellers can be easily lifted on board without the necessity of docking the vessel for that purpose, while the simple machinery used does away with the necessity for the expensive tackle and apparatus required under the present arrangement. What is of far greater importance, any defect in the screw can be discovered and remedied without the necessity of the vessel losing any part of her voyage for that purpose.

The "Viper" and her Armour-plates.—The official testing of armour-plating for Her Majesty's ships was resumed at Portsmouth on the 2nd ult. with the trial of a 4½in. plate, measuring 15ft. by 3ft. 9½in. from the well-known firm of John Brown and Company, Atlas Works, Sheffield. The plate represented the armour for the twin-screw gunboat *Viper*, iron-built, of 737 tons and 160 horse-power of engines, constructing for the Admiralty by Messrs. John and Wm. Dudgeon. The firing was from the 95cwt. 68-pounder solid shot gun, at 200 yards distance, with the full service charge of 16lb. of powder, the armour-plate being bolted on the sides of the America target frigate. Twelve shots in all—eleven of iron and one of steel—were fired at the plate, the details of which it is unnecessary to enter into, owing to the superior quality of the plate both in material and manufacture. The steel shot fired at the plate, which was also from the works of John Brown and Company, had been before fired at a plate without suffering any danger. On this occasion it struck the *Viper's* 4½in. plate on the indent made by an iron shot previously fired, bnt, snch was the excellent qnality of the plate, the steel shot was foiled and nearly buried itself in metal 1in. and 2-10ths beyond the plate's outer surface. The "backing" of the plate was very inferior, the ship being, in fact, worn out for target pnrposes, notwithstanding which the plate went through its trial in a manner far beyond the general successful average of plates of the same thickness of metal. The *Viper* has been designed by Mr. E. J. Reed. Chief Constructor, and with a sister vessel building in another private yard, will inaugurate the introduction into Her Majesty's navy of the twin-screw principle, driven with independent engines. The building of the *Viper* has been consigned to the Messrs. Dudgeon by the Admiralty.

TRIAL OF THE "ACHILLES."—The iron frigate *Achilles*, 20 guns, 6,079 tons, 1,250 horse-power of engines, Capt. E. Vansittart, commenced her official trials in her sea-going trim on the 14th ult., at Portsmouth, with her run over the trial-ground at the measured mile in Stokes-bay, with full boiler power, and in making her circles—also under full power. The ship's draught of water was 25ft. 6in. forward, and 26ft. 10in. aft. She was not quite complete in all her stores, although the deficiency was but trifling, and she had 560 tons of coal in her bunkers, when she could have stowed 760 tons. The wind was moderately fresh, abont 4 in strength, from E.N.E., with smooth water. The engines drive a four-blade Mangin screw, the blades being fixed at equidistant intervals round the boss on the shafting, the diameter of the screw being 24ft. 6in. and its pitch 25ft. 5in. The following are the results of the *Achilles'* runs on this occasion :—

No. of rnn.	Time. M.	Time. S.	Speed of Ship. Knots.	Steam. Lb.	Vacuum. Inches.	Rev. of Engines.
1	4	13	14·220	22½	26	49½
2	5	6	11·764	23	25	49
3	4	3	14·815	23½	25½	49½
4	5	8	11·668	22	26	48½
5	3	56	15·254	23	25½	49¼
6	5	16	11·392	23½	25	50
7	3	50	15·652	23	25	50
8	5	19	11·284	25	26	50

Throwing the two first rnns out of calculation, the remaining six give the ship a speed of knots of 13·419. After the runs had been conclnded, the ship was tested in her turning powers in making circles with the following results :—To port: Half circle made in 4min. 21sec.; full circle, 8min. 36sec.; angle of rudder, 25·5; turns of wheel, 3; men at wheel, 21; time in getting up helm, 1min. 4sec.; revolutions of engines, 47.—To starboard: Half circle made in 4min. 4sec.; full circle, 7min. 56sec.; angle of rudder, 25·5; turns of wheel, 3; men at wheel, 18; time in getting up helm, 1min. 40sec.; revolutions of engines, 44. The next step, and the final experiment of the day, was to test the engines in their working to signal, which gave the following satisfactory resnlts :—Engines stopped from time of moving telegraph on the qnarterdeck bridge in 19sec., started ahead in 6sec., and from that position started astern in 16sec. The engines made 13·250 revolutions dnring the day, and their indicated power during the runs over the measured mile was, as near as possible, 5,000 horse. The temperatures taken during the first and last runs were—

When taken.	On deck.	Engine-room.	Fore stokehole.	Aft stokehole.
1st run	48	70 84 63	94 92 114	116 125 118
6th run	48	74 83 65	90 104 118	123 130 128

The official trial of the *Achilles* was concluded on the 13th ult. with her half-boiler power trials of speed at the measured mile, and her tested time in making circles to port and starboard. The runs over the measured mile gave the following results :—1st run, 5min. 10sec., 11·613 knots; 2nd rnn, 5min. 49sec., 10·315 knots; 3rd run, 4min. 55sec., 12·203 knots: 4th run, 6min. 4sec., 9·890 knots. The mean speed of the ship was 11·131 knots. The tested time in making the circles gave these results :—To port. Time in getting helm up, 1min. 9sec.; angle of rudder, 28 deg.; turns of wheel, 3·5; men at wheel, 14; half circle made in 5min. 17sec.; full circle ditto, 10min. 37sec.; revolutions of engines, 37. To starboard—Time in getting helm up, 1min. 32sec.; angle of rudder, 27·5 deg.; turns of wheel, 3·5; men at wheel, 14; half circle made in 5min. 14sec.; full circle ditto, 10min. 3sec.; revolutions of engines, 37.

TRIAL TRIP OF THE "CADMUS."—The screw steamer *Cadmus*, 21, 1,466 tons, 400-horse power, having nndergone extensive alteration and repair both to hull and machinery, was on the 8th ult. taken ont of Chatham harbour to the measured mile at the Maplin Sands, near the Nore, for the purpose of testing her steaming qualities, her former trials having proved unsatisfactory. Her engines were manufactured by Messrs. Penn and Sons. The cylinders are each 5ft. 4in. in diameter, and the length of stroke is 3ft. 3in. The four boilers are fed by sixteen furnaces. Since the *Cadmus* has been in the hands of the shipwright and engineer department at Chatham she has been fitted with a "left-handed" Griffiths screw, in lieu of her former Admiralty propeller. The screw weighs rather less than ten tons, and is 16ft. in diameter, with a length of blade of 3ft. 6in., the edge of the blades during the trial yesterday being 3in. out of the water. The screw is set at a pitch of 24ft., but this can be varied from 20ft. to 28ft. On being placed on the trial-ground six runs were taken over the measured mile, with the following results :—First run—time, 4min. 57sec.; speed, in knots per hour, 12·121; number of revolutions, 62. Second run—time 5min. 59sec.; speed, 10·027 knots; number of revolutions, 61. Third run—time, 4min. 58sec.; speeed, 12·5 knots; number of revolutions, 62. Fourth run—time, 5min. 12sec.; speed, 11·538 knots; number of revolutions, 61. Fifth run—time, 4min. 34sec.; speed, 13·138 knots; number of revolutions, 62. Last run—time, 5min. 16sec.; speed, 11·392 knots; and number of revolutions, 61. From the mean of these readings the first averages were 11·074, 11·263, 12·019, 12·338, and 12·265 knots; and the second means 11·168, 11,641, 12,178, and 12·301 knots, giving the true mean, or actual speed of the ship, as 11·882 knots per hour. The result is considered very satisfactory. It shows that the changes made in the *Cadmus* have increased her speed nearly 2¼ knots per hour, her average speed on the occasion of her last official trial at he deep-sea draught being only 9·709 knots per hour. On the former occasion of her trial it was found impossible to keep the steam at a greater pressure than 17·25lb., even with the throttle-valve but a quarter open. The exit area of the stoke-hole, which in other vessels of the corvette class amounts to 20 square inches per horse power, in the *Cadmus* was only 7-10ths of a square inch, and to these great defects the unsatisfactory results then obtained were attributable. Since that occasion the changes made have been very great, and these now combine to make the *Cadmus* one of the fastest of her class of vessels in the navy. After the full-boiler runs were completed a couple of runs were taken at half speed, with two of the boilers cut off, when the mean average speed realised was 9·05 knots. At the termination of the speed trials the steamer was tested in making the circles and half circles. When at full boiler power, with the helm brought over hard to port, at an angle of 21deg., the complete circle was made in 3min. 35sec.; at half boiler power the full circle was made to starboard in 5min. 50sec., with the helm at an angle of 27deg. The half circle at full power mas made to starboard in 2min. 11sec.; and to port in 2min. 5sec. From the time of telegraphing the order from the bridge to the engine room the engines were stopped dead from full speed in 15sec., and started ahead in 10sec.; the time occupied in starting astern after the transmission of the order was 6sec. The engines worked with remarkable steadiness and regularity, and there was a total absence of hot bearings. The boilers emitted a full supply of steam, and the indicator cards showed the actual work of the engines during the trial to be 1,580 horse power. During the trial yesterday the temperature, which on deck was 51deg., averaged 60deg. in the engine room, and 111deg. in the stoke-holes. The *Cadmus* has all her guns, shot, shell, and other stores on board, and her bunkers filled with upwards of 200 tons of coal.

NAVAL APPOINTMENTS.—The following appointments have taken place since onr last:—G. Tucker, Assist.-Engineer, to the *Cumberland*, as supernumerary; B. G. Little, of the *Donegal*, confirmed as Second-class Assist.-Engineer; R. Williams, Chief Engineer, to the *Orlando*; J. G. Bain, Assist.-Engineer, to the *Victoria and Albert*; T. F. P. Shelley and H. W. Wilkins, Assist.-Engineers, to the *Urgent*; E. G. Ashworth, Engineer, to the *Cumberland*, for the *Chasseur*: W. Dark, Engineer, to the *Cumberland*, for the *Fearless*; T. H. Kitto, of the *Defence*, G. F. Sutton, of the *Cumberland*, H. Hull, of the *Indus*, and W. Tottenham, of the *Royal Oak*, promoted to be Engineers; J. Gordon, of the *Curlew*, F. W. Robinson, of the *Triton*, W. Chase, of the *Euryalus*, T. Gray, of the *Sutlej*, W. Harwood, of the *Esk*, and W. B. Cottam, of the *Leander*, promoted to be Acting Engineers; J. W. S. Nott, Engineer, confirmed to the *Asia*, as supernumerary; G. Woolard, in the *Trafalgar*, E. Clark, supernumerary in the *Asia*, and N. D. Chambers, in the *Dauntless*, promoted to First-class Assist.-Engineers; W. G. Starling, of the *Enterprise*, promoted to First-class Assist.-Engineer; E. J. B. Bird, Chief Engineer, to the *Cadmus*; B. F. Pine, Chief Engineer, to the *Highflyer*; H. Knight, Engineer, to the *Cadmus*; J. Sumner, Engineer, to the *Highflyer*; J. Adams, Assist.-Engineer, to the *Highflyer*; H. J. Iles and J. D. Chater, Assist.-Engineers, to the *Cadmus*.

MILITARY ENGINEERING.

SMART PRACTICE.—At Shoeburyness, the Armstrong and Whitworth Committee fired 100 rounds rapid fire from the Armstrong 12-pounder breech-loader field gun. There was an interval of 10 minutes after the first 50 rounds. The time, as taken by the committee, was—for the first 50, 6 min. 58sec., and for the second 50, 6min. 35 sec.; 13min. 33sec. in all. Thus the gun was fired throughout the 100 rounds at the rate of 7½ ronnds a minute; and for the second 50 rounds at the rate of 8 rounds a minute. It was supposed on the ground that four shots were often in the air at the same time. This is by far the most rapid artillery fire on record, and it is more than twice as rapid than ever has been accomplished by any muzzle-loading gun. No water was used, nor any sponging, nor did any hitch of any sort occur. At the 52nd round the lanyard that pulls the friction tubes broke; this caused a delay of 20 seconds.

STEAM SHIPPING.

SHIPBUILDING AT PRESTON.—Works upon a considerably large scale have lately been established at Preston, Lancashire, for the construction of iron or composite steam and sailing vessels, the execution of girder works, &c. We understand the company are prepared to construct vessels up to 320ft. in length. They have in their manager (Mr. T. Smith, M. Inst. N.A., for some years with C. J. Mare and Co., and more recently General Superintendent of the shipbuilding establishment of Messrs. Randolph, Elder, and Co., Glasgow) a naval architect of considerable experience in his profession. Amongst vessels built from his designs and under his superintendence, we may instance a few whose names are familiar to the readers of THE ARTIZAN, viz.:—The *Chile, Quito, Payta, Talca, Colleen Bawn, M'Gregor Laird, Nora Creina, Surprise, Emerald Isle*, &c.

STEAMSHIP BUILDING ON THE CLYDE.—The *Osman Ghazy*, a war vessel of 4,200 tons burden, lately built by Messrs. Napier and Sons, of Glasgow, for the Turkish Government, has been successfully towed down the Clyde and berthed in Port Glasgow harbour, where her fittings will be completed. The *Osman Ghazy* drew 21ft. of water. The screw steamer *Liverpool*, lately launched from the yard of Messrs. A. and J. Inglis, has attained on her trial trip a speed of 12 knots; she has been placed on the Liverpool and Sligo station. The *Louisa Wallace*, a paddle of 930 tons, built by Messrs. Aitken and Mansel, of Whiteinch, has just been launched. Her dimensions are as follows:—Length of keel and forerake, 240ft.; breadth of beam, 28ft.; depth of hold, 11ft. 6in. She is to be fitted with oscillating engines of 250 horse-power by Messrs. James Aitken and Co., of Cranstonhill. The *Florence*, a blockade runner, built and engined by the same parties, has made a satisfactory trial trip, having "run the lights" (a distance of 14¾ nautical miles) between Cloch and Cumbrae, in 55½ minutes. The *Florence* is an iron vessel, 250ft. long, 31ft. beam, and 11ft. 6in. depth of hold; she is propelled by oscillating engines of 250 horse-power. Messrs. W. Simons and Co., of Renfrew, have launched for the Italian mail service the *Principe Oddini*, a screw, of 1,000 tons and 200 horse-power. She has accommodation for 1,000 troops, and has also first-class cabins for 100 passengers. Mr. J. G. Lawrie, of Whiteinch, has launched the *Rangitato*, a screw, of 650 tons, fitted for the accommodation of 140 passengers, and to be employed in the Australian mail service. Messrs. W. Denny and Brothers, of Dumbarton, have launched the *Ajax*, a twin screw, of 515 tons, and 120 horse-power. A duplicate vessel is expected to be launched in a few days. The *Ajax* and her neighbour, the *Hercules*, are intended for towing purposes. Mr. A. Denny, of Dumbarton, has on hand four tugs of 500 tons and 240 horse-power each. Messrs. T. Wingate and Co., of Whiteinch, have launched the *Bella*, a paddle, of the following dimensions:—Length between perpendiculars, 230ft.; breadth of beam, 26ft.; depth moulded, 10ft. 6in.; burden, 770 tons (builders measurement). The *Bella*, which has engines of 200 horse-power, is a sister ship to the *Armstrong*, built by the same firm. She is built to the order of Mr. J. Wilkie, of Glasgow. Four other steamers, three of which have been receiving repairs, have attracted a good deal of attention on the Clyde during the last few days. They are the *Flamingo*, the *Florence*, the *Alice*, and the *Fanny*. The *Florence* is a new steamer of 1,100 tons, and a sister ship to the *Banshee*. The *Alice* and *Fanny* have had an extensive overhaul. They were originally the *Orion* and the *Sirius*, built at Greenock in 1859 for the St. Petersburg and Lubeck Steam Navigation Company.

IRON SHIPBUILDING AT CARDIFF.—The first iron steamer constructed in Cardiff has been launched from the premises of Mr. N. Scott Russell. She is called the *Mallorca*, and is built for a Spanish Royal Mail Company, to run between Barcelona and the island of Majorca. Her dimensions are—Length, 230ft.; breadth, 26ft.; depth, 15ft.; and she is propelled by paddle engines of 190 nominal horse-power, which are guaranteed to drive her at 12 knots per hour. She is constructed upon Mr. Scott Russell's longitudinal principle, and is an elegant model. The iron is made by the Dowlais Company. The launch excited considerable interest, as being the first that has taken place from that port, and is expected to be the forerunner of many. Messrs. Batchelor and Messrs. Hill are also building iron ships.

AN IRON VESSEL FOR AN ENGLISH SHIPOWNER is in course of construction at the Transatlantic Shipyard, St. Nazaire. This vessel, which is of about 1,000 toas, is the first built in France for England.

THE TRIAL TRIP OF THE "VOLDROGUE," screw steamer, recently launched from the yard of Mr. Leath, at Rutherglen, recently came off sneeessfully. The vessel measures 155ft. by 19ft. by 14ft., and is fitted with condensing engines of 70 horse-power nominal, and capable of working up to 250. The distance between Cloch and Cumbrae Lights was run in order to test her speed, and it was found that she made fully 13 miles an hour, and was free from vibration.

THE "GEORGIA BELL" recently underwent her trial trip at Liverpool. She ran as far as the North-west Light-ship, and her average speed was 14 knots per hour.

TRIAL TRIP OF THE "EIDER."—The Royal Mail Company's new paddlewheel steamship *Eider*, intended for intercolonial service on the West India station, had her official trial at the measured mile in Stokes Bay on the 15th ult. This vessel has been built and engined by Messrs. Caird and Co., of Greenock, and is fitted out in every department with the most careful attention to the wants and requirements of the service in which she will be employed. Her leading dimensions are as follows:—Length, 296ft.; breadth, 32 1-10ft.; full tonnage, 1,563; registered tonnage, 1,144 24-100; horse-power, 310 nominal, She is fitted with tuhular boilers and surface condensers; cylinders, 64in.; length of stroke, 6ft. 6in.; diameter of wheels, 24ft.; and feathering floats. The results of four runs at the measured mile (the first and third runs against a strong tide) were as follow:—1st, 4min. 58sec., equal to 12·080 knots per hour; 2nd, 4min. 3sec., 14·815 knots; 3rd, 5min. 2sec., 11·920 knots; 4th, 4min. 5sec., 14·694 knots. Revolutions of engines, 27½; steam 30lh; vacuum, 27½lb. The Admiralty mean gave an average speed of 13·372 knots per hour. The quantity of coals on board was 330 tons, and the vessel's draught of water was 12ft. 7in. forward and 12ft. 11in. aft. The hull of the vessel is coated with Peacock and Buchau's improved compositions for ships' bottoms. The machinery worked with the most perfect ease throughout the trial. Four other steamers are now building for this company—namely, the *Douro* and the *Rhone*, 2,434 tons and 400 horse-power each; the *Danube*, 1,670 tons and 400 horse-power; and the *Arno*, 1,134 tons and 250 horse-power. Of these the *Douro* and the *Arno* are heing constructed hy Messrs. Caird and Co., and will be ready for sea by March and April next respectively.

Trial Trip of the "Nyanza."—The official trial of the Peninsular and Oriental Company's new paddle-wheel steamer *Nyanza*, named after the lake discovered by Messrs. Speke and Grant at the supposed source of the Nile, recently took place, at the measured mile in Stokes Bay. This vessel was huilt hy the Thames Ironworks and Shiphuilding Company, from designs by Mr. G. C. Mackrow, the naval architect to that company, and her engines were constructed by Messrs. Rennie, of Blackfriars-road, London. The *Nyanza* is 310ft. long, 36ft. in width, and 30ft. deep from top of keel to deck, her tonnage (builders' measurement) heing 1,988 11-94, and her displacement at the draught on trial of 17ft. 9in. fore and aft was 2,964 tons. She had on hoard 493 tons of coal, 46 of water, 75 of stores, and 57 of kentledge, giving a total weight of 671 tons. Four runs were made at the measured mile, and in spite of a very strong wind (force 6) from the S.W., the following very satisfactory result was obtained:—

	Steam.	Vacuum.	Revolutions.	Time. M. S.	Speed.
First run	26½lb.	26½lb.	25 lb.	4 55	12·203
Second run	25 „	26 „	24¾ „	4 0	15·000
Third run	25 „	26 „	24½ „	5 8	11·688
Fourth run	25 „	26 „	25 „	3 58	15·126
Mean	25⅝lb.	26⅛lb.	24⅞lb.		13·504

The engines worked throughout the day in a most satisfactory manner, not the slightest trouhle being experienced from hot hearings, priming, or any other cause. They are on the oscillating principle, cylinders 78½in. diameter, and stroke 7ft., the proportions heing considerably stronger than usual, in order to prevent liability to accident. The surface condensers contain 43,000ft., or nearly nine miles of solid-drawn copper tubes, fixed in Muntz's metal tube plates, arrangements heing provided so that the engines may be worked, if required, as an ordinary injection engine. The circulating water in the condensers is driven by centrifugal pumps, each of which is worked by an independent engine. The air pumps are worked by large eccentrics on a straight intermediate shaft—a plan hy which the crank in the centre of the intermediate shaft is rendered unnecessary, and which has heen adopted hy Messrs. Rennie in all the paddle-wheel engines lately constructed hy them. The boilers are on Mr. A. Lamh's pateut flue principle, with his improved "scroll" superheaters. We understand that these engines are the largest oscillating paddle-wheel engines using surface condensation which has ever yet been constructed on the Thames. The *Nyanza* has a spar deck, with direct and commodious accommodation fore and aft between decks. She has berths for 143 first and 34 second class passeugers.

LAUNCHES.

Launch of the "Limerick."—On the 10th ult. Messrs. J. Wigham Richardson and Co. launched from their iron shiphuilding yard, at Low Walker, a first-class passenger steamer of nearly 800 tons, O.M., named the *Limerick*, for the London and Limerick Steam Shipping Company. Her dimensions are—Length, 220ft.; heam, 28ft.; depth, 17ft., with direct acting engines, hy Messrs. R. and W. Hawthorn, of Newcastle. This vessel has a full poop, house amidships for passengers, and topgallant forecastle. She is fitted with cranes, &c., for cargo, and all the appliances rendered necessary hy the rapidly increasing trade of the sister isle.

Launch of a Turkish Ironclad.—The successful launch of the ironclad frigate *Sultan Mahmoud* from the yard of the Thames Ironworks at Blackwall took place on the 14th ult. Her length over all is, in round numbers, 300ft., her hreadth extreme, 56ft., and her depth amidships, 37½ft. Her tonnage is 4,220 tons; she is to have engines hy Messrs. Salkeld and Co., of 900 nominal horse-power, which can work up safely to 3,000, and her armament is to he 20 guns of the heaviest calibre which we yet know how to construct, or at least to use with safety to the gunners. Vessel, guus, masts, and rigging,—in fact, everything hut crew, will he English, when she is delivered to the Turkish authorities iu the Golden Horn, and she has been huilt under the inspection of officers of the Admiralty specially appointed for that purpose, and on the same plan of internal construction as that adopted in the *Warrior*, *Minotour*, aud other of the most celebrated vessels in our service. The improvement in the plating of the *Mahmoud* consists chiefly in making the plates thicker at the water-line, and gradually tapering them off as they rise to the level of the upper deck, so as to keep the great mass of dead weight as nearly as possible on a level with her centre of gravity, or line of flotation. At the water-line her plates are 5½in. thick, lessening upwards in a gradual reduction of thickness to 4½in. She was launched with no less than 172 of these plates, weighing about 700 tons, fixed on, so that now only an equal number of thinner plates remain to he bolted on to make her fit for active service. Though only a vessel of the *Hector* and *Valiant* class, she is, unlike them, coated with armour-plates from stem to stern, and fitted with a submerged prow or heak, for use as a ram as opportunities may offer. This "heak" is of the kind now tolerably well known as the swan-hreasted bow, which projects under water some 10ft. beyond the apparent hows, or what seems to be the actual length of the vessel. The theory of its use is, of course, that of striking an armour-clad enemy helow the water-line, and therefore also helow its armour.

TELEGRAPHIC ENGINEERING.

Pneumatics applied to Telegraphy.—The Electric and International Telegraph Company have lately opened a central station in York-street, Manchester; and to facilitate the despatch of messages to it from their hranch offices at Ducie-huildings and Mosley-street, they have connected the offices with pneumatic message or carrier tubes, similar to those they have applied iu London and Liverpool. The new system will enable the company to perform the service required of them more expeditiously and cheaply, and to obviate the liability to error consequent upon the transmission of messages hy telegraph between the ceutral and hranch offices.

The Atlantic Telegraph.—The new Atlantic cable is being coiled from the company's premises (late Glass, Elliott, and Co.'s), Morden Wharf, Greenwich, on hoard the *Amethyst* Admiralty vessel, for conveyance to the *Great Eastern* at Sheerness. The necessity of keeping the cable constantly under water has led to the erection of eight enormous tanks on the company's premises, into which the cable is daily being coiled from eight corresponding closing machines, at the rate of 80 miles per week. From these tanks it is being transferred to tanks on hoard the *Amethyst*, which will hold 110 miles. Another vessel, named the *Iris*, also lent by the Admiralty, has been altered and fitted with tanks which will hold 155 miles. The *Great Eastern* has been fitted with five large tanks, and it will occupy three days to transfer the cahle from the *Amethyst* to that vessel. The cable will he laid across the Atlantic by Messrs. Canning and Clifford in June next. The *Great Eastern* will have 500 hands on board, with a weight of 15,000 tons, including 4,500 tous of cahle aud 8,000 tons of coal.

RAILWAYS.

Metropolitan Railways.—Notices for twenty-seven bills have been given for lines and junction lines for the metropolis and the suburbs alone, but none of them are equal in magnitude to auy of those of last session. The Metropolitan District Company (part of the inner circle) merely propose to divide their authorised double junction line with the West London Railway, from Kensington to Fulham, and to purchase land, houses, and property for the purpose. The East London (Thames Tunnel line) have come forward with a modified scheme for constructing a railway from the Great Eastern at West-place, Bethnal-green, passing through the Thames Tunnel to the London and Brighton Railway at Deptford, with a hranch to the South-Eastern Railway, aud also to the Great Eastern at Liverpool-street, to Whitechapel, and to the London and Blackwall Railway at Mile-end Old Town. The Eastern Metropolitan propose to construct a railway from Aldgate to Mile-end. The Metropolitan and St. John's Wood Railway Company ask for power to extend their liue to Willow-road, Hampstead. The Waterloo aud Whitehall Company propose to make a railway from Great Scotlaud-yard, passing under the Thames to the Waterloo station of the London and South-Western Railway Company. The London, Chatham, and Dover propose to make a junction line from the Lambeth to the London and Brighton Railway at Hanover Park-road, to oblige the Crystal Palace and South London Company to abaudon the construction of the portion of the line from Camherwell to Denmark Hill, to make a junction line at Beckeuham, and to abandon the whole of their Bickley and other unauthorised junctions; they also propose to enable the London and South-Western Company to work over and use with their engines and carriages the railways, sidings, and stations of the London, Chatham, and Dover Company in Surrey, Middlesex, and London.

Railways in Sweden.—The railway betweeu Stockholm aud Malmoe, a town at the south of the Swedish peninsula, on the Sound, nearly opposite Copenhagen, has just been opened. The capital of Sweden is, in cousequence, at a distance of only twenty hours from the continent.

Railway Rates of Carriage and the Port of Liverpool.—It was stated, on the 15th ult., in the course of discussion at the Mersey Docks and Harbour Board, that the unequal rates of carriage charged by the railway companies, which have long been complained of as detrimental to the Liverpool trade, were discouraging the importation of guano at that port, and diverting the imports from the Chincha Islands to the eastern ports. Although no complaints have ever heen made of the warehouse charges for storing guano at Liverpool, as much as 7,000 or 8,000 tons have been taken to Hull during the past few weeks. It was shown that this was not only a loss to the reveuue of the port, but a great injury to shipowners, who were compelled to send their ships where no outward freights could be obtained. Several memhers stated that the rates of carriage from Hull to Manchester were as low as from Liverpool to Manchester; that the rates to the north were all in favour of Hull; and that a determination existed to send to Liverpool only so much guano as was required for the district immediately surrounding that port.

RAILWAY ACCIDENTS.

The Great Northern Railway.—On the night of the 8th ult., a Midland engine and a South Yorkshire train came into collision at Doncaster, and had it not beeu that the passenger train had not attained a high rate of speed the consequences would have heen more serious than they proved to he. The Midland train between Sheffield and Doncaster entered the Great Northern station at five o'clock, and the engine, as usual, passed on to the turntahle at the northern end of the platform to he reversed, iu order to be attached to the other end of the train to which it was when it came in. It had been turned and was proceeding to the southern end of the station when it met the South Yorkshire train for Thorne aud Keadby just leaving the down platform. A collision ensued, and both engines were thrown off the rails, and the up and down lines of the Great Northern were hlocked up. The passengers were much shaken aud two of them iujured.

Singular Railway Accident.—On the 13th ult. an accident of a somewhat unusual character happened to one of the trains at the Mortlake station of the Richmond and Windsor branch of the London and South Western Railway. The North London train, which left the new Kingston terminus at 3.25 p.m., reached the Mortlake station at 3.55, when it stopped for the purpose of taking up and setting down passengers. It had hardly resumed its journey before the driving axle of the engine broke in two, and the engine hecame immovable, thus completely blocking the up-line, aud considerably alarming the passengers.

Accident on the Great Western Railway.—An accident which might have heen attended with a large sacrifice of human line occurred on the line of the Great Western Railway, at the Panghourne station, on the night of the 15th ult. A narrow gauge special luggage train reached Panghourne shortly before teu o'clock, and from some defect in the valves of the engines, which caused a want of steam, the train was unahle to proceed. The switchman, anticipating the arrival of the Birmingham express, directed the driver to get on to the down line, and there appeared enough steam to enahle this to be done. Soon afterwards the down mail was due, and the luggage train moved from the "down" to the "up" line, aud it had not been loug there when the Birmingham express was observed to he in sight, aud the accident occurred. The auxiliary signal, when first seen by the driver of the express train, was stated by him to indicate that all was right, but almost immediately it was reversed, showing that there was something on the line. He did all in his power to stop the train, but it was proceeding at express rate, and the space was too short to admit of the speed being at all checked. The result was that the engine ran into the goods train, forcing the guard's hreak-van, which was at the end of that train, over a salt van on to the top of the third van from the end, where it remained, the first salt van being dashed into pieces, and the second extensively damaged.

Fatal Railway Accident.—An accident has occurred near Falstoue station, on the Border Union Railway. The morning through goods train from Newcastle to Edinburgh, cousisting of an engine, 22 loaded trucks, and a guard's van, was approaching Falstone, about 17 miles from Riccarton, at the rate of ahout four miles an hour, when one of the sets of wheels went on to the rails leading to a coal siding, and the other set remained on the main line. After running for a very short distance the engine started entirely off the rails, and almost immediately sunk in the ground. The impetus of the heavy waggons behind forced the tender right on to the top of the engine, and the consequence was that Peter Young, the driver, and William Morris, the stoker, were crushed to death instantaueously. Robert Aitchison, the guard of the train, escaped unhurt.

Accident on the North Kent Railway.—An accident occurred at half-past four on the afternoon of the 16th ult. in the Blackheath railway tunnel. The fast train leaving Maidstone at 2.40 p.m. ran into a hallast train a quarter of a mile down the tunnel from the Blackheath end, and three-quarters of a mile from the Charlton end. The last stoppage of the passenger train was made at Woolwich at a quarter past four, and the officials and passengers assert that the way was signalled clear hoth at Charlton and the entrance of the tunnel. Be that as it may, it is certain the fast train was in the act of going through the Blackheath tunnel at the rate of about forty miles an hour, when it ran with great force into the hallast train from Higham on its way up to London. In the collision five platelayers in the ballast train were killed on the spot. The passengers were thrown from their seats against each other with great force, and all were more or less injured. The engine of the passenger train was overturned and thrown across the two lines, and the greater part of the ballast and passenger carriages were broken into fragments. The engine is totally destroyed, and the loss to the railway company in the destruction of rolling stock is estimated at not less than £3,000. The 4.20 train from London was only stopped from entering the tunnel by one or two minutes.

DOCKS, HARBOURS, BRIDGES.

SUBMARINE AND OTHER FOUNDATIONS.—An arrangement proposed by Captain Heathorn, R.A., has for its object improvements in the construction of foundations in deep water, under the circumstances of a level, shelving, or sloping bottom of a varying density, possibly covered with mud, or shingle. His method of constructing the foundations for such structures upon a level bottom is as follows:—A caisson of annular construction, but so shaped as to give the space it encloses a conical form, is made of sheet iron; the bottom portion is floated out to sea exactly over the spot upon which the building is to be erected, and there anchored; concrete is then placed in the caisson, so as to cause it to sink equally; and as soon as it is sufficiently deep in the water, an additional height of the caisson is fixed, and more concrete placed therein to sink it deeper. This operation continues until a firm foundation is obtained by the weight of the caisson, with its interior filling of concrete causing it to sink through the mud or other soft ground to the hard ground beneath. The interior is then filled up with stone or concrete, upon which, and the concrete in the caisson, the superstructure is erected. For shelving or sloping bottoms the caisson will bear only upon the highest side of the same, and to preserve the perpendicular of the caisson, immediately it touches the hard ground stones are placed in the interior of the caisson, which will naturally settle themselves in such position as to form a wall underneath that portion of the caisson which does not touch the hard ground, thereby forming a foundation upon which the caisson may rest.

PROPOSED GREAT IRON GIRDER BRIDGE.—A great railway undertaking, resembling in character the Britannia, Saltash, and Victoria bridges, and surpassing even these in point of dimensions, is to be submitted for the sanction of Parliament in the ensuing Session. The North British and Edinburgh and Glasgow Railway Companies have given notice of a Bill empowering them to construct a great iron girder bridge across the Frith of Forth from near Blackness Castle, three miles above Queensferry, on the West Lothian Coast, to Charleston, in Fifeshire. The plans of the bridge have been prepared by Mr. Thomas Bouch, C.E. The length of the proposed bridge is 3,887 yards, or two miles 367 yards. It will be about seventeen miles from Edinburgh and thirty-four from Glasgow, and is intended to accommodate an express route from these cities to the north of Scotland, in connexion especially with what is known as the "east coast" route. Instead of a single span of 600ft., with two side spans of 300ft., which was the scheme of last year, it is proposed to make four spans of 500ft. each over the navigable channel, and spans diminishing to 200ft. and 100ft. on either side. The clear height of the bridge in the channel will be 125ft. at high water of spring tides, thus giving ample height beneath for the tallest vessels frequenting the ports of Grangemouth and Alloa. The frame of the girders over the widest spans will be about 70ft., giving a total visible elevation of 195ft. for the distance of nearly half a mile, the height diminishing at the ends of the bridge as the spans become reduced in width. Taking the submerged part of the work, the height will be 25ft. of foundation below the silt bottom, 50ft. of depth of water at ebb spring tides, and 18ft. of fluctuation of tides, making in all 285ft. in height of work to be executed. The middle piers will be of stone to the height of 10ft. above high water at spring tides, and the rest of the structure will be of malleable iron. The bridge will be built for a single line of rails, with a gradient in the south end of 1 in 134, and in the north end of 1 in 100, so as to give the necessary elevation in the middle. The dimensions of the Britannia Bridge may be stated by way of contrast:—Span, 460ft.; height, 104ft.; depth of tube, 30ft. The cost of the bridge is estimated at between £500,000 and £600,000, but, on the other hand, the companies would save the capital cost of piers, breakwaters, and steamboats, and cost of working the ferries. In connexion with the Tay Bridge an unbroken express line would be provided between Edinburgh and Dundee, saving the inconvenience, uncertainty, and delay of the Burntisland and Tayport ferries.

IRON BRIDGES FOR SERVIA.—Prince Couza has granted to an English company the concession for the construction of six iron bridges over the principal rivers in Servia. They are to be completed in three years.

MINES, METALLURGY, &c.

TIN MINES IN SPAIN.—At the Royal Institution of Cornwall, Mr. R. Pearce referred to an interesting specimen of crystals of tin, from Cospino, in Spain, which had been sent by Captain Bray from the mines which he was engaged in working at that place; and he trusted that at the spring meeting of the society Captain Bray would furnish them with a paper, and some specimens from the mines at Biarritz. The Cospino mines were in Galicia, about 60 miles distant from the mines Mr. Hustler was engaged in working. Dr. Barham said that great interest attached to the tin mines in Spain, owing to the fact of the Spanish Government having for a long time ignored the existence of tin in that country. Mr. Hustler, as they were aware, was now engaged in conducting tin mines in Galicia which had yielded large quantities of tin, which had been sold in this country; and he was glad to learn from Mr. Pearce that they were likely to have some account of the old and long-abandoned tin workings in Spain.

THE MINERAL WEALTH OF TURKEY.—The *Annales du Commerce Extérieur* mention especially as regards silver, the works of Gumch-Hané and Keban-Maden. M. de Tchihatcheff estimates the annual product of the first of these works at 17,520 okas and 40,000 drachmas, and that of the second at 142,350 okas and 160,000 drachmas. The *Annales* also mention the works of Archana-Maden, for the treatment of copper minerals, which, like the establishment of Keban-Maden, were founded by Austrian engineers; M. de Tchihatcheff estimates the annual production of the Archana-Maden Works at 720,000 okas. The presence of mercury has been indicated at Inact, Kreshovo, and in the neighbourhood of Foiniczn and Sustika; that of zinc at Kreshovo; and that of arsenic at Kreshovo and Soitza. These substances, however, are not worked. A letter from M. de Tchihatcheff to M. Elie de Beaumont has made known the existence of mines of alum in Asia Minor, between the town of Chabhana-Karahissar and the coast. These mines, badly worked as they are by Armenians, yield, nevertheless, a profit of 25 to 30 per cent., and if submitted to a suitable working they might give important results. The mineral is of great purity, and is extracted at little expense by means of works executed almost exclusively open to the sky. Turkey possesses mineral salt, lake salt, and marine salt. All Turkey in Europe is supplied by the salt mines of Rimnik, in Wallachia, the annual production of which is estimated at 65,000 tons, and by the mines of Okno, in Moldavia. M. Henschling indicates, besides, that there exist two springs of salt water in Bosnia, salt pits in Albania and in Thrace, and mines of mineral salt in Asia Minor, between Kaledjik and Osmandjik. A curious geological fact is noted—the existence of two great salt wells in a complete desert in the plain of Mossoul—one at five days' journey from Bonara, and the other at two days' journey from Achpor. The Arabs of the Desert collect the salt, load their camels with it, and carry it to Mossoul, whence it is forwarded to Kurdistan. The lake salt obtained proceeds from salt-water lakes at Kava, Gulf of Sarof, and Anchiala, on the Black Sea; in Albania, at Bastowna, near Aviona; at Paliuri, near Arta; at Tutschly, and in the pashalics of Sivas and Juzgath. The marine salt made available is furnished by the evaporation of the waters of the sea, especially on the whole western coast of Asia Minor.

STEEL-MAKING by means of graphite having been referred to by M. Regnault, M. Caron has been induced to make experiments, which he has reported to the Academy of Sciences at Paris. A bar of iron, one centimetre square and thirty centimetres long, was heated in a large earthen tube, filled with new graphite, broken into pieces about a cubic centimetre in size. The air had access at the extremities, imperfectly stopped by two pieces of graphite; and the tube of porous earth permitted the entrance of the gases of the furnace fed by graphite of the same kind. The tube was exposed to a cherry-red heat for six hours, at the end of which time the bar was drawn from the tube, hammered, and tempered, preparatory to its examination. The metal was fibrous; it could hardly be bent, when cold, without being completely shattered; its surface was easily acted on by the file; in fact, it gave no trace of having become steel. Other experiments gave similar results. M. Caron says that graphite is not the only carbon incapable of transforming iron into steel. Lampblack, probably coke, and all the carbons derived of alkalies and carburetted gases will give the same results.

IRON PRODUCTION IN NORTH AMERICA.—The value of the iron made in the States was estimated by the census returns at 20 million dollars in 1850, and 28½ million dollars in 1860, being an increase of 24 per cent. in the ten years.

COAL PRODUCTION IN THE UNITED STATES.—The coal production in the States in 1860 was 15½ million tons, of which 9½ millions was anthracite. Of bituminous coal Pennsylvania produced 45·8 per cent. of the quantity, and 38 per cent of the whole; of all kinds of coal, 75·3 per cent. of the whole.

PURCHASE OF A COAL FIELD BY THE FRENCH GOVERNMENT.—"Several foreign journals (says the *Constitutionnel*), in mentioning a proposition made to the French Government to purchase near its frontier coal mines of considerable extent, have added details which are completely incorrect, and misrepresent the purely commercial and industrial character of the arrangement. The following information on the subject we believe to be correct:—The coal beds in question extend to a length of 25 miles, by a breadth of 10 miles. The annual production is 60 millions of quintals (221¾lbs. each), and may be easily doubled, for several centuries, without fear of exhaustion. The coal, the quality of which is far superior to that of Belgium, is, according to an examination ordered by a German Government, only one per cent. below that of Newcastle. In the extent of ground abovementioned there are five beds of coal of equal value, presenting together a thickness of about 30ft., and the last of which is about 135ft. from the surface. A journal has spoken of a naval station on a sea where France has great interests, and the establishment of which would be consequent on the purchase of the mines in question. Our letters inform us that the place alluded to is on the coast of the German Ocean, and has an excellent harbour, almost opposite Heligoland. The cost of the coal, extraction and transport included, would be 20 centimes the 100 kilogrammes. Our letters add that the negociations which have been opened are progressing satisfactorily."

ACCIDENTS TO MINES, MACHINERY, &c.

COLLIERY ACCIDENT NEAR MOLD.—An accident recently took place at the works of Messrs. Craig, Taylor, and Craig, Leeswood Green Colliery, near Mold, whereby nine men lost their lives. The cause of the accident is attributed to water rushing into the pit where the men were working from an adjoining old pit.

GAS SUPPLY.

A MOVEMENT is at work in London to reduce the price of gas from 4s. 6d. to 2s. 9d. per 1,000ft., at which latter price the supply is given at Plymouth, which seems to be chosen as a special instance of what can be done by liberal management, both for behoof of the public and of the shareholders, who reap the highest profits allowable, while supplying the public at the lowest possible price. At a recent meeting of the London Court of Common Council, petitions were presented by Sir F. G. Moon and Deputy Reed from the inhabitants of the wards of Portsoken and Cripplegate, praying the Court to take some steps for the relief of the inhabitants from the injurious monopoly they now suffer in the supply of gas, and to have the supply increased, the quality improved, and the price lowered. The Court was also prayed to take the necessary steps to procure an Act of Parliament to enable the Corporation to supply the consumers within the City, and thus put an end to the present unsatisfactory, expensive, and insufficient supply. Eventually the petitions were referred to the General Purposes Committee.

AT BRIGHTON, the following arrangements have been proposed by Mr. Rutter, on behalf of the Brighton Gaslight and Coke Company, and accepted by the Provisional Directors of the Brighton Gas Consumers' Company:—The price of gas to be reduced from 4s. 9d. to 4s. 6d. on 25th March, 1865; on 24th June following, from 4s. 6d. to 4s. 3d.; and on 25th December, 1865, from 4s. 3d. to 4s. per 1,000 cubic feet. After 25th December, 1866, such further reductions are to be made as may be found practicable.

AT CREWE, in consequence of a resolution by the directors of the London and North-Western Railway Company to compel all gas consumers to deposit 5s. for each gas-light, a great public meeting has been held, where it was shown that such a deposit was unreasonable and uncalled for, that the interest on the gross deposits would amount to nearly £600 per annum (for which the gas consumers received no equivalent), and that the present price of gas—6s. per 1,000ft.—was preposterously high. It was resolved that the directors be memorialised, through the local Board, to abandon the demand of a deposit, and which for some time has been exacted from new comers.

AT KIRKALDY, in Fifeshire, Scotland, a ship has been despatched for the Island of St. Thomas, with full cargo (nearly 500 tons), consisting of gasometer, gas-pipes, bricks for building in the gasometer, retorts, &c., to be used in the erection of works for the manufacture of gas to light the principal town on the Island of St. Thomas. She also took out a number of mechanics, who are to be employed in the fitting up of the works.

IN CORK the Gas Consumers' Company have reduced the price of their gas to 4s. per 1,000 cubic feet; and for street lamps, £3 each, to be lighted the whole year round. The company is paying 8 per cent. The original capital of the company was £40,000.

A PARIS JOURNAL gives the following statistics respecting the manufacture of gas in Paris:—In 1854 the total quantity produced was barely 40,000,000 cubic mètres. The ten gasworks of Paris employ 2,691 persons for the indoor service, whose salaries amount to about 2,342,000fr. Besides these there are 444 lamplighters, &c., who each receive 60c. a day, amounting in all to about a million yearly. The whole length of gas pipes laid down in Paris exceeded 200 leagues in 1861.

APPLIED CHEMISTRY.

NEW MORDANT.—A new mordant, for aniline and other dyes, is said to have been discovered. It consists of acetate of aluminium and arseniate of soda, and the discoverer, M. Schultz, believes that it is destined to replace albumen, gluten, tannin, and other matters employed for the same purpose. He mixes, at the ordinary temperature, four grammes of the aniline violet of commerce, in powder, with a quarter of a litre of acetate of alumina, and twenty grammes of arseniate of soda, thickening it with starch boiled in water—the quantity of starch to be diminished in proportion to the darkness of the colour to be fixed. In the case of prints, it is recommended to mix the arseniate of soda and the acetate of alumina with the colouring matter, and to steam the fabric or yarns over the mixture. For dyeing, it is said to be better to treat the tissue, or yarns, in the first place, with a mixture of the two salts, and afterwards to dip them in the colour vat in the ordinary way. Salts or compounds of tin, combined with alumina, may be used instead of arsenical acid.

LIST OF APPLICATIONS FOR LETTERS PATENT.

WE HAVE ADOPTED A NEW ARRANGEMENT OF THE PROVISIONAL PROTECTIONS APPLIED FOR BY INVENTORS AT THE GREAT SEAL PATENT, OFFICE. IF ANY DIFFICULTY SHOULD ARISE WITH REFERENCE TO THE NAMES, ADDRESSES, OR TITLES GIVEN IN THE LIST, THE REQUISITE INFORMATION WILL BE FURNISHED, FREE OF EXPENSE, FROM THE OFFICE, BY ADDRESSING A LETTER, PREPAID, TO THE EDITOR OF "THE ARTIZAN."

DATED NOVEMBER 25th, 1864.

2946 W. Ward—Table covers
2947 R. W. Sievier—Cannons
2948 L. Leisler—Obtaining bromine, and in apparatus therefore
2949 J. Grundy—Apparatus for heating buildings or rooms
2950 T. Knowles—Points for railways
2951 C. Reeves—Breech-loading fire-arms, and in cartridges for the same
2952 T. B. Laws—Pipes for smoking
2953 L. Crozat—Portraits or images produced by photography
2954 A. V. Newton—Hasp locks

DATED NOVEMBER 26th 1864.

2955 C Hartley & T. Hall—Looms
2956 J. Evans—Bells
2957 M. F. Heinzmann—Eyeletting boots, shoes, and other articles
2958 J. Rowley—Separating or recovering the fibres of wool
2959 L. A. W. Lund—Buttons, and such like fastenings

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2960 T. Greenhalgh—Steam engines
2961 G. Newsum—Hauling apparatus, especially applicable to agricultural purposes
2962 W. E. Carrett, J. Warrington, & J. Sturgeon—Cutting coal
2963 J. R. Crompton—Paper
2964 J. Smith—Preparing linen, jute, and other textile fabrics
2965 L. Montaigue—Turbine for drying sugar and other watery matters
2966 J. H. Johnson—Stopping bottles
2967 S. S. Maurice—Collars

DATED NOVEMBER 29th, 1864.

2968 W. Jackson, J. Glaholm, & W. Glaholm—Hydro-beer pumps
2969 M. A. F. Mennons—Blast furnaces
2970 R. Mayuard—Separating and crushing agricultural produce
2971 A. I. L. Gordon—Hats
2972 G. Axton—Making bricks
2973 C. J. Falkman—Distilling
2974 W. Gache—Paving
2975 G. Davies—Sweeping roads
2976 A. Wheatley—Obtaining heat for generating steam
2977 J. D. De Boulimbert—Replacing tobacco in the manufacture of cigars
2978 J. Pinaud—Apparatus for indicating the time engaged and the amount of fares of carriages
2979 A. V. Newton—Pressing and baling goods
2980 A. E. Dobbs—Taking deep sea soundings without the use of a line

DATED NOVEMBER 30th, 1864.

2981 R. F. Dale—Drawing-off and measuring oils and other liquids
2982 E. W. Otway—Cleaning cotton
2983 W. J. Matthews—Breech-loading fire-arms
2984 M. Henry—Indicating and measuring escapes of gas
2985 H. Caunter—Preserving ships' bottoms and other surfaces under water
2986 J. Banger—Preparing the roes of fish
2987 E. B. Dœring—Levels
2988 E. M. Shaw—Feeding steam boilers
2989 A. Hawkes—Obtaining motive power
2990 J. Wheeler—Gloves
2991 R. L Hattersley & J. Hill—Looms
2992 J. McIntosh—Drawing rollers of spinning machinery

DATED DECEMBER 1st, 1864.

2993 J. Soper—Raising and lowering weights, such as Venetian blinds
2994 F. A. Wilson—Military practice in war
2995 T. Harris—Preserving meat and other perishable articles
2996 J. Taylor—Propellers for ships
2997 J. Sax—Electric fire buttons and indicators
2998 C. Binks—Separating sulphur from coal and coke
2999 J. Neat—Mechanical hair brush
3000 F. C. Rein—Apparatus by the use of which any sound will become inaudible to the wearer
3001 T. Wilson—Breech-loading fire-arms, and in cartridges
3002 C. Smith & W. Fletcher—Casks
3003 M. J. Roberts—Reducing friction

DATED DECEMBER 2nd, 1864.

3004 S. P. Kittle—Folding spring mattresses
3005 T. W. Gray—Pumps
3006 W. Clark—Apparatus employed for actuating railway brakes
3007 G. Waites & B. Cooper—Feeding of scribbling and carding engines
3008 W. Pollock—Textile fabrics, and in machinery connected therewith
3009 E. A. Cowper—Separating cotton fibre from the seed

DATED DECEMBER 3rd, 1864.

3010 E. Bevan & A. Fleming—Construction of bottles
3011 J. France—Steam engines
3012 J. K. Crawford—Ornamental fabrics
3013 R. A. Brooman—Apparatus for heating and cooking by gas
3014 R. A. Brooman—Ornament for the back of the head
3015 C. W. Lancaster—Fuzes
3016 J. W. Proffitt—Railway carriage and passenger signals
3017 J. G. Ulrich—Packing, conveying, and storing of gunpowder
3018 C. W. Siemens—Purification and combustion of gases for heating purposes

DATED DECEMBER 5th, 1864.

3019 G. Haseltine—Combined infant tender and exercising apparatus
3020 J. G. Winter—Revolving retorts, and applying heat to the same
3021 H. Wilson—Pumps
3022 R. Tye—Sliding gasaliers, gas pendants, and gas lamps
3023 S. Young—Mechanism or apparatus for obtaining motive power
3024 R. Shaw—Locking and unlocking the doors of railway carriages
3025 J. Goodier & T. Lee—Mills for grinding corn and other substances
3026 W Clark—Fire-arms
3027 J. Yearsley & E. Tinbrell—Cleaning rice
3028 W. E. Newton—Hand stamps
3029 W. E. Newton—Method of operating guns in fortifications

DATED DECEMBER 6th, 1864.

3030 T. Atkins—Regulating the supply of hydrocarbon and other gases
3031 H. Lamplugh—Carts for carrying sacks or other heavy bodies
3032 A Blampoil—Smoke consuming apparatus
3033 W. E. Gedge—Clockwork
3034 W. E. Gedge—Improved sanatory apparatus for female use
3035 W. T. Watts—Condensing products volatilized in furnaces
3036 G. Dixon—Ruche for chenille and upholsterer's trimmings
3037 J. Stephenson—Umbrellas
3038 T. Archer—Breaking stone and similar hard substances
3039 J. Keeling—Regulating the supply of gas
3040 A. H. Robinson—Combined stretcher, cushion, bed, and wrapper for use in railway and other carriages
3041 W. Clark—Boots
3042 G. T. Bousfield—Illuminating gas
3043 W. J. Burgess—Reaping machines
3044 M. P. W. Boulton—Obtaining motive power from aeriform fluids
3045 E. T. Hughes—Treating aniline colours for dyeing
3046 R. Richardson—Felt
3047 W. E. Newton—Blowing bubbles from soap-suds to amuse children
3348 C. A. Martius—Application of photography to the ceramic arts or to glass

DATED DECEMBER 7th, 1864.

3049 A. D. Hall—Coating the bottoms of ships
3050 A. Surflen—Washing compound
3051 A. Albert—Stamping apparatus
3052 W. Husband & J. Quick—Steam boilers
3053 M. J. Roberts—Winding wool, cotton, and other substances
3054 A. Smith—Decorating japanned ware and articles of furniture with paper

DATED DECEMBER 8th, 1864.

3055 J. Liveaey & J. Edwards—Permanent way of railways
3056 H. Wilson—Injecting tallow or other lubricant into steam boilers
3057 C. Oliver—Apparatus for sounding bells on lighthouses
3058 J. Norton—Construction of bows used by archers
3059 E. Myers—Wet gas meters
3060 C. Crockford—Traction on railways
3061 A. V. Newton—Machinery for cutting soap into bars
3062 R. A. Brooman—Apparatus for freezing
3063 E. Partridge—Axles

DATED DECEMBER 9th, 1864.

3064 J. H. Johnson—Facilitating the starting of railway carriages
3065 W. Tongue—Machinery for combing fibrous materials
3066 T. H. Roberts—Apparatus for retarding carriages

DATED DECEMBER 10th, 1864.

3067 J. Holly—Enabling the guard of a railway train to keep all the doors closed until the train is brought to a stand-still, and then disengage them all at once
3068 S. Truss—Construction of rails for the permanent way of railways
3069 A. J. Sedley—Bridges
3070 L. Morgenthau—Preparing tobacco for the manufacture of cigars
3071 J. Vaughan—Heating the blast for furnaces

DATED DECEMBER 12th, 1864.

3072 G. Rooper—Saws
3073 J. Ramsbottom—Steel and iron, and apparatus employed
3074 T. Wood—Communicating and signalling on railway trains
3075 E. Brooke—Glass-house pots
3076 R. A. Brooman—Ornamenting fabrics
3077 A. Moncrieff—Mounting ordnance, and in the machinery connected therewith
3078 R. Mathers—Sawing machinery
3079 A. Baker—Ascertaining the depth of water and the speed of vessels

DATED DECEMBER 24th, 1864.

3080 F. G. Mulholland—Purifying rosin and similar substances
3081 W. B. Adams—Railways
3082 R. H. Johnson—Construction of glass-maker's pots
3083 C. Reudoll—Atmospheric railway breaks and communications
3084 R. A. Brooman—Preserving and ornamenting stone
3085 A. Brittlebank—Apparatus for brushing the hair
3086 W. H Cullingford—Thermometers
3087 A. Pemberton & J. Ford—Effecting the drag in throstle spinning
3088 A. V. Newton—Solar timepieces
3089 G. Elliott—Capstans

DATED DECEMBER 14th, 1864.

3090 E. W. Otway—Roller gins for ginning and cleaning cotton
3091 J. Barnsley—Manufacture of seamless and solid iron tubes
3092 C. Hancock & S. W. Silver—Electric insulation
3093 C. Hancock & S. W. Silver—Colour printing
3094 C. Hancock & S. W. Silver—Surfaces for designs
3095 J. B. Thompson—Coating iron and steel with gold
3096 H. Taylor—Ruffles, frills, and other gathered fabrics
3097 J. Crowley—Moulds for casting hollow ware
3098 W. Whaldall—Cakes or lozenges made of plastic materials
3099 G. W. Belding & D. E. Holman—Shaping and pressing straw hats
3100 J. G Tongue—Watches and other similar time-keepers
3101 P. F. Lunde—Obtaining extracts from vegetable substances
3102 A. P. Price—Obtaining carbonic acid gas
3103 C. P. Coles—Loading ordnance
3104 S. Hood—Securing coal plates and similar coverings
3105 J. Leeming, J. Leeming, & J. Lister—Jacquard machine
3106 G. Kent—Cleaning knives
3107 A. F. J. Claudet—Photo-sculpture

DATED DECEMBER 15th, 1864.

3108 J. A. Pols—Obtaining purified or refined oils
3109 A. R Croucher—Communication between passengers and guard
3110 C. Hancock & S. W. Silver—Elastic waterproof sheets
3111 P. A. Le Comte de Fontainemoreau—Gun barrels
3112 S. Pettit—Obtaining motive power
3113 W. Clark—Decoration of walls and other substances

DATED DECEMBER 16th, 1864.

3114 W. E. Gedge—Steam engines
3115 W. Bardwell—Method of utilising sewage and urine
3116 J. Ellis—Melting of iron
3117 S. W. Hooper—Parchment
3118 R. A. Brooman—Separating the kernel from the shell of cotton seeds
3119 F. A. Chevallier—Horizontal photographic plane tables
3120 G. Brown—Cylinders used in the manufacture of articles of pottery
3121 J. White—Closets and commodes
3122 W. McNaught—Washing and drying wool and other fibrous substances
3123 W. Cotton—Looped fabrics
3124 A. H. Robinson—Portable bedstead
3125 M. J. Haines—Straps or bands for driving machinery
3126 J. L. Norton & W. Ainsworth—Looms for weaving

DATED DECEMBER 17th, 1864.

3127 J. G. Tongue—Raising and drawing off liquids and gas
3128 P. Salmon—Rolling stock of railways
3129 F. Cooke—Hats
3130 B. Dobson, W. Slater, & R. Halliwell—Ginning cotton
3131 A. A. L. P. Cochrane—Heating and evaporating liquids
3132 A. H. Renton—Fire arms
3133 W. Brookes—Steam blowers
3134 R. A. Brooman—Liquid meter
3135 F. Price—Mills for grinding corn and other substances
3136 H L. Hall—Elastic fabrics
3137 Z. Easton—Trams for street and other roads or ways
3138 W. Howes & W. Burley—Lamps for railway and other carriages
3139 H. Davey—Steam engines
3140 W. A. Turner & T. T. Coughin—Obtaining motive power

DATED DECEMBER 19th, 1864.

3141 J. A. Hopkins & C. Culpin—Apparatus for tilling the soil
3142 W. Tate—Armour for protecting wood and iron ships
3143 E. C. M. Bonnier—Perpetual motion by atmospherical pressure
3144 E. Swinarski—Breech-loading fire arms
3145 C. W. Orford—Measuring fluids at either high or low pressure
3146 Sir J. Gray—Taps or cocks for regulating the flow of waters
3147 H. F. McKillop—Compositions for coating or covering ships
3148 R. A. Brooman—Furnaces
3149 Sir F. Blackwood—Lifting shot to the fighting deck of vessels
3150 J. Butchart, H. Stroud, & S. A. Morrison—Reefing sails
3151 E. T. Hughes—Machinery or apparatus for making laces
3152 H. J H. King, H. E. Smith, & J. B. Howell—Slide valves

DATED DECEMBER 20th, 1864.

3153 D. Millar—Moving heavy bodies
3154 W. E. Gedge—Preserving velvets, ribbons, and similar articles
3155 H. Druneau & P. Laidet—Pumping bilge water out of ships
3156 S. E. Pettee—Signalling between passengers and guards
3157 P. Cameron & T. Bowman—Textile fabrics
3158 G. Leach—Fastening for books and such like articles
3159 T. A. Grimston—Breech-loading fire-arms
3160 H. Bird—Treating sewage matters
3161 S. P. A. de Brocalde d'Eluza—Manufacture of artificial manure
3162 W. Maynes—Picker band used in looms or weaving
3163 J. P. y Llagostera—Spinning cotton and other fibrous materials

DATED DECEMBER 21st, 1864.

3164 W. A. de Briou—Preserving metals, such as polished steel
3165 T. Woodward—Breech-loading fire-arms
3166 J. Westwood—Iron bridges
3167 C. E. Bryant & S. Middleton—Mechanical chair for brushing hair
3168 C. G. Hill—Manufacture of bonnet and cap fronts
3169 M. Henry—Governors
3170 F. Tolhausen—Method of aggregating coal dust
3171 J. Ramsbotton & T. Blackburn—Engines for obtaining motive power
3172 J. W. Cowles & W. Warren—Signals between different parts of a railway train
3173 L. R. Bodmer—Working hydraulic presses and cranes
3174 W. Reid—Vehicles for the conveyance of cattle upon railways
3175 J. H. Johnson—Photographic apparatus
3176 J. Hargreaves—Looms for weaving

DATED DECEMBER 22nd, 1864.

3177 R. Wilson—Bells
3178 H. Edmonds—Vessels from which fluids are poured out through tubular spouts
3179 J. Fothergill & J. H. Fothergill—Propulsion of vessels
3180 J. G. Aram—Mode of lighting household and other fires
3181 C. G. Wilson—Pressing cotton and other elastic substances
3182 J. Byrne—Governors
3183 A. Alison—A new species of currency preventing a commercial crisis in gold
3184 R. L. Howard & J. Dauglish—Making aerated bread
3185 J. Gillespie—Construction and manufacture of retorts

DATED DECEMBER 23rd, 1864.

3186 J. B. Edge and E. Hird—Finishing cotton heald
3187 T. P. Hawkins—Fencing staples
3188 G. Haseltine—Machinery for manufacturing metallic nuts
3189 E. Toconet—Facilitating the division of the warp during weaving
3190 W. E. Gedge—Apparatus for weaving borders on napkins
3191 J. Paterson—Treatment of jute and other fibrous substances
3192 J. Bethell—Preserving wood
3193 J. F. Wheeler—Combined portable inkstand, pen, and pencil holder
3194 T. Fagg and J. Fagg—Manufacture of boots and shoes
3195 R. A. Brooman—Coke ovens
3196 R. A. Brooman—Portable fire-arms and in cartridges
3197 E. Saunders—Affixing armour plates to vessels and other structures
3198 Lord J. Hay—Autograph stamps, and in apparatus connected therewith

DATED DECEMBER 25th, 1864.

3199 W. H. Maitland—Improvements in the construction of cotton gins
3200 E. Fielding—Power looms and apparatus connected therewith
3201 C. R. Bamber—Signalling apparatus for railway carriages
3202 E. Leahy—Construction and fitting of railway wheels
3203 B. Margulies and J. K. Leather—Chromates and bichromates
3204 J. Rowberry—Improved centrifugal drying machine
3205 A. V. Newton—Means for stopping leaks in boiler tubes
3206 T. Robinson—Tea pots and jugs having metallic covers
3207 E. Morewood—Improvements in the method of coating metals
3208 C. H. Taylor—Preventing accidents in mine shafts
3209 J. H. Cheatle—Improvements in rotary and other brushes
3210 T. Whitley and J. Jowett—Machinery used in combing wool
3211 J. P. Robertson—Connector applicable to bales used in cavalry stables

ST. GEORGE'S LAN

LIVERPO

DESIGNED BY W. FAIRBAIRN

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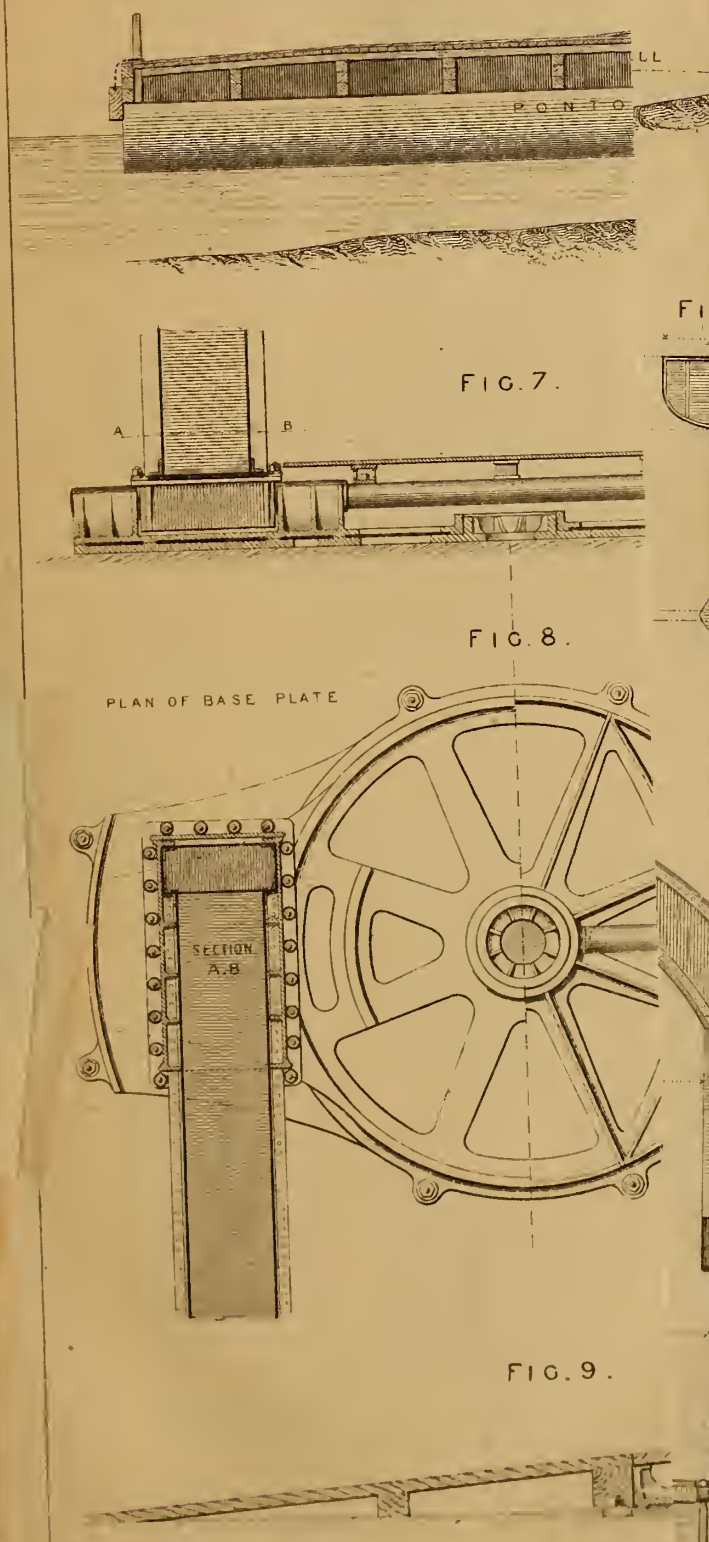

gn which was ultimately matured into
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drawings of this interesting structure
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ee wrought iron pontoons, the greater
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n easy curve, three of the pontoons at
ways, becoming gradually shorter, and
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3 and 4, are, with the exception of the end
ted, with flat top and sides, and rounded
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stiffened by means of eight bulkheads,
riveted to the sides and bottoms with
e connected by means of ten longitudinal
about 9ft. apart across the stage; the
12in. square, placed one upon the other,
ing in depth towards the centre, so as
about 12in. These girders are fixed to
eye bolts, which are passed into hooks
ontoons, and are secured to the girders
n the usual manner. By this arrange-
be readily removed from underneath
l whenever it should happen to have
are made of 9-inch timber placed about
n upon the main girders. A first layer
y 6in., is screwed down upon the joists,
by means of spikes, the upper flooring,
whole of this woodwork is made of a

iron caps, which themselves are provided
e flooring, are fixed at intervals of 10ft.
stage, and along the inner edge as far as
spaces between them are placed strong
uare at the base, tapered off to about
4ft. high above the stage, and besides

LIST OF APPLICATIONS FOR LETTERS PATENT.

We have adopted a new arrangement of the Provisional Protections applied for by Inventors at the Great Seal Patent Office. If any difficulty should arise with reference to the names, addresses, or titles given in the list, the requisite information will be furnished, free of expense, from the office, by addressing a letter, prepaid, to the Editor of "The Artizan."

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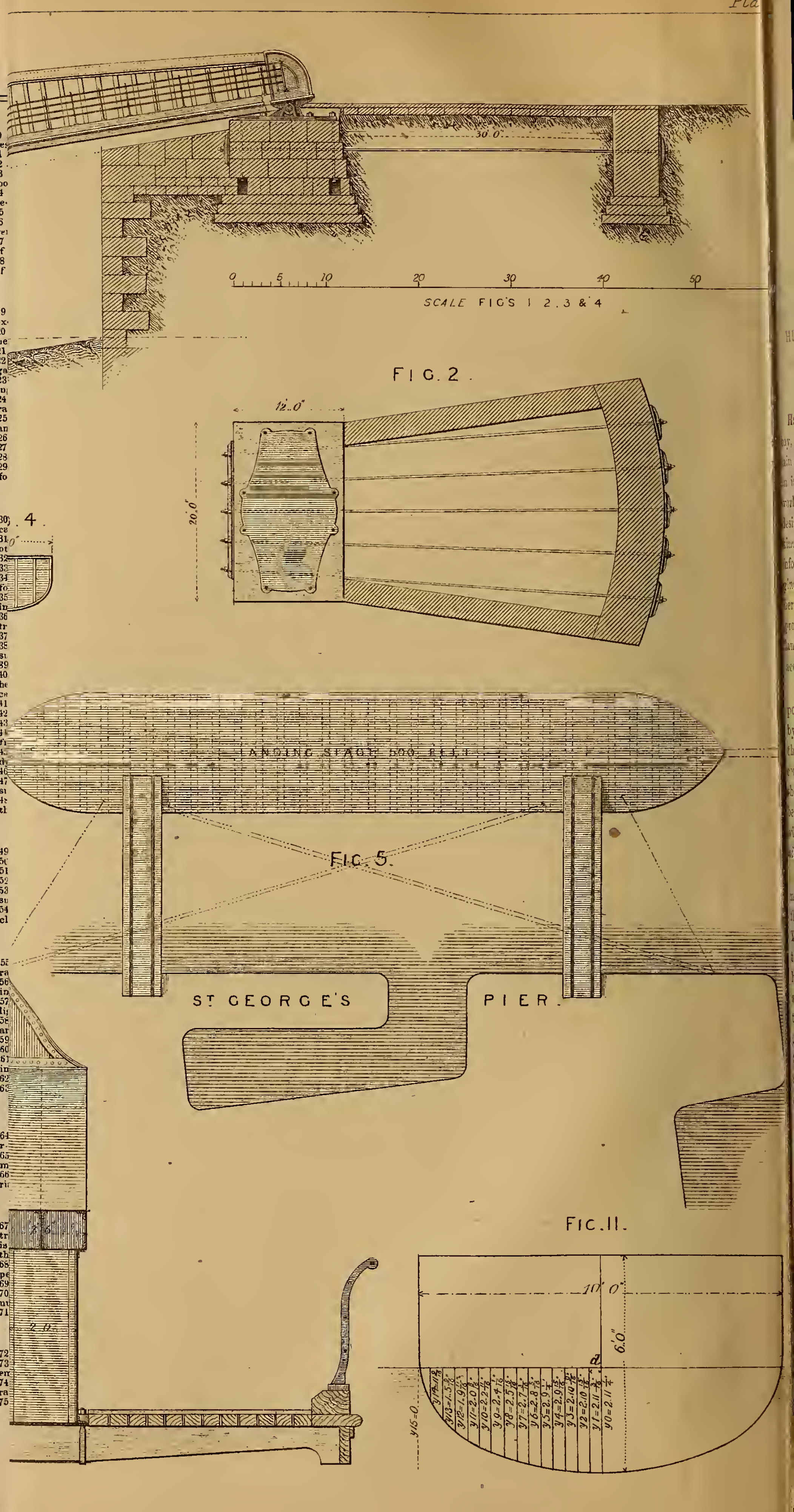


THE ARTIZAN.

No. 26.—Vol. 3.—Third Series.

FEBRUARY 1st, 1865.

HISTORICAL AND DESCRIPTIVE SKETCH OF THE MERSEY DOCKS AND HARBOUR.

By J. J. Birckel.

(*Illustrated by Plate* 274.)

Having completed our description of the estuary proper, and of the bay, our course now should be at once to enter upon a description of certain of the structural details of the Docks themselves, commencing with an inquiry into the nature of their foundations. But in preparing this work we are mindful that a considerable number of our readers are desirous of obtaining information of a mechanical nature, rather than the kind which we have so far laid before them in treating of this subject—information which belongs exclusively to the province of the Civil Engineer, and which is likely to minister to his wants alone. We, therefore, here shall deviate from that which would be the natural order of progression, and shall describe and analyse the principal features of the landing stage and its bridges, illustrated upon plate No. 274, and by the accompanying woodcuts.

The traffic, both of passengers and goods between Liverpool and its important trans-Merseyan foster child, Birkenhead, is carried on exclusively by means of ferry steamboats, since no bridge has yet been thrown across the river at any point lower than Warrington; and the proposition for constructing a submarine tunnel to connect the Lancashire and Cheshire shores which has from time to time been made, and which has just lately been revived again, has so far been but coldly received by the otherwise enterprising merchants of this great emporium of the foreign trade of the country.

Of the present extent of the traffic to and from Birkenhead some idea may be formed from the fact that the number of passengers which crossed the river during the last year has been computed at about 27,000,000. The number must, of course, have been considerably below this figure twenty years ago, during which period the trade of the port appears to have nearly doubled itself; and there cannot be the least doubt that the accommodation then provided was an encouragement to the traffic across the river, which must have greatly accelerated its growth, even if the general trade of the port had remained stationary. Assuming, then, that the traffic was only one-tenth its present amount—and this is putting it at a very low figure indeed—that would put the number of passengers daily at 7,600, the greater proportion of whom would cross and recross at the business hours of morning and evening, and all of whom had to wend their way down to the steamers by a comparatively narrow flight of steps, built into, and forming an integral part, as it were, of the river wall, close up to which the boats had to run before the stage was built. Thus it is evident that the passenger traffic must have been subject to frequent interruptions, either during stormy weather, or at low tides, when the boats could not reach the wall. At a later period, that is, just before the structure which forms the subject of this paper was designed, a small wooden stage was constructed to serve as a kind of landing platform, and no doubt in its days it must have been a great boon to those who had to cross the river frequently.

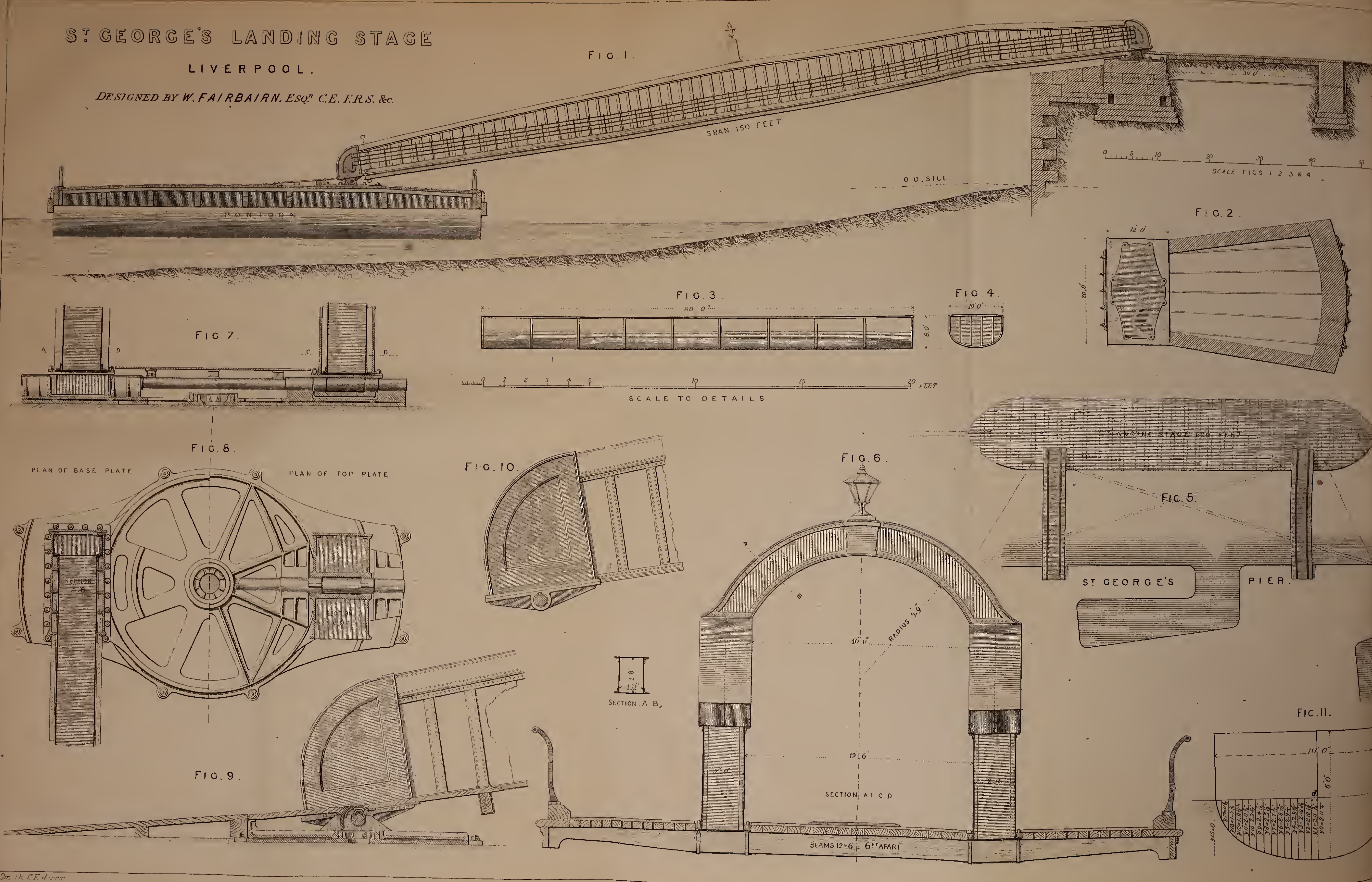
In 1845, however, the Dock Committee offered for competition, prizes for the best designs of a permanent landing stage, one of the conditions made by them being, that the stage should not project into the river; but they afterwards departed from this, their original condition ("as is always the case with competition committees," says our friend Mr. Boult), and awarded the first prize to the design which was ultimately matured into the subject before us, and which, as the reader will perceive, projects considerably out into the river.

We do not know who was the fortunate individual whose design was accepted; but the duty of reducing it into a practical shape, and of seeing it carried out, was entrusted to the late Mr. Cubitt, who himself confided to Mr., now Dr. Fairbairn, the task of designing and constructing the bridges, swivels, turntables, and of their land fastenings. Dr. Fairbairn has been kind enough to send us the shop drawings of the portion of the work designed by himself, and of its immediate connections, for we should here state that no drawings of this interesting structure now remain in the possession of the Dock authorities; and if, through the liberal spirit of the veteran engineer, we are enabled to lay its main features before the eyes of our readers, it is owing solely to his well-known conservative practices in the conduct and management of his own *very extensive* establishment so long as he remained at its head, one of the features of which was to preserve, as far as possible, a record of every engineering fact with which he had been connected, as much for the benefit of others as of himself.

The stage consists of thirty-three wrought iron pontoons, the greater portion of which are 80ft. long, 10ft. wide, and 6ft. deep; but as the stage is run to a point at each end by an easy curve, three of the pontoons at each extremity are tapered off endways, becoming gradually shorter, and the endmost ones are triangular in shape. It may here at once be said that this construction, which entailed a deal of trouble in the making of the pontoons, without any commensurate return, has not been repeated in any of the stages which have since been built.

The pontoons, illustrated in figs. 3 and 4, are, with the exception of the end ones, made of ¼-inch plates, lap jointed, with flat top and sides, and rounded bottom; the ends are riveted to the sides, top, and bottom, with 3-inch angle irons, and in their length they are stiffened by means of eight bulkheads, made likewise of ¼-inch plates, and riveted to the sides and bottoms with 3-inch angle irons. The pontoons are connected by means of ten longitudinal timber beams or girders, placed about 9ft. apart across the stage; the outer girders consist of two beams 12in. square, placed one upon the other, and the following ones go increasing in depth towards the centre, so as to give the flooring a camber of about 12in. These girders are fixed to the pontoons by means of linked eye bolts, which are passed into hooks riveted against the sides of the pontoons, and are secured to the girders by means of nuts and lock nuts in the usual manner. By this arrangement, any individual pontoon may be readily removed from underneath the stage, in order to be repaired whenever it should happen to have become leaky. The flooring joists are made of 9-inch timber placed about 3ft. 9in. apart, and are bolted down upon the main girders. A first layer of flooring, made of planks 4in. by 6in., is screwed down upon the joists, and upon this is placed and fixed, by means of spikes, the upper flooring, made of planks 2in. by 6in. The whole of this woodwork is made of a soft description of timber.

Mooring posts covered with cast iron caps, which themselves are provided with a strong base and bolted to the flooring, are fixed at intervals of 10ft. along the whole river front of the stage, and along the inner edge as far as the bridges at each end. In the spaces between them are placed strong wooden guard posts about 12in. square at the base, tapered off to about 10in. by 7in. at the top; they are 4ft. high above the stage, and besides


St GEORGE'S LANDING STAGE
LIVERPOOL.
DESIGNED BY W. FAIRBAIRN. ESQr C.E. F.R.S. &c.
FIG. 1.
SPAN 150 FEET
PONTOON
O.D. SILL
SCALE FIG'S 1 2 3 & 4
FIG. 2.
FIG. 3.
80' 0"
FIG. 4.
10' 0"
SCALE TO DETAILS
FEET
FIG. 7.
FIG. 8.
PLAN OF BASE PLATE
PLAN OF TOP PLATE
SECTION A.B.
SECTION C.D.
FIG. 10.
FIG. 6.
RADIUS 5' 9"
SECTION. A B.
SECTION AT C.D
BEAMS 12×6. 6 FT APART
FIG. 9.
FIG. 5.
LANDING STAGE 500 FEET
St GEORGE'S
PIER
FIG. 11.
W. Smith C.E. direxr

being fixed to the timbers below, they are bolted to the floor by means of strong wrought iron knees, and from them are suspended, with chains of about $1\frac{1}{2}$in. iron, large rubbing beams, about 2ft. 6in. wide by 15in. thick, all round that portion of the stage against which the boats may be moored, to prevent injury both to the pontoons and to the boats. Convenient sheds are placed upon the stage, subdivided into parcel and refreshment rooms, and an open shed, affording shelter to passengers in stormy weather. Gas and water mains are conducted down to the stage along the under side of the bridges, and the whole structure is conveniently lighted at all points, both for ordinary and for signalling purposes.

The bridges consist each of two hollow girders 150ft. span, with a clear roadway of 10ft. between them, and with a side walk of about 6ft. 6in. clear width outside each girder. The flooring of the roadway consists of a lower layer of planks, 4in. by 6in., and of an upper layer 2in. by 6in., and is carried upon joists 12in. by 6in., placed 6ft. apart, and the joists themselves are bolted to the bottom of the flanges of the girders by means of strap bolts. Two strong cast iron curbs are placed lengthways upon this roadway, in order to limit and define the track to be used by carts. The side walks are carried upon wrought iron brackets fixed to the under side of the girders, and made of two deep angle irons, bolted back to back; their flooring consists of one layer of planks about 3in. by 5in., not closely jointed. Along their outer edges are placed timber curbs, upon which are fixed strong wrought iron hand railings. These consist of standards, placed about 3ft. apart, which are alternately $1\frac{1}{8}$in. and $\frac{5}{8}$in. thick, and about $2\frac{1}{2}$in. broad. Through these are passed, at the top and near the foot, $1\frac{1}{8}$in. round bars, firmly fixed to each alternate standard by means of lock nuts, and two $\frac{5}{8}$in. rods are loosely passed through the standards in the space intervening between the upper and lower rails.

The girders are constructed on Dr. Fairbairn's cellular principle in the top or compression flanges, and are 9ft. $7\frac{1}{2}$in. deep in the centre, tapering down to 5ft. $10\frac{1}{2}$in. at the ends. The bottom flanges are made of two plates $\frac{7}{16}$in. thick in the centre of the girders, reduced to $\frac{3}{8}$in. towards the ends, by 2ft. 6in. wide; they are riveted to the sides by means of 3in. angle irons $\frac{3}{8}$in. thick, with $\frac{3}{4}$in. rivets placed 4in. apart; the joints of the plates are protected by long covering plates, chain riveted. The top flanges are 2ft. 6in. wide also, and the cellulæ are 12in. deep; their top and bottom plates are $\frac{3}{8}$in. thick in the centre, and $\frac{5}{16}$in. at the ends of the girders; their sides and mid feather are made of $\frac{5}{16}$in. plates throughout, and the whole is firmly riveted together and to the sides of the girders by means of 3in. angle irons, with $\frac{3}{4}$in. rivets; the joints of the plates are covered with strips $4\frac{1}{2}$in. wide and $\frac{5}{16}$in. thick. The cellulæ are turned down at the ends of the girders, and abut upon the bottom flanges—a mode of construction which ensures a very neat finish.

The sides of the girders are made of $\frac{1}{4}$in. plates 2ft. wide, increasing in thickness at the ends up to $\frac{1}{2}$in. The joints of the plates are covered outside with strips $4\frac{1}{2}$in. wide, and inside with T irons $4\frac{1}{2}$in. by $2\frac{1}{2}$in., corresponding in thickness with that of the plates, which they unite; the rivets are $\frac{3}{4}$in. thick.

Assuming the ultimate tensile strength of the iron to be 20 tons per square inch, the aggregate area of the bottom flanges of the two girders being 70 square inches, the span 150ft., and the depth of the girders 9ft. $7\frac{1}{2}$in., the breaking weight W, in the centre, will be found from the equation

$$\frac{W \times 150\text{ft.} \times 12}{4} = 115\tfrac{1}{2}\text{ in.} \times 70\text{ sq. in.} \times 20\text{ tons.}$$

Whence W becomes

$$W = \frac{115\frac{1}{2} \times 70 \times 20 \times 4}{150 \times 12} = \text{say } 360 \text{ tons.}$$

or 720 tons of a load equally distributed over the whole area of the bridge.

If the safe load be now taken at one-third the breaking weight, it follows that each bridge may be loaded to the extent of 240 tons; from this figure, however, must be subtracted 133 tons, the weight of the structure itself, leaving 107 tons for the safe external load; and as the total area of the table and side walks amounts to about 3,300 square feet, the safe external load per square foot would thus be about $\frac{2}{3}$ of a cwt. From this calculation it appears that the carrying capability of the bridges is considerably below that of the stage itself, as may be seen by referring to the subjoined estimate of weight and displacement; but if it be argued, as we believe it sometimes has been, that the weight of the structure itself should not be subject to multiplication by the factor of safety, then subtracting 133 from 720 and dividing by 3, the safe external load becomes $195\frac{2}{3}$ tons, and the safe load per square foot about $1\frac{1}{6}$cwt., which practically may be said to correspond with the maximum weight with which the stage may be loaded.

This coincidence of figures leads us to infer that the strength of the bridges was calculated according to the method indicated in the last instance.

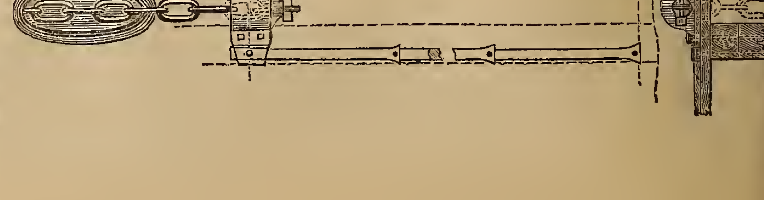
The factor of safety which we have adopted in this inquiry is, we are aware, considerably lower than that usually taken, but the maximum safe load thus obtained is one which practically can never be reached by a simple concourse of human beings. For the same reasons it will be found impossible to so load the stage as to entirely submerge the pontoons, so long as its use is confined to the objects for which it was intended; and thus it would appear that there has been perfect unity and consistency of purpose in the design of these two distinct elements of the entire structure, namely, the bridges and the stage proper.

If the factor of safety were taken at 4 instead of 3, the maximum safe load would become $\frac{7}{8}$ cwt. per square foot, which we are inclined to think is the greatest stress that could be attained with a crowd of human beings, provided, at any rate, the crowd be not in motion.

A cross section through the stage, and a longitudinal elevation of the bridges, as they appear at low tide, are shown in Fig 1, upon Plate 274, and an enlarged cross section through one of the bridges is illustrated by Fig. 6. Fig. 2, upon the same plate, also illustrates the land fastenings of the structure, and from it may be seen that the pier, which carries the bridge, is prevented from slipping forward by being moored to an arched wall, placed as far inland as possible, by means of a series of tie bolts.

The bridges are so constructed as not only to vibrate in a vertical plane with the rise and fall of the tide, but their centres of vibration are placed upon turntables (illustrated in the accompanying plate, at Fig. 7, 8, 9, and 10), which enable the axes of the bridges to take a horizontal angular deviation, under the action of the velocity of the stream. The wisdom of this precautionary measure will be quite apparent when it is stated that the stage shifts about 2ft. up and down the river under the action of the flood and ebb tides—a circumstance which shows that the structure possesses that amount of elasticity which is required to prevent undue strains upon the hinges of the bridges and their land fastenings.

The stage is moored to the river wall by means of 6 massive chains $2\frac{3}{8}$in. diameter, the general arrangement of which is shown upon the small scale plan (Fig. 5). One single chain at each end runs nearly straight across to the wall, and one double chain runs from each end in a diagonal line to the same mooring post as the single chain from the opposite end. The



stage, besides this, is moored to the river bed by means of two $1\frac{3}{4}$in. chains at each end—a precautionary measure, no doubt, to prevent it dashing against the wall, if from any cause the bridges should at any time be removed.

The fastenings of these chains upon the stage are illustrated by the woodcut in the preceding column, and those of all the other chains are similar thereto.

APPROXIMATE CALCULATION OF WEIGHT OF STAGE AND BRIDGES, AND OF THE DISPLACEMENT.

Pontoons.

		Lb.
Top, 10′ 0″ × 93′ 0″ × 10lb.	=	9,300
Sides, 19′ 0″ × 93′ 0″ × 10lb.	=	17,670
2 ends, 10′ 8″ × 5′ 3″ × 2 × 10lb.	=	1,120
8 bulkheads, 10′ 8″ × 4′ 0″ × 8 × 10lb.	=	3,440
455′ L iron, 3″ × 3″ × $\frac{1}{2}$	=	4,550
Total		36,080
Add $\frac{1}{12}$th for rivet heads		3,007
Total		39,087, say $17\frac{1}{2}$ tons.

	Tons.
For 32 pontoons	= 560

Timber Beams, Joists, and Flooring.

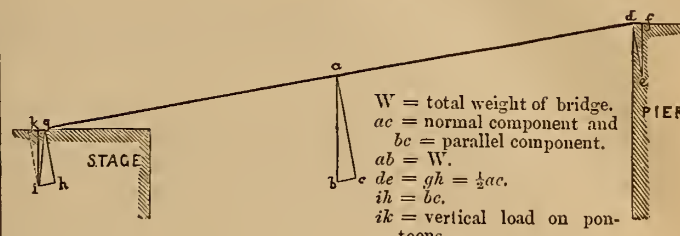
		Cubic Ft.	
10 longitudinal main beams, 2′ 4″ × 1′	=	10,465	
Flooring joists, about 11,300′ × 9″ sq.	=	6,328	
Lower layer of flooring, 4″ thick, 455′ × 81′	=	12,284	
Upper layer of flooring, 2″ thick, 455′ × 81′	=	6,142	
Rubbing beams	=	2,400	
Mooring posts and guard posts	=	700	
Total		38,319 at 45lb.	= 770
Cast iron cages to mooring posts			= $11\frac{1}{2}$
Spikes, wood screws, and bolts			= 19
Guard chains, railing iron, and iron railing posts			= 2
Iron knees for guard posts and chains for suspending rubbing beams			= 6
Anchor chains, mooring chains, and fixings			= 20
Turntables of bridges, with end caps of the latter			= $14\frac{1}{2}$

Bridges.

			Lb.	
Bottom:	1 girder, 48′ of 2 plates, 2′ 6″ × $\frac{7}{16}$	=	4,200	
	„ 107′ of 2 plates, 2′ 6″ × $\frac{3}{8}$	=	8,025	
	25 covering plates, 2′ 8″ × 2′ 6″ × $\frac{7}{16}$	=	2,900	
	330′ L iron, 3″ × 3″ × $\frac{5}{8}$	=	4,125	
				19,250
Top:	96′ plates, 2′ 6″ × $\frac{3}{8}$	=	3,600	
	227′ plates, 2′ 6″ × $\frac{5}{16}$	=	7,093	
	498′ vertical plates, 12″ × $\frac{5}{16}$ = 6,225	=	6,225	
	1780′ L iron, 3″ × 3″ × $\frac{7}{16}$	=	16,000	
	216′ covering strips, $4\frac{1}{2}$ × $\frac{3}{16}$	=	650	
				33,568
Sides:	812′ plates, 2′ 0″ × $\frac{1}{4}$	=	16,240	
	45′ 6″ plates, 2′ 0″ × $\frac{5}{16}$	=	1,137	
	42′ 6″ plates, 2′ 0″ × $\frac{3}{8}$	=	1,257	
	41′ 6″ plates, 2′ 0″ × $\frac{7}{16}$	=	1,453	
	58′ 0″ plates, 2′ 0″ × $\frac{1}{2}$	=	2,320	
	15′ 0″ plates, 1′ 6″ × $\frac{1}{2}$	=	450	
	1,000′ strips, $4\frac{1}{2}$′ × $\frac{1}{4}$	=	3,750	
	1,000′ T iron, $4\frac{1}{2}$ × $2\frac{1}{4}$ × $\frac{6}{16}$	=	7,250	
				33,857
	Total			86,675
	Add $\frac{1}{12}$th for rivet heads			7,220
	Total			93,895

Or say, for one girder, 42 tons, and 2 girders	84 tons.
Timber in flooring and joists	38 „
Spikes, screws, and bolts	1 „
Railing and railing posts	$2\frac{1}{4}$ „
Cast iron curbs	$7\frac{1}{2}$ „
Total for one bridge	133 „

The maximum load upon the stage, as derived from the weight of the bridges, occurs at lowest tides when the distribution of the weight is obtained from the accompanying diagram, from which it may be computed for the two bridges at	= 140
Approximate weight of sheds, parcel and refreshment rooms	= 60
Lamps, lamp posts, landing bridges, and sundries	= 6
Total load	1,620



NOTE.—In this diagram it is assumed that a temporary equilibrium has taken place similar to that which would obtain if both abutments of the bridges were immovable.

The stage may be assumed to be carried by 32 pontoons of equal dimensions, when the load per pontoon becomes 50·72 tons, and the displacement 50·7 tons × 35 = 1775·2 cubic feet. The pontoons being 80ft. long, the area of immersion will be 22·19 square feet, and the depth of immersion or greatest draught of water will be 2ft. $11\frac{1}{4}$in. nearly, as may be seen by computing the area thus immersed, from the diagram, Fig. 11, on accompanying Plate, by means of Simpson's rule. Thus, if the half width of the pontoon be divided into 15 parts, each of these will measure one-third of a foot, and the formula

$$A = \tfrac{1}{3} d \left[y_o + y_n + 4 \left(y_2 + y_4 + \text{etc.} + y_{n-1} \right) + 2 \left(y_1 + y_3 + \text{etc.} + y_{n-2} \right) \right]$$

becomes,

$$A = \tfrac{1}{9} \left[2'\,11\tfrac{1}{4}'' + 4 \left(2'\,10\tfrac{15}{16}'' + 2'\,9\tfrac{15}{16}'' + 2'\,8\tfrac{5}{16}'' + 2'\,5\tfrac{15}{16}'' + 2'\,2\tfrac{11}{16}'' + 1'\,9\tfrac{9}{16}'' + 11\tfrac{9}{16}'' \right) + 2 \left(2'\,11\tfrac{3}{16}'' + 2'\,10\tfrac{9}{16}'' + 2'\,9\tfrac{3}{16}'' + 2'\,7\tfrac{3}{16}'' + 2'\,4\tfrac{7}{16}'' + 2'\,0\tfrac{5}{16}'' + 1'\,5\tfrac{9}{16} \right) \right] = 11{\cdot}17 \text{ sq. ft.}$$

or for the two halves, 22·34 sq. ft.

The remaining available depth of immersion under external loads is therefore 3′ $0\frac{3}{4}$″, and the available displacement per pontoon,

$$3'\,0\tfrac{3}{4}'' \times 10' \times 80' = \text{say } 2{,}450 \text{ cubic feet;}$$

or, assuming 35 cubic feet to correspond to a ton,

$$\frac{2{,}450'}{35} = 70 \text{ tons;}$$

and for 32 pontoons,

$$32 \times 70 = 2{,}240 \text{ tons.}$$

The area of the stage may, with a sufficient degree of approximation, be taken at

$$455 \times 81 = 36{,}855 \text{ square feet;}$$

to which should be added one-half the area of the two bridges, or

$$150 \times 22 = 3{,}300 \text{ square feet;}$$

making a total of 40,155 square feet; and the total load per square foot required to submerge the pontoons entirely may be ascertained to be

$$\frac{2{,}240 \times 20}{40{,}155} = 1{\cdot}11\text{cwt.}$$

or $1\frac{1}{10}$cwt. about.

No concourse of human beings, however densely packed, could load the stage to that extent; and it may therefore be said that the carrying capabilities of this structure are quite commensurate with the objects for which it was designed.

The total cost of this landing stage was £57,000.

(To be continued.)

NAVAL WARFARE.—SHIPS AND GUNS.

Notes and Suggestions on the State of our Navy, 1865.

The present state of change and so-called reconstruction in our navy, unsatisfactory as it is in many respects, is yet satisfactory in one way, showing that our naval authorities are awake to the necessity of keeping pace with the continual fresh discoveries and appliances in offensive and defensive warfare made both here and in other countries. Thus in the last few years we have seen the gradual conversion, of our sailing ships, first, into paddle, then into screw steamers, now into ironclads and turret rams; and, perhaps we shall have next, submarine torpedoes, driven with two screws instead of one.

But, unluckily, we have been working very much in the dark, and too hastily, so that each new step in advance, showing us that much that has been done before has been in a wrong and useless direction, opens the way to fresh modes of attack, and tends to further constructive changes.

It would greatly further the adoption of a sounder system for the future if all the most eminent nautical and engineering men of the day were consulted, to whom might be submitted for trial the many likely schemes of inventors on these subjects. The Admiralty plan seems hitherto to have been to build new and vast armour-plated ships hastily and at great cost, and afterwards, by experiments on their targets, to prove that they would easily be riddled by steel projectiles. In fact, Mr. Reed and the Admiralty have been designing too hastily, and without looking far enough ahead; and though lately we have obtained some fine new additions to our ironclad fleet in return for the immense sums lavished in this direction, we have also bought with them, and very dearly too, the knowledge that none of them are, or apparently can, be made impenetrable; but that they can all be pierced by heavy steel projectiles, nearly as easily as our former wooden walls were by the old 32-pounder, and that, too, leaving rams and submarine attacks out of the question. Modern shells, with stronger powder, and heavier projectiles may play a more destructive part on them than has ever yet been seen in the annals of naval warfare. Besides their seagoing and fighting qualities have yet to be proved. And although it may be alleged for our comfort that we are far ahead of all other nations in shipbuilding resources, as well as in vessels actually afloat, and in all means both of attack and defence, yet even if this were the case, we have not yet attained in our war ships many desirable and requisite qualities which they should, and might, possess; and certainly we have not yet succeeded in combining in any one ironclad ship great speed and heavy guns with light draught of water, quick manœuvring powers, with sufficient stowage for fuel, and protection against sinking, by the adoption of water-tight compartments. Many other requirements are necessary to make a ship of war efficient at the present day, and their combination is the difficult nautical problem which we have yet to solve.

It must be remembered that other nations, France and Russia especially, are following in our steps and profiting by our experience, are also avoiding our mistakes, and availing themselves of our engineering and mechanical resources, are ready to pick up reward, and make use of valuable suggestions and inventions which our Admiralty neglect. It is not so much a question of nautical skill and courage (in which we still pride ourselves, and perhaps justly, to be pre-eminent), but rather of skilfully using mechanical resources; and we must not trust to the chance of any of our adversaries not possessing and using similar advantages in means of attack and defence.

It seems now certain that guns with steel shot, and, perhaps, shell too, can be made and worked on board ship to penetrate any iron armour side that any sea-going ship can safely carry; and so our search for impenetrability seems useless, and it would seem that we are but loading our vessels with a fearful useless weight of armour which renders them unseaworthy in bad weather, and unable to carry more useful loads, such as more fuel, or means of attaining greater speed, or heavier guns; and as it would be impossible to plug up shot holes made at sea in an iron plated vessel, she would only sink the quicker for her weight of armour unless buoyed up (which none of them as yet are) by a sufficient number of watertight compartments.

It would be wiser to turn our attention to try and utilise the weight otherwise by making our ships practically unsinkable by some such system as Mr. Lumley's, for instance. Also we might make more use of tough steel in shipbuilding and engineering than hitherto, thus securing strength with lightness. If armour plating be used at all in future, it should only be employed in forming as perfect a protecting belt as possible round the water line, and for, say about 5ft. above and 5ft. below it, and also to protect the crew, guns, powder magazines, steering apparatus, and rudder, the pilot, screws, boilers, and steam machinery (which last should be kept as far below the water line as practicable). And it will be advisable to place all armour plating as much at an angle as practicable, to slant off and turn the force of a shot. Thick wooden or other backing helps much to deaden the force of a blow from shot, but unless it can be rendered uninflammable, it is dangerous if shells be used against it; and it must also be provided with an inner iron skin to stop splinters.

Another important point to be considered in the construction of our future ships of war is their protection against, if not their employment as, rams and submarine means of attack, such as torpedoes, which will probably be much used in future naval warfare. The cellular system of numerous compartments will be indispensable in strengthening the bottoms of ships against such like so-called infernal machinery; and though it is true that it is difficult to secure comfortable and healthy ventilation and light in such vessels, yet it must be tried, as such submarine craft are already being constructed in America and for Russia. This should be a warning and caution to ourselves.

A vessel shaped something like the cigar ship (if it can be made seaworthy), only capable of acting as a ram either way, and fitted with gun turrets, would probably be a formidable enemy, and hard to hit, as she would expose (as all war ships should) but little surface to an enemy, and that sloping; and if painted a light sea-green colour, and made to dodge about in circles at long range, would probably seldom be hit. Masts and sails should be little depended on in war ships, as they are too conspicuous, and offer a mark to the enemy, and are so liable to be shot away and hamper the ship and screw in their fall. If used to give sailing advantages, and save fuel, they should be light, and so fitted as to be lowerable during fighting. The strongest construction for a ship's bottom seems to be double and cellular in many compartments filled in with wood between, and should be readily accessible everywhere, as also the inner sides, to repair damages; otherwise it would be a good plan to protect the vessel on the inside by a belt or trough-like compartment, running all round, and filled up with coals, shot, or shell, and with such an internal belt or trough (being water-tight) it would not signify, even if water entered into it through shot-holes, as it could get no further. The machinery of a vessel is, in fact, often thus protected by being surrounded by the coal bunkers. The outer side of an iron vessel might be protected against fouling and corrosion by first sheathing it with wood, and then coppering on this.* Felt, pitch, red leaded canvass, india-rubber, or some such substances, might be applied between the wood and plating, if found necessary. The inside of an iron vessel may be protected by sheathing in a similar manner, which would keep the plates and rivet heads from corrosion by the bilgewater. Speed and powers of manœuvring combined with superior range as well as power of guns, will in future determine the issues of naval fights.

War ships should also draw as little water as possible, to render them more useful on shallow coasts and river service, and they should be of a moderate length and handy size for quick manœuvring. We can get speed without going to such monster size as our *Achilles*, *Minotaurs*, &c., whose vast unwieldy bulk possess no advantages save weight, with the greater counterbalancing drawback of being huge targets for an enemy's guns, and of drawing some 25ft. to 30ft. of water. Speed and handiness, *i.e.*, quick turning power, will be gained by using two screw propellors (on the twin principle astern), to which system, instead of a single screw, we shall probably have to adapt our war ships before long, and the sooner we do so the better, instead of going on with the inferior plan; for the twin screw system possesses many advantages, requiring less draught of water and lighter machinery, which will be easier, cheaper, and quicker to make, fit, and repair, and also gives equal speed with increased turning and steering facilities.

The twin screws being smaller, may be immersed deeper, and so work better and safer; and if one of them, or one engine be damaged, or even if the rudder be injured, any vessel so fitted with two screws is not helpless and unmanageable as a single screw ship would be, but may be worked with one screw, or engine independently; or steered with the two screws without necessitating any use of the rudder if that be damaged. Very few of our present war ships are fast enough for cruisers; and as there are many slow ones, and many which carry only a few days' fuel, they are unfitted for combined use as a squadron.† All war ships should also be so strongly built that they may be used as rams if necessary (as in the

* Mr. Reed has thus protected the armour plates outside.

† The value of a combined squadron must be measured by the speed of its slower ships.

case of the *Tennessee*, American ram); but this power, though valuable, must be cautiously exercised, as the shocks would be dangerous both to hull and machinery, unless the latter be protected by a spring or india-rubber foundation. Some such springy material has also been suggested, in connection with other backing, &c., for use as armour, as it would both give way to the force of blow from shot, and also as the hole, when made, would have a tendency to close it up again. The resisting power of a great thickness of compressed cardboard, or even paper, is well known, and has been experimented on and advocated by Admiral Sir E. Beecher; but such materials are too combustible and not durable enough.

It has been also suggested that in broadside battery ships the guns might be made moveable on tramways and turntables across from side to side, so that extra weight of broadside may be given to either side as required, thus requiring fewer guns in all than as at present, whilst the number on one side at a time might be greater; but it seems doubtful how this would work with heavy guns in the heat of combat or in a heavy sea. Another plan suggested conists in mounting only one or two heavy guns on deck, so as to fire in a line fore and aft, and quickly manœuvring the ship, always to keep her in this position to the enemy whilst attacking, so that her broadside cannot be injured, whilst her head and stern may be well protected, whereas she would rake the enemy in his weakest part, thus making the ship the gun-carriage. But the better plan seems to be to use Capt. Coles's turret or cupola system, only instead of revolving turrets as hitherto used, the turret might be fixed, the gun or guns only revolving on a turntable carriage, firing through a slot cut through the side of the turret nearly all round (except enough support left for the upper part) so that with two, if not with a single, turret, a range in all directions all round might be obtained. This slot may be protected inside by an armour-ring, which revolves with the gun, and the slot need only be a little wider in height than the bore of gun, as elevation and depression can be given at the breech, the muzzle remaining all round throughout at the same height. The guns used might be either breech-loading, or be run back on a slide on their carriage turn-table, so as to load at the muzzle. With such a slide, powerful india-rubber springs, both for compression and extension, would be necessary on account of the recoil. This plan would he lighter, less complicated, quicker to work, and less likely to get damaged or unworkahly jammed than when the whole turret revolves, and would also require fewer men and less machinery to work it—a great advantage on board ship. The guns might also be loaded below deck, and then raised into the turret by a balanced hydraulic lift arrangement, as in Walker's patent. At present, a war ship without armour plating unless it be built unsinkably in sufficient watertight compartments, or unless it possess superior speed, is at the mercy of every enemy's guns that can catch it; if well armour plated, it is in danger from those only which are armed with heavy guns and steel projectiles, and from rams, &c. If armed with weak and inferior guns, it can engage only weak adversaries with any chance of success; but, if properly armed, it may attack any foe, though, if without speed and quick manœuvring powers, it will find its armament, however perfect and powerful, useless against a quick-heeled though otherwise inferior foe, for by possessing superior speed and quick manœuvring power, a weak, unarmed ship can always hope to escape. Speed and good guns are, in fact, more useful than armour if it be found so impossible to combine the two in perfection that we have to choose between them. But with all such powers, a well armed and well-armoured ship is the nearest approach to perfection in destructive and defensive warfare that can be attained.

The chief problem now to be solved is, whether it is better not to armour plate at all, but to employ the weight otherwise, unless we can do so perfectly, completely, and unavoidably, or whether any armour plating, though weak, penetrable, and imperfect, is better than none at all. Of course, if we do armour plate at all, it must be done on the best and strongest principle known (weight permitting). We may learn much from the experience which the present lamentable American war affords us in naval construction, as they have tried the various applications of ironclads, monitors, and rams by the test of actual fighting, and thereby ascertained both their advantages and deficiencies, most of which latter are remediable. Latterly, Admiral Farragut has done good service at Mobile with the old, despised wooden ships by lashing them together, and so using them as rams against the ironclad ram *Tennessee*, in which ship, though herself almost uninjured, the crew were unable to stand the repeated violent concussions and shocks, and therefore surrendered. But the old question of iron versus wooden war ships is practically decided by the former gradually superseding the latter everywhere, owing to their many advantages, such as greater room and buoyancy, finer lines, and consequent higher speed, greater security against fire, facility of building, increase of strength, and many other qualities, though it is true that wooden ships possess one great advantage, viz., that they do not corrode and deteriorate so quickly as iron, and that they may readily be coppered, and their fouling be prevented, which is a great hindrance in many iron ships not painted over with proper composition.

ON THE APPROXIMATE GRAPHIC MEASUREMENT OF ELLIPTIC AND TROCHOIDAL ARCS, AND THE CONSTRUCTION OF A CIRCULAR ARC NEARLY EQUAL TO A GIVEN STRAIGHT LINE.

BY W. J. MACQUORN RANKINE, C.E., LL.D., F.R.SS.L. & E.

(From the Philosophical Magazine.)

The three following rules are very obvious results of the application of Simpson's method of approximate integration to the rectification of curves generated by rolling; and it is possible that they may have been already published by other authors; but as I do not know of any such publication, and as the rules are useful and convenient, I beg leave to offer them.*

The general proposition of which the rules are particular cases is the following well-known one. Let a plane disc of a figure roll on a plane base-line of any figure: let there be a tracing point in the disc, and let r denote the rolling radius, or distance of the tracing point at any instant from the instantaneous centre, or point of contact of the disc and base line. Then while the disc rolls through the angle ϕ, the tracing point describes an arc of the length $\int_0^\phi r \, d\phi$. To calculate an approximate value of this integral, divide the angle ϕ into either $2n$ or $3n$ equal intervals (the number being the greater the closer the required approximation). Measure the rolling radii corresponding to 0 and ϕ, and to each of the intermediate angles, and let them be denoted by r_0, r_1, r_2, &c. Then the mean rolling radius is approximately for $2n$ intervals (by Simpson's first rule)

$$r_m = \frac{1}{6n}(r_0 + 4r_1 + 2r_2 + 4r_3 + \ldots + 2r_{2n-2} + 4r_{2n-1} + r_{2n});$$

and for $3n$ intervals (by Simpson's second rule),

$$r_m = \frac{1}{8n}(r_0 + 3r_1 + 3r_2 + 2r_3 + \ldots + 2r_{3n-3} + 3r_{3n-1} + 3r_{3n-1} + r_{3n});$$

and the arc described by the tracing point is approximately equal to a circular arc of the radius r_m, subtending the angle ϕ.

RULE I.—To construct a circular arc approximately equal to a given arc CD (fig. 1), not exceeding a quadrant, of an ellipse whose semi axes OA and OB are given.

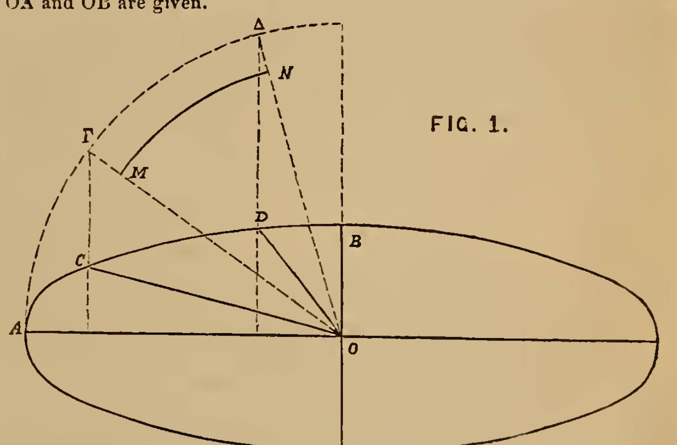


FIG. 1.

In Fig. 2, draw a straight line, in which take EF = OB and FG = OA. Bisect it in H; and about that point, with the radius HF = HK = $\frac{OA - OB}{2}$, describe a circle. Mark the points c and d in that circle, by laying off Ec = OC, and Ed = OD.

Then divide the arc cd into $2n$ or $3n$ equal intervals, as the case may be, and measure the distances from the ends of the arc and the points of division to G; these will be rolling radii of the ellipse, as generated by rolling a circle of the diameter EH inside a circle of the diameter EG, the tracing point being at the distance HF from the centre of the rolling circle; and the Simpsonian mean (as it may be called) of those rolling radii will be the radius of the required circular arc.

Then in Fig. 1 describe a circle about O with the radius OA; through C and D draw straight lines parallel to OB, cutting that circle in Γ and Δ; join OΓ, OΔ; and about the centre O, with the mean rolling radius already found, describe the circular arc MN, bounded by the straight lines OΓ, OΔ; this will be the required circular arc approximately equal to the elliptic arc CD.

* A process nearly identical with that of Rule I. is applied by John Bernoulli to the rectification of the whole ellipse, but not to elliptic arcs. (*Johannis Bernoullii Opera*, vol. I., § 83.)

The same circular arc may be drawn, if required, in Fig. 2 as follows:—From any convenient point L in the circumference of the circle FK, draw straight lines through c and d; and about L as a centre, with the mean rolling radius already found, describe the circular arc m n bounded by those lines.

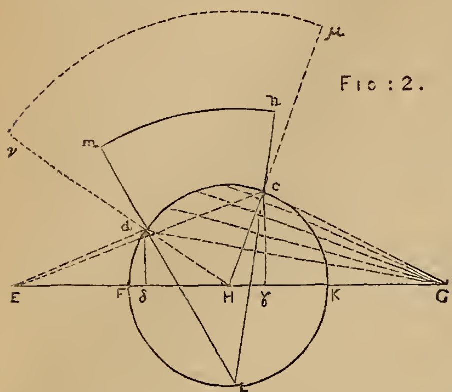


Fig: 2.

RULE II.—To construct a circular arc approximately equal to a given trochoidal arc, and not exceeding the arc between a crest of the trochoid and the adjoining hollow.

In Fig. 2 make GH = the radius of the rolling circle which generates the trochoid; and describe the small circle FK about H with a radius equal to the distance of the tracing point from the centre of the rolling circle. Take Gγ and Gδ respectively equal to the perpendicular distances of the two ends of the given trochoidal arc from the base line on which the rolling circle rolls. Through γ and δ draw straight lines perpendicular to GH, cutting the small circle in c and d. Divide the arc cd into $2n$ or $3n$ equal intervals, and measure the distances from the ends of the arc and the points of division to G; these will be rolling radii; and their Simpsonian mean will be the radius of the required circular arc.

From H draw straight lines through c and d, and about H, with the radius already found, describe the circular arc μ ν, bounded by these straight lines: this will be the required circular arc approximately equal to the given trochoidal arc.

RULE III.—To find the radius of a circular arc which shall be approximately equal to a given straight line, and shall subtend a given angle.

This question is solved by regarding the straight line as forming part of an ellipse whose shorter semi axis is = 0. Let P Q, fig. 3, be the given straight line. Construct the triangle P Q R, in which Q is a right angle, and P the complement of the given angle; so that R is the given angle itself. Bisect the hypothenuse P R in S, about which point describe a circular arc traversing P and Q. Divide that arc into $2n$ or $3n$ equal intervals: measure the distances from its ends and from the points of division to the point R, and take their Simpsonian mean; this will be the radius R T of the required arc T U, which is approximately equal to the straight line P Q, and subtends the angle P R Q.

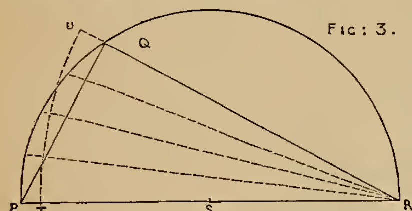


Fig: 3.

Remarks.—It is evident that the processes described in the three preceding rules are graphic methods of approximating to elliptic functions of the second kind, and that, if put in an algebraical form, they would become identical with the method of approximation to the function E described by Legendre in the Appendix to the first volume of his "Traité des Fonctions Elliptiques."

The amplitude of the function is represented by

$$\phi = \text{M O N of fig. 1},$$

$$= m \text{L} n = \frac{\mu \text{H} \nu}{2} \text{ of fig. 2},$$

$$= \text{Q R P of fig. 3}.$$

The modulus in fig. 1 is the eccentricity of the ellipse, in fig. 2,

$$\frac{\sqrt{\text{F G}^2 - \text{K G}^2}}{\text{F G}}$$

and in fig. 3, unity; and the unit line in fig. 1 is O A, in fig. 2 F G, and in fig. 3 P R.

The degree of precision of the approximation depends on the smallness of the intervals into which the amplitude is divided—the error diminishing somewhat faster than the fourth power of the interval, as Legendre, in the Appendix already referred to, has shown to be the case for every application of Simpson's formula. Thus, in the application of Rule III., the following are examples of the greatest proportionate errors (which are always in excess):—

Intervals of Amplitude.	Errors of Rule III.
45°	about $\frac{1}{400}$
30°	" $\frac{1}{2500}$
$22\frac{1}{2}$°	" $\frac{1}{8000}$
15°	" $\frac{1}{48000}$

The errors of Rules I. and II. become smaller than those of Rule III. as the modulus diminishes—that is, as the ellipse approaches to a circle, and the trochoid to a straight line. The following are examples of the errors of Rule I., in the length of a circular arc equal to an elliptic quadrant, the major semi-axis being unity:—

Eccentricity.	True length (from Legendre's Tables).	Approximate length by Rule I.			
		Two intervals of 45°.	Errors.	Three intervals of 30°.	Errors.
$\sqrt{\frac{1}{2}}$	1·3506	1·3538	·0032	1·3520	·0014
0·6	1·4184	1·4195	·0011	1·4186	·0002
0·5	1·4675	1·4681	·0006	1·4678	·0003

SUPPLEMENT TO A PAPER ON STREAM-LINES*

BY W. J. MACQUORN RANKINE, C.E., LL.D., F.R.SS.L. & E.

The following is a demonstration of the proposition, stated in an addendum to the previous paper, that *all waves in which molecular rotation is null, begin to break when the two slopes of the crest meet at right angles*:—

The profiles of the layers of a series of waves are converted, as is well known, into undulating stream-lines, by supposing the actual motion of the particles of water to be combined with a uniform translation equal and opposite to the velocity of propagation of the waves.

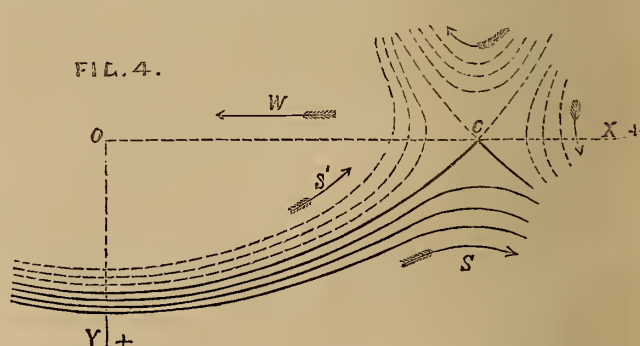


FIG. 4.

Thus, let $-c$ be the velocity of the waves propagated in a *negative* direction, as indicated by the arrow W in Fig. 4; and, as in article 13 of the original paper, let $c\,(u - 1)$ and $c\,v$ be the horizontal and vertical components of the actual velocity of a particle of water in the waves, so that $c\,u$ and $c\,v$ shall be the components of the velocity of the same particle in the undulating stream into which the waves are converted, and which flows in a *positive* direction, as indicated by the arrows S S′.

The tangent of the slope of a stream-line or wave-line at any point is obviously $\frac{v}{u}$.

The crest of a wave-line is a point where $v = 0$ and u is a minimum. The latter property distinguishes it from the trough, where $v = 0$ also, but u is a maximum.

The equations of a crest are as follows:—

$$v = 0; \; \frac{d\,u}{d\,t} = 0.$$

A wave begins to break so soon as its crest ceases to be rounded and becomes angular, as at C in Fig. 4; and at such a point it is evident that u must vanish as well as v. The ratio of two quantities which vanish simultaneously is equal to the ratio of their differentials. Hence the

* The "Paper on Stream-lines" was given in THE ARTIZAN volume for 1864.

equations of a sharp crest, in addition to the equations (I.) and (II.), are the following:—

$$u = 0, \quad \frac{\frac{dv}{dt}}{\frac{du}{dt}} = \frac{v}{u}.$$

By putting for $\frac{d}{dt}$ the equivalent operation $cu\frac{d}{dx} + cv\frac{d}{dy}$, the preceding equations are transformed into the following.

At every crest,

$$v = 0 \quad \ldots\ldots\ldots\ldots \quad \text{(I.)}$$

$$u\frac{du}{dx} + v\frac{du}{dy} = 0 \quad \ldots\ldots\ldots\ldots \quad \text{(II.)}$$

and at every sharp crest,

$$u = 0 \quad \ldots\ldots\ldots\ldots \quad \text{(III.)}$$

$$\frac{u\frac{dv}{dx} + v\frac{dv}{dy}}{u\frac{du}{dx} + v\frac{du}{dy}} = \frac{v}{u} \quad \ldots\ldots\ldots\ldots \quad \text{(IV.)}$$

Equation (IV.) may be reduced to the following form:—

$$\frac{dv}{dx} + \frac{v}{u}\left(\frac{dv}{dy} = \frac{du}{dx}\right) - \frac{v^2}{u^2}\cdot\frac{du}{dy} = 0 \quad \ldots\text{(IV. A)}$$

The well-known equation of continuity is

$$\frac{du}{dx} + \frac{dv}{dy} \quad \ldots\ldots\ldots\ldots \quad \text{(V.)}$$

which reduces (IV. A) to the following:—

$$\frac{dv}{dx} - 2\frac{du}{dx}\cdot\frac{v}{v} - \frac{du}{dy}\cdot\frac{v^2}{u^2} = 0 \quad \ldots\ldots\ldots\ldots \quad \text{(IV. B)}$$

whose two roots are as follows:—

$$\frac{v}{u} = -\frac{\frac{du}{dx}}{\frac{du}{dy}} \pm \sqrt{\left\{\frac{\frac{dv}{dx}}{\frac{du}{dy}} + \frac{\frac{du^2}{dx^2}}{\frac{du^2}{dy^2}}\right\}} \quad \ldots\ldots\ldots \quad \text{(VI.)}$$

and those two roots are the tangents of the slopes that meet at the crest.

It is known that in a perfect fluid the quantity known as the molecular rotation, or

$$\frac{c}{2}\left(\frac{du}{dy} - \frac{dv}{dx}\right)$$

is either nothing, or a constant for each stream-line. The present proposition refers to the case in which

$$\frac{du}{dy} - \frac{dv}{dx} = 0 \quad \ldots\ldots\ldots\ldots \quad \text{(VII.)}$$

and consequently the tangents of the two slopes are the two values of the expression

$$\frac{v}{u} = -\frac{\frac{du}{dx}}{\frac{du}{dy}} \pm \sqrt{\left\{1 + \frac{\frac{du^2}{dx^2}}{\frac{du^2}{dy^2}}\right\}} \quad \ldots\ldots\ldots\ldots \quad \text{(VIII.)}$$

but the product of those two values is $= -1$; therefore at every sharp or breaking crest of a wave in which there is no molecular rotation, the two slopes meet each other at right angles. Q. E. D.

28. The preceding demonstration applies to all waves whatsoever in which molecular rotation is null. In waves which, besides having that property, are symmetrical at either side of the crest, each of the slopes which meet at the crest of a wave on the point of breaking is inclined at 45° to the horizon.

29. Fig. 4 (which is reduced from a diagram exhibited at the late meeting of the British Association) represents one-half of a forced wave, such as has been described in articles 13 and 14 of the previous paper. At C is a right-angled crest; and the full line traversing C is that for which $b = 1$. The dotted continuations of the same line above C satisfy the some equation, but do not belong to any possible wave surface. The full lines below C are wave lines, for which b has a series of values greater than 1, viz. $1\frac{1}{12}$, $1\frac{2}{12}$, $1\frac{3}{12}$, &c.; and the dotted curves above C fulfil the same equations, but are not possible wave lines. The dotted lines to the right and left of C are stream lines for which b has values less than 1, such as $\frac{11}{12}$, $\frac{10}{12}$, $\frac{9}{12}$, &c., and are not continuous wave lines.

ON A NEW METHOD OF WORKING ATMOSPHERIC RAILWAYS.

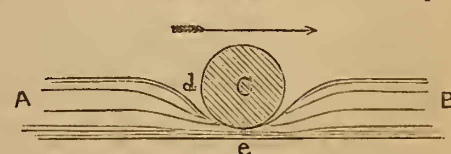
By FRANCIS CAMPIN, C.E.

The atmospheric system of railway propulsion having been in several localities tested as to its practicability, and found wanting, appears for some years to have been set aside, no attention being paid to it except by those personally interested in its success; and so the locomotive has had a clear field, having no rival except in one or two instances where the gradients are too heavy for the ordinary mode of working, and stationary power is requisite. Recently, however, the subject of atmospheric propulsion has received attention, as it seems, suitable, if its peculiar difficulties can be overcome, for the working of underground railways, where the presence of the locomotive is frequently incouvenient. The obvious advantages of a perfect system of atmospheric propulsion are briefly—simplicity of the machinery, impossibility of collision, as two trains cannot meet on one line of rails, nor can one overtake that preceding it; and reducing the weight of the train by displacing the locomotive, and the consequent reduction of wear and tear in the permanent way. The difficulties which have hitherto resisted the practical application of the system are—the mode adopted for connecting the propelling piston to the train of carriages; the continuous valve on the air tube working very unsatisfactorily; the low pressure at which the propelling power is worked, by the reason that only the atmospheric pressure is available, because if compressed air were admitted within the air tube, the valve would be blown open, and the operation of the machinery stopped; and a valve could scarcely be made to open inwards, as, in that case, it would come in the way of the piston within the tube.

By the method which it is the object of the present paper to describe, any reasonable pressure may be employed, and the difficulty of the valve is obviated by doing away with it entirely. It is the invention of Mr. William Lake, C.E., who has devoted considerable attention to this subject, which is now promising fruitful results to those who shall succeed in practically establishing the utility of the atmospheric railway.

I will now proceed to explain the details of the machinery by means of which it is proposed to conduct the traffic according to Mr. Lake's principle, commencing with the tube and gearing on the carriages.

The air tube laid between the rails, instead of being rigid as heretofore, is made of some flexible substance, such as idia rubber, upon which runs a roller attached to the bottom of the carriage or carriages to be propelled, the roller also being coated with an elastic substance and fixed at such a level that it will, by pressing on the tube, collapse and close it at the point of contact. Then, if air be forced into the tube, the roller will be forced along, drawing the train with it, the effect upon the roller being the same as if it were placed upon an inclined plane. The annexed sketch may perhaps make the action above described more clear. Let A B represent a portion of the elastic air tube, compressed so as to be closed by the roller C. If air be forced into the tube at A, then, by reason of the pressure exerted at the point d, or rather along the inclined surface d of the tube, the roller C is caused to progress along the tube in the direction of the arrow, or from A to B, and *vice versâ*. The impelling force will be proportional to the area of the tube A B, and the pressure of the air forced into it, but care must be taken that the diameter of the roller C is properly proportioned to that of the tube A B, or a point may be arrived at where motion will cease, if the roller be continually reduced in size—the larger it is the easier will it work, as the propelling power will have as it were a greater amount of leverage, this leverage being proportional to the distance from the centre of force d acting on the roller to the bottom point e of the roller.



The first questions to be answered as to the practical working of this project on a large scale, are,—Will the elastic tubing bear the pressure thrown upon it, and the constant passing of the roller over it? To which it is answered that, not only is it possible to make elastic tubing to fulfil these conditions, but responsible manufacturers are prepared to undertake it, and to guarantee it to a much higher pressure than would ever be required in working, or, in figures, to upwards of 250lbs. per square inch. Let us now take a case and determine the size of tube necessary to propel a train at average velocities upon an incline of 1 in 100 rise; the weight of the train will be taken as 50 tons, the speed about 30 miles per hour, and the working effective pressure of the compressed air in the elastic tube 50lbs. per square inch. In order to be on the safe side, the resistance of the train in rolling friction will be assumed as 20lbs. per ton.

The resistance from friction will be 50 tons × 20 lbs. = 1,000 lbs.; that due to the incline 50 tons × 2,240lbs. ÷ 100 (ratio of gradient) = 1,120 lbs.;

total, 1,000 lbs. + 1,120 lbs. = 2,120 lbs. propelling force required. This divided by the working pressure gives the area of the working tube, thus 2,120 lbs. ÷ 50 lbs. = 42·4 square inches, corresponding to a diameter of 7·375 in. This size is so moderate that it is evident there is no difficulty about getting the requisite power to propel trains upon any incline—(thus if the gradient were even 1 in 30, the tube would only need an increase of pressure within it from 50lbs. to 112lbs. per square inch, or an increase of diameter of from 7·375 in. to 11 in.; and it may here be noted that the roller will be within certain limits capable of acting on tubes of varying diameters.) Now, let us determine the amount of power requisite to maintain the motion of the train at 30 miles per hour on the gradient of 1 in 100. The propelling force is 2,120lbs., and 30 miles per hour equals 2,640ft. per minute, giving for the work per minute 2,640ft. × 2,120 lbs = 5,596,800ft. lbs. requiring for its performance 169·6 horse-power. To run the same train on a level the work would be 2,640ft. × 1,000lbs. = 2,640,000ft. lbs. corresponding to 80 horse-power.

We will now pass on to the means to be adopted for supplying the air at the required pressure to the elastic air-tube. Stationary engines placed at certain points on the line would be employed to force air not at once into the air-tubes, but into an accumulator which would at the same time act as a governor. This accumulator would consist of a cylinder with a loaded piston, on which the weight would be such as should equal the pressure to be created in the air tube; then if the pumping engine worked too fast the piston in the accumulator in rising would close the throttle-valve, and *vice versâ*. In the case of the train leaving one section of tube for another which would occur at each pumping station, the following course would be adopted to prevent inconvenience arising from the sudden removal of the load from the engine at the previous station.

The train, in passing the end of the section of tube upon which it has been travelling, is caused to act upon a tumbler attached to the permanent way, which tumbler closes the valve admitting air from the accumulator into the elastic air tube; then the engine pumps air into the accumulator only, until the plunger therein by rising cuts off the steam, and so stops the engine. The same result may be produced in other ways, but the above appears most certain, and, therefore, preferable.

In applying the foregoing method to the propulsion of railway carriages, it is argued that great advantages will be obtained, for the tube is small in size, very durable, and easily replaced; and, further, an uniform speed can be maintained, as the tubes can be increased in size on gradients, the same roller being capable of acting upon tubes of various diameter, as mentioned above, and by these means the speed of the train is maintained without raising the pressure in the elastic tube.

PATENT, LAMINATED, SUSPENDED DOCK GATES.

By R. A. Peacock, C.E., Jersey.

These gates are built up of planks frequently crossing each other, and made watertight with putty and paint. The bars, when completed, are bound round at about every 4 feet with bands of some of the compounds of copper—say King's copper, for example; or otherwise, the planks are fastened to each other by compressed oak trenails, as the planking is fastened to the ribs of a ship; the whole being tarred over when complete. Each gate is then suspended from a stout iron girder built into the side wall of the lock, and otherwise securely fastened. Through a boss in the outer end of this girder a wrought iron screw passes, 5ft. 5in. long and 9in. in diameter, for a 70ft. lock, the head being downwards; and the screw is retained in position by a brass nut working on the top of the girder. From the head of this nut as a pivot, having a brass plate affixed on it, well lubricated with tallow to diminish friction, the gate is suspended by a strong wrought iron frame well fastened to the gate. This pivot being 6ft. above water, is consequently accessible at all times to apply grease, &c. The gates are curved, and form the same angle with the sides of the lock, as is recommended in the paper for which the late Professor Barlow received the Telford gold medal. They are trussed in three places, which maintains the curve and makes them very strong. Farther to diminish friction, no rollers are used at the bottom of the gate; and, therefore, to maintain the form of the gate and prevent its outer end from drooping, two wrought iron diagonal ties are used, one passing from the bottom outer end of the gate to near the top of the girder, and the other from the outer end of the gate at top water line, to near the opposite side of the top of the girder; and these two ties are connected (by "gibbs and cotters," so that they can be tightened as occasion requires) to a collar, the inside of which has a brass plate affixed, well lubricated with grease, and the collar works round the boss of the girder as the gate opens or closes.

For a lock 70ft. wide and 27ft. depth of water over sill, a pair of these gates costs £2,200, the £200 being allowed for winches. Each gate weighs 45 tons. There is a notice of these gates in the British Association's last volume.

Calculation.—The area of the pivot, placed 6ft. above water, is 318·77 superficial inches, by which the weight of the gate being divided, gives a pressure on the pivot of 2·32cwt. per square inch. And Mr. George Rennie found, by an elaborate series of experiments which are well known, that brass upon cast iron, with the pressure aforesaid, gave a friction of ·214, or a little more than one-fifth of the whole weight. Ferguson also found the friction of polished steel on copper one-fifth of the weight, and of polished steel on brass one-sixth of the weight (see Telford's Mem. Book, p. 667), so that these two experiments substantially confirm each other. The 45 tons × ·214 gives 9·63 tons, the friction to be overcome. The centre of the pivot being 37ft. from one end of the gate, and 1ft. from the other end, gives a leverage of 37 to 1; and 9·63 divided by 37 gives 583lbs., the resistance to be overcome after allowing for the leverage of the gate. By means of a winch of moderate power two men can overcome a resistance of 583lbs., and open or close the gates with a speed of—say, at the rate of 1 mile per hour, viz., in 36 seconds; but say, in round numbers, about two-thirds of a minute. This mechanism is obviously as simple, as durable, and as little liable to get out of order, as can well be imagined; and it can be applied to most existing gates.

INSTITUTION OF CIVIL ENGINEERS.

At a recent meeting, Mr. F. B. Doering exhibited and explained a level which, for readier adjustment, was supported upon a gimbal joint, instead of on parallel plates; and he stated that the plan was applicable to other surveying instruments. The method was similar to that adopted for a ship's compass, with the addition of vertical arcs, at right angles to each respective axis, which were clamped to each other and to the frame that was screwed on to the ordinary tripod stand. In the field, when using this instrument, however uneven the ground might be, the legs were put down in the most convenient manner irrespective of level. The clamps holding the telescope rigid with the stand were then slackened, and the telescope set approximately level by hand. The clamping screws were then tightened, and the final adjustment effected by two tangent screws at right angles to one another, and connected respectively with each arc at the clamps. On moderately level and firm ground, it was not necessary to unclamp the joint of the instrument; as it might be set up approximately level in the ordinary way by the legs, and be brought to a perfect adjustment at once by the tangent screws. By dividing one of the arcs into degrees, the instrument could be used for measuring vertical angles, and thus the height of any point at a distance, required for checking, might be obtained. It was believed that, by this method, a level could be set up on sidelong, soft, or broken ground, with as much ease as on firm, level ground; and that, as none of the movable parts were liable to become jammed, as in the parallel plate system, a more perfect adjustment was practicable. A level constructed in this manner had been tried in wet weather and in high winds, and proved to be as steady as any instrument hitherto made.

ANNUAL GENERAL MEETING.

December 20th, 1864.

In presenting an account of the proceedings during the past twelve months, the Council reported, that the characteristic feature of steady, progressive development was never more fully exemplified, in any similar period, since the first establishment of the Institution. The meetings had proved very attractive, the discussions had been well sustained, the library was fast becoming rich in all professional and scientific works of this and other countries, the number of members and associates had greatly increased, and the financial condition was very satisfactory. The importance to engineers of being connected with the Institution was felt more and more every day; and although the time had not yet arrived, when it was considered imperative for every one practising the profession to have received the diploma of the Institution, yet in general opinion it might fairly be said, that that position had been attained. On these grounds, therefore, it was more than ever essential, that the qualifications of all candidates for admission should be most scrupulously examined; and that the members should satisfy themselves, before signing any proposition paper, that the person so recommended possessed such character, practice, and experience, as to entitle him to the distinction he sought.

There had been twenty-three ordinary general meetings during the session, when eleven "papers" had been read, many of the evenings having been entirely occupied by discussions. The communications related to the details of erection of three lighthouses for facilitating the navigation of the northern portion of the Red Sea; to the causes of the decline in the duty of Cornish pumping engines; to the circumstances which determined the velocities of influx and reflux, and consequent scour, attendant on the final closing of embankments for reclaiming land from the sea, or from a tideway; to a description of the features of, and changes in, that portion of the east coast of England between the Thames and the Wash estuaries; to the actual state of the works in the Mont Cenis Tunnel, perhaps the most important and interesting work of civil engineering in the present day; to an inquiry into the resistances to bodies passing through water; to the Santiago and Valparaiso Railway; to the structure of locomotive engines, for ascending steep gradients, when in combination with sharp curves, and to the impedimental friction between wheel tires and rails; to the distillation of coal and the manufacture of coke; and to the machinery employed in sinking artesian well on the Continent.

With regard to the publication of the minutes of proceedings, it was stated that volumes xxi. and xxii. would shortly be issued, and that the general index to the series of volumes from i. to xx. inclusive, in itself a volume of about four hundred pages, was also nearly ready.

A new edition of the catalogue of the library was in preparation, in continuation of that issued in 1851, now out of print. At that date the library contained upwards of three thousand volumes and fifteen hundred tracts; now the collection amounted to about five thousand five hundred volumes, and three thousand tracts.

The tabular statement of the transfers, elections, deceases, and resignations, showed that the number of elections had been 93, of deceases 25, of resignations, 6, and of erasures 7, leaving an effective increase of 55, and making the total number of members of all classes on the books on the 30th of November last, 1,095. This was an increase of nearly 5·3 per cent. in the past twelve months.

The deceases announced during the year had been:—Francis Baird, Thomas Bartlett, John George Bodmer, Thomas Casebourne, Charles Dean, Joseph Gibbs, George Hurwood, James Jones, Rhys William Jones, Edward Oliver Manby, George Meredith, George Mackay Miller, William Chadwell Mylne, Richard Roberts, William Simpson, and Adam Smith, members; John Staines Atkinson, William Bagnall, Frederick Lawrence, William Llewellin, Thomas Telford Mitchell, Robert Ransome, Charles Frederick Stuart Smith, Alfred Thompson, and Arthur Wightman, associates.

This list included the names of many very old members, several of whom had been engaged under the first President, Telford, as well as one of the six founders of the Institution—Mr. James Jones—who in its early days acted as Secretary, and whose death, at an advanced age, was the result of a lamentable accident.

The abstract of the receipts and expenditure for the year ending the 30th of November last, as prepared by the auditors, showed that the payments during the twelve months had amounted to £2,955, against receipts from all sources of £4,414; and that the amount obtained from subscriptions and fees alone, without including the dividends upon investments, and the sums derived from other sources, had exceeded the disbursements by about £450. The Council had therefore been again enabled to add to the Institution Fund, by the purchase of £1,000 Four per cent. debenture stock, of the London, Brighton, and South Coast Railway Company. On comparing this statement of accounts with the average of the previous ten years, it appeared that the total income now exceeded that average by nearly 40 per cent., while the increase in the disbursements during the same period had been less than 20 per cent. The realised property of the Institution now comprised:—I. General Funds, £10,819 12*s.* 10*d.*; II. Building Fund, £1,751 0*s.* 1*d.*; and III. Trust Funds, £9,970 12*s.* 7*d.*; making a total of £22,541 5*s.* 6*d.*, as against £20,649 16*s.* 2*d.*, at the same period last year.

The propriety of establishing a Benevolent Fund in connection with the profession received the serious consideration of the Council before any steps were taken to ascertain the views of the members generally. It was well pointed out by Mr. F. J. Bramwell (M. Inst. C.E.), with whom the present proposal originated, that in most, if not in all, other professions and occupations, there was a regularly organised system, for the aid of decayed members, and of the families of deceased members, when in necessitous circumstances; and that, inasmuch as the civil engineers already formed a numerous and increasing body, in some respects more liable to those misfortunes and vicissitudes which were known by experience to overtake those following other pursuits, it was incumbent on the profession, that some business-like action should be taken, in preference to soliciting subscriptions for individual cases, now unfortunately found to be frequently requisite. Private inquiries among a few of the members of the Institution having shown that such a fund, if properly managed and adequately supported, could not fail to be productive of immense good, it was determined to appeal to the general body, and the result had been such a response as fully to justify the course which had been pursued. Already from 224 contributors, donations to the amount of £21,884, and annual subscriptions to the extent of £487, had been promised. Of these contributors, 97 were donors only, 14 were both donors and annual subscribers, and 113 were annual subscribers.

At the meeting recently held in the rooms of the Institution, the Fund was formally established, and that portion of the General Committee which it was recommended should be elected by the contributors, was appointed. At the same time the Committee was requested to prepare a scheme, with by-laws and rules, for the administration of the fund, and to report the result of their deliberations to a general meeting of the contributors, to be summoned for the 17th of January next. The Council would not venture to anticipate what might be the issue of the considerations of the Committee, but they felt assured that a measure so calculated to enhance the character of the profession would be cordially supported; and on every ground they commended it to the most favourable notice of the members.

If the object of the profession of a civil engineer be, as described in the Charter of Incorporation of the Institution, "the art of directing the great sources of power in Nature for the use and convenience of man," it might fairly be asked, what other profession played so large a part in developing the material resources of the world, and in facilitating that intercourse between nations which tended to promote peace and good-will. It should then be the constant endeavour to make the Institution the depository of the accumulated knowledge of all the members; and all should strive so to sustain and consolidate the Institution, that it might continue truly and faithfully to represent the important interests committed to the care of the civil engineer.

After the reading of the report, a Telford medal and a Telford premium of books were presented to Mr. W. Lloyd; a Telford medal to M. Pernolet; a Telford medal and the Manby premium, in books, to Mr. G. H. Phipps; Telford premiums of books to Messrs. J. B. Redman, W. Parkes, T. Sopwith, jun., J. M. Heppel, and G. R. Burnell: and Watt medals to Messrs. T. Sopwith, jun., W. Bridges Adams, and J. Cross.

The thanks of the Institution were unanimously voted to the President for his attention to the duties of his office; to the Vice-Presidents and the other members and associates of Council for their co-operation with the President, and their constant attendance at the meetings; to Mr. F. J. Bramwell, as the originator of the present movement for the establishment of a Benevolent Fund in connection with the profession; to Mr. Charles Manby, Honorary Secretary, and to Mr. James Forrest, Secretary, for the manner in which they had performed the duties of their offices; as also to the Auditors of the Accounts, and the Scrutineers of the Ballot, for their services.

LIVERPOOL POLYTECHNIC SOCIETY.

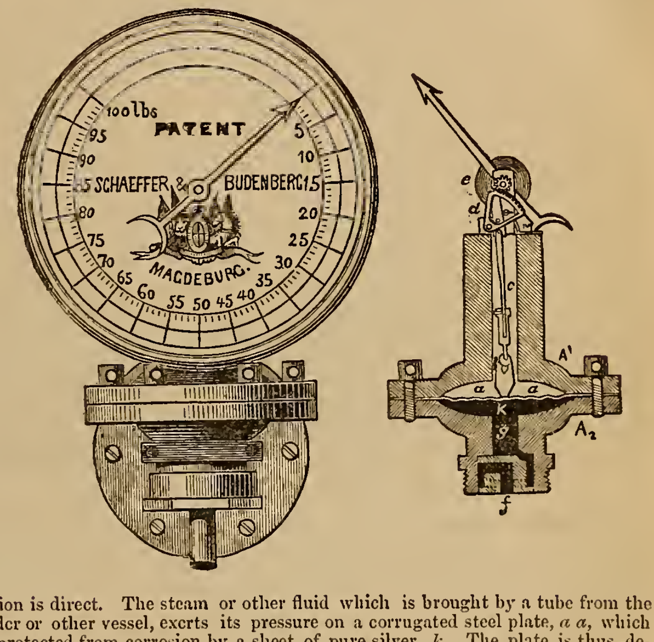
EIGHTH MEETING.

Lieut.-Colonel Clay in the Chair.

Mr. A. Budenberg read the following paper on "Pressure Gauges, and other Instruments used in Steam Engineering."

Letters patent were granted to Mr. Schaeffer early in 1850, by the Prussian Government, for the invention of the "Manometer," or Pressure and Vacuum Gauge, which I am about to describe to you, and which has become so great a success, as may be judged by the fact that, since the 23rd of January, 1850, when those letters patent were granted, upwards of 60,000 gauges of that construction have been sold. The well-known difficulty to obtain letters patent from the Government of Prussia, which is particularly illustrated by the refusal of such for Giffard's Injector, gives some reason to believe that Schaeffer's invention was entirely new and without precedent, when it is remembered that in Prussia the decisions arrived at in applications for letters patent depend entirely upon this point—whether the presumed invention is entirely new, or whether anything similar to it has been made before.

The following is the description of these gauges, whose construction, however, is so simple, that it explains itself fully by reference to the illustrations. Their



action is direct. The steam or other fluid which is brought by a tube from the boiler or other vessel, exerts its pressure on a corrugated steel plate, *a a*, which is protected from corrosion by a sheet of pure silver, *k*. The plate is thus deflected upwards, and when the pressure is removed, it returns to its original position; it will thus be perceived that the accuracy of the gauge depends almost entirely upon the perfect elasticity of this steel plate. A small block provided with a socket-joint is fixed to the joint, and its motion is transferred to the quadrant, *d*, by means of the connecting pieces, *b* and *c*; this quadrant communicates the motion finally to the index by gearing into a small pinion, fixed upon the axle or pivot which carries the index, and the gearing is so proportioned as to multiply that motion sufficiently to render the divisions of the dial clear and legible.

The spiral or hair spring, *e*, regulates the motion of the index, and makes it continuous and steady. The dial shows actual pressures, and is accurately divided to the scale of an open mercurial column, and every gauge is repeatedly tested before delivery. The divisions on the dial are in one pound per square inch, and in atmospheres; sometimes they are made to represent the pressure of a column of water, 34ft., nearly corresponding with one atmosphere, or fifteen pounds pressure per square inch.

For about two years past our firm have manufactured gauges for hydraulic pressure up to ten tons per square inch, on a principle similar to Bourdon's Gauge, improved and modified to suit that particular purpose. These gauges, of which a sample is exhibited, are made of a semicircular steel tube, elliptic in its cross section, into which water (or, in preference, oil) is introduced, which, when it is subject to pressure, tends to straighten or uncoil the tube. A toothed connecting rod is attached to the end of the latter, and made to gear into a small pinion fixed upon the spindle to the index, which registers the pressures as divided upon the dial by actual experiment, as is the case with the steam gauges just described, in tons per square inch.

Messrs. Brockhurst and Sullivan, of the firm of Dewrance and Co., formerly Bourdon's agents in this country, took a patent in January last for a pressure gauge, similar to the one I have just explained, in so far as regards the semicircular tube. These gentlemen claim that particular construction, and the practice of filling the tube with oil, as some of the principal points of their patent, although our firm had adopted that form of tube a considerable time before them, and have tested in Magdeburg and Manchester the tubes and other springs by the medium of oil, a practice which has been adopted by others as well as by ourselves, long before Messrs. Dewrance and Co. thought it worth their while to take a patent for it.

The only point in Messrs. Dewrance and Co.'s patent, which is as original as it is novel, is the introduction of a valve, whose special function is to close up the aperture which connects the tube with the pressure pipe, and thereby to disconnect the whole mechanism of the gauge from that pipe, the pressure of whose contents it is intended to register. The consequence of this arrangement is, that the gauge will register a certain maximum pressure, but it never indicates any excess of pressure, in case such has been attained; whereas it has been our uniform and careful practice to construct our gauges in such manner that the index shall be thrown out of gear, whenever the maximum pressure which the gauge is intended to register has been exceeded; and I shall leave this meeting to judge of the relative merits of Messrs. Dewrance and Co.'s innovation and of our own practice.

Mr. Birckel said: It was my desire to bring this subject before the Society, because I had noticed that shortly after the lapse of the patent of Bourdon's gauge, which had acquired a certain amount of celebrity, the agents of Bourdon in this country took out a patent for certain alleged improvements in these gauges. I did not then know what these improvements were; but having mentioned the circumstance to Mr. Budenberg, he explained to me their nature, when I found that the only novelty was the valve which is intended to shut off the pressure when it has reached a certain intensity. I thought that a practice like *that* was so contrary to all we had hitherto done in steam engineering, so contrary to all regulations which had hitherto been issued by the Manchester and other Boiler Associations, the tendencies of which have invariably been to render everything accessible, and to divulge everything that is going on in the boiler, that it ought to receive due publicity. Now, here we have a gauge which, for the sake of its own protection, shuts off the pressure, so as to prevent injury to itself from over-pressure, although when that point has been reached any amount of extra pressure might be put on the boiler without any one knowing anything about it. As soon as I saw that, I thought it a subject worth bringing before such a Society as this, in order that its merits, or rather its demerits, might be made known to the world. Mr. Budenberg labours under the disadvantage of being a foreigner, and cannot explain himself so clearly as we might wish him to do; but he has endeavoured to show you that by them a gauge has been constructed such that, when the maximum pressure has been reached which the gauge is desired to register, the index shall be thrown out of gear; and when that has taken place, it never again can indicate any pressure whatever, until the maker of the instrument, or any person able to do it, has taken it down and put it into working order again. It registers, therefore, the fact that there has been too great a pressure in the boiler (or other vessel)—it registers that fact, and in so far provides a precautionary measure against accidents from over-pressure. The merits of Messrs. Budenberg's gauges may be appreciated sufficiently by the fact that 60,000 of them have been manufactured and used in the space of fourteen years. It appears, from an inspection of its structure, that the principal element in the gauge is the corrugated steel-plate, which really forms the spring, by the deflection of which the amount of pressure is indicated; and I think that the correctness of those indications for any continued length of time entirely depends upon the tempering of that steel-plate, and upon the quality of the steel of which it is made. I should think that Mr. Budenberg ought to have a few facts to mention in reference to this—namely, how long any of these plates have been known to work with accuracy, and I shall be very glad to be informed of the length of time their elasticity is likely to remain perfect.

Mr. Budenberg: I may say that in Manchester and its neighbourhood, where great attention has been paid to the working of steam gauges, ours have given the utmost satisfaction. For instance, the Messrs. Hick, of Bolton, who have been using them ever since we have had them in England, declare that they are the best of all gauges. Last year, at Messrs. Hawthorn's, in Newcastle, Mr. Scott, the engineer, told me they had one of our gauges on one of their boilers for eleven years, which had continued true during the whole of that time, while gauges of other makers had become quite incorrect after a space of two years.

Mr. Dawson: The Secretary's inquiry was as to the quality of the steel.

Mr. Budenberg: That is decidedly the most important part of our gauges—namely, the quality and the tempering of the steel; and the secret of our success lies in the fact that we have had all the springs tempered by one man. Mr. Shobelt, who is present, is one of our oldest hands, and he can tell you that the making and the tempering of the plates, and the making of the socket joints, are the most difficult, and at the same time most important, points in our gauges. We have only employed one hand for each of these parts, and have never deviated from this rule. By practising things in this way, we have been able to produce a good article; but had we employed a new man every fortnight or so, we would never have made a good gauge. The corrugated steel-plates are tempered in oil; and this is a nice operation, for they must not be too hard, and yet they must be hard enough. The other parts, however, must also be well made; for although the steel plate were perfect, if the other parts were not made carefully, the gauge would not move freely, and therefore not indicate correctly. According to our experience, no metal will do for the spring except steel, and we invariably use cold-drawn Sheffield steel.

Mr. Maxwell Scott: I consider it a very satisfactory point that these gauges will throw themselves out of gear in case a pressure has been attained beyond that which they are made to indicate. This feature, I think, is not generally known; for although Mr. Budenberg has several times called on me with these gauges, he never mentioned that circumstance to me before. I should like to ask the method of forming the corrugations in the steel-plate, whether they are stamped as candlesticks and such things are done, or otherwise? I should like to know also the thickness of the steel plates, and how the difference in the thickness of different plates is compensated for in the graduation of the dial, whether by the tempering, or by the hair spring in connection with the index?

Mr. Budenberg: The fact is, we require different thicknesses of steel for gauges of different range of pressure, and we have a great deal of trouble at times to get steel of the thickness we want it. I think it is No. 36 (wire gauge) we generally use; that is the finest steel we use, and we have had a great deal of trouble to get it so fine. We had at one time an order from Mr. Collett, of the St. Katharine Dock Company, to make a gauge to indicate the pressures of a column of water ranging up to 4ft. The lowest point of the reservoir was at an elevation of 11ft., and he had an idea that the index-hand should go thrice round the dial for these 11ft.; and that for the 4ft., of which he desired to register the varying heights, it should make a complete revolution, and indicate every fourth of an inch of height of water. We tried to make the gauge as proposed to us, but could not succeed; and Mr. Schaeffer at last accomplished it in a different way. Some of the teeth of the quadrant were cut away, so that it should not begin to indicate until the 11ft. of water were on; and in this manner it has been working satisfactory for four years. As for the plates, they are stamped.

Mr. M. Scott: Would not a column of mercury be better for such a purpose?

Mr. Budenberg: I thought so too at the time, but it is now made and working well at this time, as I may refer you to Mr. Collett, of the St. Katharine Docks. Through his recommendation, based on the working of this gauge, we have our gauges in use everywhere in these docks. Mr. Anderson, of Woolwich Arsenal, is also very favourable to them, and he has them in use extensively throughout the gun factory.

Mr. Scott: How do you compensate for different degrees of deflexion of different thicknesses of plates in the gauges?

Mr. Budenberg: We have to mark the divisions of the dial for every single pound of the range, by testing with a mercury column; we try them very often over, and we mark off every single pound. Every gauge is marked off in this way; we could not make two gauges to one pattern. There are no two dials exactly alike; it is with them just as with human faces, they look sometimes very like one another, but there is a difference when you examine them.

Mr. Clay: It would be very difficult to manufacture the plates of the same thickness.

Mr. Budenberg: This spring has no compensating effect; every plate is tried separately. It is often necessary to put the markings out again; we have to go over this operation several times before we can put the pressures on the dial finally.

Mr. Smith: I should rather have had a description of different kinds of gauges than a description of Mr. Schaeffer's gauge. Mr. Schaeffer's gauges, like others, are difficult to repair; and I think it would be a good thing to use a relief valve like that proposed by Mr. Dewrance, if it was possible to make the valve so as to blow a whistle when it was open, and thus indicate that the limit of safe pressure had been exceeded. There is such a variety of gauges in use, that I do not know the difference between them. I should have liked to have heard from our Secretary, who is so well versed in all these matters, the history of pressure gauges, and their peculiarities. Its cheapness is no doubt a recommendation to Mr. Schaeffer's gauge. This may be accounted for by its coming from Germany, where labour is cheaper than with us, but I know that the gauge is really an excellent one. The mercury column is as good a gauge as can be constructed, and I have been told that an improved mercurial gauge has been introduced. I should have liked to have heard a description of it.

Mr. Birckel: I think it is too much of Mr. Smith to expect that Mr. Budenberg will come here to blow anybody else's whistle but his own. There are so many different gauges, both in use and out of use, that it would be very difficult for me to go into the history of steam-gauge construction. I believe that the two principal gauges known are Schaeffer's and Bourdon's. There is Smith's, and various others, but I do not know the peculiarities of their construction. The principle of construction of Bourdon's Gauge has been illustrated to the meeting to-night, as one of these gauges has been passed round the room. The mode of action of Bourdon's tube is to partly uncoil itself under an internal pressure, and the extent to which it is straightened is registered in much the same way as in Schaeffer's gauge.

Mr. Budenberg: The principle of Bourdon's is so far different from ours, that in the latter the elastic medium is a plate, and in the other it is a tube, and the expansion or uncoiling of the tube turns the index.

Mr. Birckel: Mr. Smith was saying that the mercurial gauge was as good as any other gauge; but I think it right to state that the mercury gauge is the standard of this, and should be the standard of any other gauge, so that when you measure pressures by means of this gauge, you only read the indications transferred from the open mercurial gauge to this one.

Mr. Clay: There was a gauge invented by Mr. Alexander Allan; probably Mr. Grey can enlighten us about it.

Mr. Budenberg: It is not much in use, except only on the locomotives of the line with which he is connected. It is filled with water, I believe; and is something like a closed mercurial gauge, or compressed air gauge, only the medium here is water. There is always a deal of mischief in air gauges, and on the Continent they are entirely condemned. In Prussia you would not be allowed to put one of them on a boiler. The present law in Prussia, which I believe to be quite good, is, that you must have a mercury column in every boiler-house. You may have a gauge such as ours on each boiler, but you must have also a mercury gauge connected with the others, and so arranged that they each and all may be shut off and tested severally, in order to ascertain whether they are working alike, and in harmony with the mercurial gauge. I have a copy of the law with me, and I think no objection to it can be seriously made. It says,—"The law that each boiler must have a separate gauge remains in force, but the choice of construction is free, and we recommend, on account of their practicability, and because they can easily be read off, the use of spring gauges, but we require them to be often compared with the controlling gauge." That is to say, suppose you have twelve boilers, every boiler would have one gauge; and in a corner of the house an open mercurial column is placed, and is connected with all these gauges. You have a tap to shut off each of them, but from time to time you have to test them, or perhaps the inspector comes round and sees whether they are all working alike. That is the present Prussian law.

LONDON ASSOCIATION OF FOREMEN ENGINEERS.

On Saturday, the 7th ult., the members of this Society met for the annual election of Officers and the transaction of general business. Mr. Joseph Newton, in resigning the post of President, to which he had been elected on six successive occasions, thanked his constituents for the uniform kindness and forbearance they had continuously shown towards him. Their good feeling, he said, had rendered his task an easy and pleasant one. The Society, he was happy to state, was gradually increasing in strength and usefulness. During the past year, thanks to Messrs. Henry Grissell, Telford Field, Henry Maudslay, John Penn, and Mr. William Smith, C.E., of THE ARTIZAN, Engineering Journal, the jealousy and doubtfulness with which their proceedings had previously been regarded by engineering employers had nearly disappeared, and that harmony and union, which he (Mr. Newton) had striven anxiously to promote between masters and men, approached consummation. It was all along known to himself and fellow members that there existed no just ground for the fears which some employers entertained of the effects of "combination" among their foremen, seeing that that combination, if so it might be termed, was solely designed to promote scientific, intellectual, and benevolent ends. The Association had at all times scrupulously avoided interference with trade arrangements between employers and employed, and eschewed touching upon what were known as workshop secrets. Such a course it would pursue in the future; and by it he felt assured they must eventually win the confidence, and gain the support, of the heads of every engineering establishment in the kingdom.

The Superannuation Fund originally suggested in the rules of the society, and prominently brought to public notice last year, by Mr. Grissell, was progressing favourably, and a good account would be rendered of it at the coming anniversary dinner. After some further remarks, Mr. Newton formally vacated the chair. His absence from it, however, was not of long duration, for Messrs. Hayes, Usher, Briggs, Ross, and several other members, backed by the unanimous approval of a numerous auditory, exhorted him to return to the post of president for another year, or, at least, until the superannuation fund should have been completed, and very reluctantly Mr. Newton accepted his re-election. Mr. Thomas Sanson was next chosen as vice-president, and Mr. David Walker as secretary; and, after the nomination and election of several new members, Mr. C. F. Hayes proceeded briefly to explain some of the processes connected with the drawing of steel tubes. He produced numerous specimens of such tubes, round, hexagonal, and square on their outward surfaces. They varied in size from 2in. diameter to $\frac{1}{16}$th of an inch, and some of the dies, mandrils, and tools used in the operation of drawing them were also introduced. It was explained that the peculiarities of the process were, that the material was dealt with while in a perfectly cold state, and that tubes could be produced of any size up to 2ft. in diameter and 50ft. in length. Mr. Hayes further stated that, as he had previously been engaged at the Royal Small Arms Factory, Enfield Lock, he was enabled to assure his hearers that by the drawing arrangements, rifle barrels could be supplied truer in the bore, stronger, and at very much less cost than they could be manufactured at that establishment.

A short but animated and practical discussion followed Mr. Hayes's remarks, and in this Messrs. Irvine, Briggs, and Walker took prominent parts. It elicited the facts that any kind of steel or other homogeneous metal might be converted into tubes, and that the strength of the material was enhanced rather than deteriorated by the process. Experiments, it was said, had demonstrated this. Steel tube drawing, too, furnished an excellent means of testing the quality of the metal supplied by various makers. The lateness of the hour prevented further consideration of the subject on the night in question, but a comprehensive paper upon it was promised by Mr. Hayes for the monthly meeting in February. This was officially announced by the Chairman, who also intimated that the twelfth Anniversary Festival of the association, fixed to take place on the 18th of February, at the Bridge House Hotel, would be presided over by John Penn, Esq.

CHEMICAL SOCIETY.

A CONTRIBUTION TO THE HISTORY OF THE OXIDES OF MANGANESE.

By W. DITTMAR.

It has long been known that oxides of manganese, when heated to redness in air, either evolve or absorb oxygen, so as constantly to leave a residual oxide of the composition Mn_3O_4. Some years ago, Schneider found that when the ignition is made in pure oxygen, the residue consists of Mn_2O_3.*

This result differs from what might have been expected, for we do not know of any chemical action exerted by nitrogen on the oxides of manganese or on free oxygen; and, therefore, one might have thought that air would act simply like dilute oxygen, and produce the same oxide.

To explain the result of Schneider's experiment, we must suppose either that artificially made oxygen differs in some respects from that in the atmosphere, or what is more likely, that the proportion of oxygen in the residue depends on the *tension of the oxygen* in which the original oxide was heated, as well as on the temperature to which it was exposed.

Accepting this latter explanation, we say that at a red heat, in presence of oxygen of the tension of one atmosphere, the oxide Mn_2O_3, being the most stable under these conditions, is formed, while at the same temperature, with oxygen of the tension of only one-fifth of an atmosphere, the oxide Mn_3O_4 is the most stable, and hence it is produced. This leads to the question, what oxides will be formed when oxygen of intermediate tensions is employed? Will there be a continuous series of oxides corresponding to a continuous series of oxygen tensions under which they have been formed?

* Poggendorff's Annalen, cvii. 605

These questions seemed to me to merit an experimental investigation, and that the more, because the results of such an inquiry would be a small contribution to our as yet very imperfect knowledge of the laws which govern the influence of physical conditions on chemical reactions.

In a preliminary series of experiments, pure binoxide of manganese, prepared by heating the nitrate, was heated to dull redness in a combustion tube, whilst in the first experiment a current of nitrogen, in the second one of air, and in the third one of oxygen, was kept passing over it. After weighing the residual oxide, it was again heated under the same conditions as before, and then weighed a second time. Finally, by ignition in a current of hydrogen, it was reduced to protoxide, which was also weighed. The following table contains the results:—

TABLE I.

No. of Exp.	Gas employed.	Weight of the Oxide after 1st heating = P.	Weight of the Oxide after 2nd heating = P′.	Weight of Mn O.	Composition of Oxide = $Mn O_x$.
1	Nitrogen ...	0·7984 grm.	0·7971	0·7184	From P; x = 1·494 From P′; x = 1·486
2	Air............	0·891 „	0·891	0·798	x = 1·517
3	Oxygen	1·084 „	1·084	0·969	x = 1·527

From these data it will be seen that in each of the three experiments, Mn_2O_3 was obtained. This fact led me to think that Schneider, in heating an oxide of manganese in pure oxygen, obtained the sesquioxide, only on account of his having performed his experiments at about the same temperature that I employed, at which air, and even nitrogen, gives the same result as oxygen.

The second series of experiments showed, however, that the oxide Mn_2O_3 *is* stable when heated in oxygen, even at a higher temperature than would suffice in presence of air to reduce it to Mn_3O_4. In this series of experiments, pure binoxide of manganese, in a porcelain or platinum boat, was placed within a porcelain tube, and the whole heated to bright redness for about an hour, while a current of dry nitrogen or oxygen, or a mixture of the two, was passing over it. The oxide was then analysed as before, by igniting in hydrogen and weighing the protoxide left. Most of the experiments were conducted under the ordinary atmospheric pressure; but in a few, the tension of the gas in which the $Mn O_2$ was heated, was diminished below one atmosphere by connecting the exit-end of the porcelain tube with a large bell jar, within which the pressure was diminished, and kept constant by means of an air-pump. The following table gives the result of eighteen experiments carried out in this manner.

TABLE II.

No.	Nature of Atmosphere.	Tension* in atmospheres of V.	Tension* in atmospheres of Θ.	Tension* in atmospheres of N + O.	Weight of Oxide of Manganese.	Weight of MnO obtained from it.	Composition of Oxide being Mn Ox.
1	Oxygen	0	1	1	0·95	0·8491	1·527
2	Nitrogen	1	0	1	0·4269	0·3993	1·307
3	Air.............................	0·79	0·21	1	0·7485	0·6935	1·352
4	Equal vol. of air & oxygen	0·40	0·60	1	0·6559	0·5879	1·513
5	Nitrogen	1	0	1	0·3942	0·3670	1·329
6	Oxygen	0	1	1	0·8738	0·7844	1·506
7	Air.............................	0·79	0·21	1	0·6163	0·5672	1·384
8	1 vol. oxygen, 2 vol. air ...	0·53	0·47	1	0·7465	0·6687	1·516
9	Vacuum of air	0·013	0·003	0·016	1·0256	0·9505	1·350
10a	1 vol. oxygen, 5 vol. air...	0·66	0·34	1	0·7571	0·6821	1·488
10b					0·9038	0·8098	1·515
11a	Mixture of oxygen and nitrogen, both artificially made..............	0·81	0·19	1	0·6756	0·6265	1·348
11b					0·3426	0·3180	1·343
12	Oxygen of low tension ...	0	0·17	0·17	0·9062	0·8412	1·313
13	„ „ ...	0	0·027	0·027	0·6769	0·6292	1·336
14	„ „ ...	0	0·16	0·16	0·6333	0·5876	1·345
15	15 vol. air, 1 vol. oxygen	0·74	0·26	1	0·8172	0·7362	1·488
		0·74	0·26	1	0·8658	0·7736	1·527

It will be seen that in each of the experiments the number of the equivalents of oxygen (O = 8), combined with one of manganese (Mn = 27·5), was very near

* The tensions given do not pretend to be more than rough approximations to the real values.

either to $1\frac{1}{2}$ or to $1\frac{1}{3}$—that is to say, either Mn_2O_3, or Mn_3O_4 was produced, and intermediate oxides were not formed. These two oxides which were formed are easily distinguished, the sesquioxide being black, while the oxide, Mn_3O_4, is brown. In a few cases a large quantity of the brown oxide was obtained side by side, but not mixed, with a small quantity of the black sesquioxide; but the amount of the latter was never sufficiently great to make the composition of the whole, as given in the table, differ materially from Mn_3O_4. In all cases in which Mn_3O_4 was obtained, the partial tension of the oxygen lay between 0 and 0·21 atmospheres. As is stated in the table, some of the experiments were made with nitrogen (Nos. 2 and 5), and some with air (Nos. 3, 7, 9) of different pressures. Others were performed with oxygen of low tension (Nos. 12, 13, 14), or with a mixture of artificial oxygen and nitrogen (Nos. 11a and 11b). In those experiments which gave Mn_2O_3, the tension of the oxygen lay between 0·26 and 1 atmosphere. Oxygen tensions between 0·21 and 0·26 atmospheres did not occur in this series; still we can assert, with a high degree of probability, that the function expressing the relation between the composition of an oxide of manganese, formed at a bright red heat in an atmosphere of oxygen, and the tension of that oxygen, is discontinuous, or that Mn_2O_3 is formed whenever the tension exceeds and Mn_3O_4, whenever it is below, a certain definite limit.

To find out whether there is really such a limit, and if so to determine its position, I undertook a third series of experiments, which, for the sake of comparison, were made as uniform as possible. In each experiment the bioxide of manganese was placed in a platinum boat, which was itself placed on a strip of platinum foil, and by means of this introduced into the porcelain tube. (The same tube and boat were used in all the experiments). The tube was subjected to the strongest heat of a Hofmann's gas furnace for about half an hour, while a current of oxygen and nitrogen, mixed in exactly known proportions, was sent through it. The boat was then quickly withdrawn from the tube and allowed to cool. As this required only a very few minutes, no appreciable quantity of Mn_2O_3 could be formed at the temperatures conducive to its formation. The oxide was then weighed and analysed by determining the amount of Mn_3O_4 which it gave when ignited in a current of air partially deprived of its oxygen. The mixtures of oxygen and nitrogen which I employed were made from air and oxygen.

The air was collected in a glass gasometer over water, which had been previously saturated with air at the temperature of the laboratory. Its volume was determined by measuring the water which it displaced, and its temperature was assumed to be that indicated by a thermometer hung up close to the gasometer, while its tension was made equal to that of the surrounding atmosphere. In some experiments, the temperature was taken more carefully by plunging the whole gasometer into a water-bath of a constant known temperature, until equilibrium of temperature was established. The oxygen was measured out in a small glass gasometer, which was entirely immersed in a water-bath of known and constant temperature. The tension of the gas was in most cases made equal to that of the atmosphere, by originally collecting it under a higher pressure, and after establishing the desired temperature, allowing the excess of the gas to escape through a layer of water from 1 to 2 mm high. Lastly, the oxygen was transferred to the air gasometer by displacing it with water, through which oxygen had been previously passed for some time. The gaseous mixture was displaced by water previously saturated with air, and before entering the porcelain tube, it passed first through a soda-lime, and then through a chloride of calcium tube, to free it from carbonic acid and water.

The volume of the oxygen formed in all cases only about one-twentieth of that of the air, and hence any error in measuring the proportions of oxygen and air gave rise to a comparatively small error in estimating the proportion of oxygen in the mixture. For the same reason, the absorptiometric exchange between the gaseous mixture and the water could not change the composition of the former to any appreciable extent.

In determining the composition of the mixtures, one volume of air was assumed to contain 0·2093 vol. of oxygen. The following experiments were carried out in the manner described:—

Table III.

The following abbreviations are used in the sequel:—
V for volume in litres, and P for pressure in inches of mercury of a gas.
t for temperature in centigrade degrees.
Q for volumes of oxygen in 100 volumes of gaseous moisture.
p for partial pressure of the oxygen prevailing during the experiment.
B for height of barometer in inches.
W for weight in grammes.

Experiment 17.

*Air.** V = 10·90 } P the same in both cases.
*Oxygen** V = 0·50 } t not observed.
As the temperatures of both gases were about the same Q is approximately = 24·4
B during ignition = 29·68; hence p = 7·24.
The greater part of the oxide obtained was brown, a small portion of it black.
W of oxide obtained = 1·0716.
W after reduction to Mn_3O_4 = 1·0683.
Therefore its composition:—

Mn_3O_4 .... 0·9739 grammes.
Mn_2O_3 .... 0·0977 „

Experiment 18.

Air. V = 10·91; t = 12·2, P = that of atmosphere = B.
Oxygen. V = 0·35; t = 9·5, P = B + 1·2.
Hence Q = 23·5.
B during ignition was not observed. Taking it = 30, p becomes = 7·05.

* In this, as well as in the following experiments, the V and P given for air and oxygen refer to the moist gases.

W of oxide obtained = 1·8884.
W after reduction to Mn_3O_4 was = 1·8880.
Loss of oxygen = 0·0004, corresponding to 0·0118 of Mn_2O_3; the rest consisted of Mn_3O_4.

Experiment 19.

Air V = 10·91; t = 13·3; P = 29·92.
Oxygen V = 0·54; t = 10·3; P = 30·5.
Hence Q = 24·7; B during ignition = 29·84; hence p = 7·38.
Weight of oxide obtained, 0·9030.
After reduction to Mn_3O_4, 0·8626.
Hence its composition: MnO 1·557; *i.e.*, Mn_2O_3.

Experiment 20.

Air. V = 12·77; t = 10·5 } P the same in both cases.
Oxygen. V = 0·490; t = 8·3 }
Hence Q = 23·9, and as B during ignition = 29·46, we have p = 7·04.
Most of the oxide obtained was brown, a small part was black.
W of oxide = 0·8222.
After reduction to Mn_3O_4 it was 0·8217.
The 0·0005 of oxygen lost correspond to 0·0148 of Mn_2O_3; the rest, 0·8074, consisted of Mn_3O_4.

Experiment 21.

Air. V = 11·41; t = 15·8 } P the same in both cases.
Oxygen. V = 0·503; t = 12·2 }
Hence Q = 24·3, and as B during ignition = 21·52; therefore, p = 7·17.
Most of the oxide was black, a small portion only being brown.
W of oxide = 1·1745.
After reduction to Mn_3O_4 it was 1·1417.
Hence composition:

Mn_3O_4 = 0·2035.
Mn_2O_3 = 0·9710.

Experiment 22.

Air. V = 11·90 } P and t exactly the same in both cases.
Oxygen. V = 0·499 }
Hence Q = 24·1, and as B during ignition = 29·32, therefore p = 7·07.
W of oxide obtained 0·8648.
After reduction to Mn_3O_4 it was 0·8643.
The 0·0005 of oxygen lost correspond to 0·0148, of Mn_2O_3, the rest consisted of Mn_3O_4.

Experiment 23.

Air V = 11·7 } t and P the same in both cases.
Oxygen V = 0·499 }
Hence Q = 24·2, and as B during ignition = 29·54, p = 7·14.
W of oxide = 0·6513.
After reduction to Mn_3O_4 = 0·6281.
Therefore composition, $MnO_{1\cdot510}$, *i.e.* Mn_2O_3.

Experiment 24.

Air V = 14·54 } P and t the same in both cases.
Oxygen V = 0·502 }
This mixture was employed three times under different pressures.

Experiment a.—The tension of the mixture was made greater than that of the atmosphere by forcing it, after coming out of the porcelain tube, through a layer of water, 4·5in. deep. B during ignition = 29·96, hence p = 7·14.

This time the binoxide of manganese, previous to being heated in the mixture of oxygen and nitrogen, was converted into Mn_2O_3 by ignition in pure oxygen.

Experiment b.—The oxide obtained in experiment a was heated in the same gas as before, but this time without increasing its pressure beyond that of the atmosphere B = 29·95, therefore p = 7·06.

Experiment c.—The oxide obtained in experiment b was heated in the same mixture of N and O as before; the tension of the latter, however, was brought down below that of the atmosphere by sending it from the porcelain tube into a large bolt-head, within which the pressure was diminished and kept constant by sucking. The difference between this pressure and that of the atmosphere was measured by means of a water-manometer. The height of the latter was kept as near as possible to 5·5in. B = 29·9; hence p = 6·95.

At last the oxide from experiment c was reduced to Mn_3O_4 in the ordinary way.

The composition of the oxides obtained in these three experiments is given in the following table:—

Weight of Mn_2O_3 employed = 1·1852.

Exp.	p.	W of Oxide.	Composition.
a.	7·14	1·1842	$Mn_{1\cdot503}$
b.	7·06	1·1842	$Mn_{1\cdot503}$
c.	6·95	1·1469	1·0463 of Mn_3O_4* and 0·1006 of Mn_2O_3
After reduction to Mn_3O_4		1·1435	Mn_3O_4

* A small portion of the oxide was black; the greater part was brown.

It is seen that, under the oxygen tension of 7·06, Mn_2O_3 was not decomposed, while under the oxygen tension of 6·95 it was for the most part reduced to Mn_3O_4. Under the conditions prevailing in experiment 24, therefore, the point of discontinuity above spoken of seems to correspond very nearly to an oxygen pressure of 6·95in.

Experiment 25.

Air $V = 14·00$
Oxygen $V = 0·407$ } t and P of both gases the same.

The same mixture was employed under two different pressures.

In *Experiment a*, the tension of the mixture of nitrogen and oxygen was made to exceed that of the atmosphere by 6·8in. of water pressure. B = 30·03, therefore p = 7·07.

Experiment b. Pressure of gaseous mixture = B = 30·05, hence p = 6·96. Under this pressure, the oxide obtained in experiment a was ignited. The composition of the oxides will be given below.

Experiment 26.

Air $V = 14·02$
Oxygen $V = 0·408$ } P and t the same in both cases.

Experiment a. In this mixture the oxide obtained in experiment 25 b was heated. During the ignition B = 30·02, therefore p = 6·95.

Experiment b. 11·26 litres of the same mixture of nitrogen and oxygen as was used in experiment a, of the temperature of 14° C, were mixed with 1·00 litre of air of 8° C. P of both gases the same. In this mixture the oxide obtained in experiment a was ignited. B, during the ignition, 30·04, hence p = 6·90.

Experiment c. 8·75 litres. at 11° C., of the same mixture of nitrogen and oxygen as was used in experiment b, were mixed with 0·50 litres (at 8°) of air. P of both gases was the same. In this mixture, the oxide obtained in experiment b was heated. B during ignition = 30·05, therefore p = 6·87.

Experiment d. The oxide obtained in experiment c was again ignited in the same mixture of nitrogen and oxygen B = 30·03, hence p = 6·87.

Experiment e. The oxide obtained in d was reduced to Mn_3O_4.

Composition of Oxides obtained in Experiments 25 and 26.

Exp.	P.	W. of Oxide.	Composition.
25a	7·07	0·7982	$Mn O_{1·505}$
25b	6·96	0·7982	$Mn O_{1·505}$
26a	6·95	0·7953	0·0829 of Mn_3O_4
			0·7124 of Mn_2O_3
26b	6·90	0·7982	$Mn O_{1·505}$
26c	6·87	not determined	Mixture of brown and black oxide.
26d	6·87	0·7745	0·1184 of Mn_2O_3
			0·6561 of Mn_3O_4
26e		0·7705	Mn_3O_4

In order to define approximatively the range of temperatures within which the experiments of this series had been performed, a piece of aluminium and also a piece of pure silver were placed into the porcelain tube, and heated in the same manner as had been the case with the oxide of manganese. Twenty minutes after the tube had become thoroughly heated, the aluminium was found to be fused, but not the silver.

We see that sometimes pure Mn_2O_3, sometimes pure Mn_3O_4 was formed, while in some cases both were obtained, side by side, not mixed; one of them, however, always greatly predominated in quantity.

Mn_2O_3 was formed alone or predominated in experiments:—

	19	21	24a	23	25a	24b	25b	26b
P being respectively	7·38	7·17	7·14	7·14	7·07	7·06	6·96	6·90

Mn_3O_4 was formed alone or predominated in experiments.

	26d	24c	20	22
P being	6·87	6·95	7·04	7·07*

These results seem to confirm the conclusions drawn from the second series of experiments. Experiments 24 b and 24 c, and also 26 b and 26 d, clearly show that, at a certain temperature, and in a certain atmosphere of nitrogen and oxygen, Mn_2O_3 will be stable, while a slight diminution in the tension of the oxygen, the other conditions remaining the same, will cause its reduction to Mn_3O_4. The exact value of the limiting tension of the oxygen below which Mn_3O_4, and above which Mn_2O_3 is formed, depends, no doubt, on the temperature to which the oxide of manganese is exposed. If we suppose that the function expressing this dependency is a continuous one, the apparently anomalous result of the third series of experiments, viz., that at oxygen tensions contained between 6·60 and 7·07, either of the two oxides may be formed under apparently the same conditions, may be explained.

I cannot conclude without expressing my best thanks to Mr. Francis Jones, for his valuable assistance during the earlier part of this investigation.

* Experiment 18 is not mentioned here, because in it the barometer was not observed during the ignition; also experiment 17 is omitted, because the high value of P deduced from it, makes me suspect some error committed in making the synthesis of the gaseous mixture.

SHIPBUILDING IN IRELAND.

We have been pleased to be able to record, from time to time, the progress made of late in shipbuilding and marine engineering by enterprising firms in the sister Isle.

We are glad to notice that the firm of Messrs. Walpole, Webb, and Bewley of the port of Dublin ship-yard, have recently completed for the Dublin and Kingstown Steam Packet Company, for passenger traffic between Dublin and Kingstown, a paddle-wheel steamer—the *Anna Liffey*—the trial trip of which took place on the 12th inst., and gave very satisfactory results as to her speed and general efficiency. The length of the *Anna Liffey* over all is 190ft., her breadth of beam, moulded, 20ft.; depth, to top of spar deck, 11ft. 10in.; draft, in trim, 4ft.; the deck is flush from end to end; the tonnage, registered, is 281·93. She is fitted with oscillating condensing engines, by Messrs. McNab and Co., of Greenock, of 100 horse-power nominal. Diameter of cylinder, 40in.; length of stroke, 3ft. 9in. The boilers are by Messrs. Walpole, Webb, and Bewley, the builders of the vessel, and are, we believe, the first set of marine boilers ever made in Dublin.

The following are the particulars of her trial trip on the 12th inst., when she was commanded by Captain Williams. The day was a very severe one against the steamer, which is intended to attain her greatest speed in calm water. The vessel started from the dock at half-past eleven, when she was taken up the river and moored for a few minutes at the Steam-packet Company's starting wharf. At nineteen minutes past twelve she started from thence, proceeding at a reduced speed down the river. At thirty-eight and three quarter minutes past twelve she rounded Poolbeg Light, and, on steering for Kingstown, had a strong, gale from the S.W. At fifty-two minutes past twelve she passed the East Pier, and her speed being slowed inside the harbour, she was alongside the wharf in three minutes more. Thus her first trip was made in 36min. After some delay at Kingstown for the purpose of coaling, she started again for a run down the south coast, and rounded the East Pier at forty-three minutes past two. On this occasion it was found by the log that she attained a maximum speed on that part of the run of fifteen nautical miles per hour, which is a very fair result, considering that the state of the weather was most unfavourable, and those handling the vessel had had no previous experience either of her or the engines.

At a little after four o'clock she was headed back for Kingstown, and ran to Dalkey Sound in forty eight minutes, which was, according to the registered log, a speed of 16·32 statute miles an hour, being an increase upon the previous rate. The maximum of revolutions of the wheels attained per minute was thirty-five.

Having landed some passengers in Kingstown, she started for Dublin at a quarter past five p.m. During the interval between passing the East Pier this time and reaching the Poolbeg Light, she attained a speed greater than at any time before, the space between the two lighthouses being traversed within fifteen minutes. She then came slowly up the river, and was moored at a berth at Messrs. Walpole, Webb, and Bewley's wharf.

APPOINTMENTS IN THE ENGINEER ESTABLISHMENT OF THE DEPARTMENT OF PUBLIC WORKS IN INDIA.

For the information of our correspondents who have inquired as to the class of subjects included in the Examination Papers, we append those for the Competitive Examinations for 1863 and 1864, which are included in the list of Mr. Geo. P. White, C.E.:*—

EXAMINATION PAPERS

For Competitive Examination of Candidates for Appointments in the Engineer Establishment of the Department of Public Works in India, held at the India Office, London, in June, 1863.

George Preston White, C.E., *Examiner*.

Note.—You are particularly requested to write legibly, and to answer the questions as concisely as possible. Prefix the number of the question to each answer. In those cases in which free-hand sketches or diagrams are used to illustrate the subject, it is requested that they may be carefully executed, in order to show the candidate's proficiency in this style of drawing. Candidates must not during the examination, refer to any book or MS., nor communicate with each other; their doing so will disqualify them. Candidates are required to produce *bonâ fide* finished drawings, with certificate, respecting which there will be a *viva voce* examination.

Describe the course of education you have undergone, name the engineer to whom you have been a pupil, the number of years articled, the nature of the works on which you have been engaged, and state in what branch of the profession you have had most practical experience.

Railway Estimates.

Calculate the quantity of earthwork in the accompanying table; explain how the Tab. Numb. is obtained, and the different modes of calculating earthwork.

* The other subjects upon which candidates are examined are:—Euclid, arithmetic, trigonometry, mensuration, algebra, mechanics, and hydrostatics, by the Rev. I. Cape; and levelling, surveying, and geometrical drawing, by Major-General A. G. Goodwyn. For information, in addition to what we have given above, we would refer our correspondents to the returns upon the subject of the Engineer Establishment and Public Works Department, ordered by the House of Commons to be printed on the 17th June, 1864, and being in continuation of the Parliamentary Paper, No. 473, of Session 1863.

Cuttings.

Base, 30ft. Slope, 1½ to 1.

No. on Section.	Depths.		Lengths in Links.	Tab. Numb.	Cont. C. Yds.	Total in C. Yds.	Price.	£ s. d.
1	0	22	7·00	21·19				
1	22	28	8·00	62·76				
1	28	17	15·00	53·69				
1	17	0	29·00	14·80				
2	2	7	20·00	6·24				
2	7	9	10·00	12·46				
2	9	3	10·00	8·83				
2	3	7	20·00	7·02				
2	7	7	15·00	10·50				
2	7	2	15·00	6·24				
3	3	9	25·00	8·83				
3	9	2	25·00	8·02				
3	2	8	10·00	7·11				
3	8	7	5·00	11·46				
3	7	0	10·00	4·80				
4	4	16	20·00	17·33				
4	16	16	20·00	32·00				
4	16	25	25·00	46·50				
4	25	23	20·00	58·69				
4	23	0	10·00	22·57				

Fill up the prices and amount in the accompanying table for a Parliamentary Railway Estimate, and state at what distances usually it becomes desirable to throw stuff to spoil, and use side cutting.

Base, 30ft. Slopes, 1½ to 1.

No. on Section.	Contents in Cube Yards.	Material.	Where taken to.	Average lead in chains.	Price per C. Yard	Amnt.
						£ s. d.
1	18,334	Brown & Blue Clay	No. 1 Bank ...	20		
1	43,118	ditto	No. 1A Bank...	40		
1	301	ditto	No. 2 Bank ...	8		
	5,600	ditto	Subsidence in No. 1A Bank 10 per cent. on contents.........	40		
	19,500	Stuff for burning into ballast for 1 mile 5 furlongs, including fork, or to widen bank.........	....	40		
	37,507	Clay to spoil or to widen banks	....	...		
2	12,000	Stuff for burning into ballast for 1 mile up to 2nd mile, or to go to spoil...	....	40		
	36,128	Clay....................	To spoil	...		
3	786	Yellow & Blue Clay	No. 3 Bank......	8		
3	12,000	Stuff for burning into ballast for 1 mile to 3rd mile, or to go to spoil...	....	40		
3	26,660	Clay..................	To spoil,			
4	88,229	Yellow & Blue Clay	No. 4 Bank ...	60		
4	9,577	ditto	Subsidence in No. 4 Bank 10 per cent. on contents.........			
4	24,000	Stuff for burning into ballast for 2 miles up to 5 miles, or to spoil bank...	....	40		
4	112,402	Yellow & Blue Clay	To widen banks or to spoil	40		
			Total			

Fill up the prices and carry out the amounts in the accompanying columns, for a Parliamentary Railway Estimate.

No.	Description.	Road.	Span.	Quantity.	Price.	Amount.	Total Amount.
						£ s. d.	£ s. d.
	Parish road level crossing at 25 miles 1½ fur., gates, culverts, and cottage						
	Road diverted, including metalling and fencing on one side.			L. Yards 270			
	Earthwork to approaches			C. Yards 600			
	One road bridge at 25 miles 4¼ fur. in 12ft. embankment, brickwork in bridge	25	12	C. Yards 350			
	Backing up bridge, excavated approaches, & metalling roadway						
	3ft. culvert in 14ft. embankment at 25 miles 4¾ fur.			L. Yards 25			
	2ft. culvert at 25 miles 6½ fur. in 10ft. embankment			L. Yards 20			
	Parish road level crossing in 8½ft. embankment at 25 miles 7 fur., including gates, culverts, and cottage						
	Earthwork			C. Yards 3,000			
	Metalling			S. Yards 1,250			
	Single fencing			L. Yards 276			
	2ft. culvert at 25 miles 7¾ fur. in 7ft. bank.			L. Yards 20			
						Total...	

Make an estimate for one mile of double railway.

	£ s d.	£	s.	d.
tons of rails, 75lbs. to the yard .... at				
tons of chairs.. „				
sleepers .... „				
cube yards of ballast..................................... „				
lineal yards double road laying, including pins and keys .... „				
lineal yards double 4-rail fencing, including quick, mound, and ditch .... „				
Field gates and making good fences, say				
Trespass and compensation for damage by carting......				

Roofs.

5. Make a free-hand sketch of a Mansard roof, an M roof, and a Hammer-beam roof, and explain the object of the hammerbeam.

6. Explain the objects of the following parts of a roof, viz., king post, queen post, tie beam, straining beam, rafters, purlins, braces, ridge piece, struts; and make a free-hand sketch of a truss for a roof 45ft. span, showing the connection of the different parts, and explain the different strains.

7. Give the names of some remarkable examples of roofs in wood and iron, stating the span.

8. Make a free-hand sketch to show the mode employed to counteract the thrust and settlement in a mediæval roof, that is where an ordinary horizontal tie beam cannot be introduced.

Irrigation.

9. In carrying out works of irrigation in tropical countries, state what are the chief circumstances requiring attention.

10. State what has been the average cost per acre to irrigate land in Piedmont, Lombardy, and India; and what is the average return on money thus invested, and the increase of produce due to irrigation.

11. Describe the different modes employed to irrigate land. Name the crops most requiring irrigation, specifying which require complete and which partial irrigation, and the length of time and seasons of the year when water is most required.

12. What is the maximum and minimum gradient per mile you would recommend for the main canals in works of irrigation?

13. Assuming the evaporation in Southern India to be half an inch per day, how many tons of water would be evaporated from an acre of land completely irrigated per day?

Foundations.

14. Describe the different methods in practise for making foundations under water. State the comparative advantages of the different systems, and make free-hand sketches to illustrate the subject.
15. State which are the best and which are the most difficult soils to form foundations on.

Bridges and Viaducts.

16. Describe the different forms of girder, viz.:—The trellis, the Warren, the tubular, the bow and string, and Brunel's girder; state the comparative advantages and cost.
17. What are the circumstances which would guide you in employing cast iron, wrought iron, stone, brick, timber, or wire, in the construction of bridges and viaducts?
18. Make a design for a centre, of simple construction, for a brick elliptical arch of 50ft. span and 20ft. rise, and name any important example of bridge centering.
19. Give transverse sections of the best forms for girders of cast, wrought, and boiler plate iron, and state the general results arrived at from the experiments of Messrs. Stephenson, Fairbairn, Hodgkinson, and Barlow.
20. Enumerate some of the scales most commonly used for plans, elevations, and sections.
21. In what strata is coal, iron, lead, copper, tin, fire-clay most commonly found? What are the surface indications of the existence of minerals? state briefly the usual methods employed for exploring, working, draining, and ventilating mines; and describe the principle of the Davy lamp.
22. Explain the uses of the fly wheel, the governor, and the parallel motion of a steam engine; make free-hand sketches of the two latter, and state by whom they were invented.
23. How is pig iron, wrought iron, and steel manufactured; and what is the object of employing the hot blast? Give the letters or marks used in the trade and in specifications to denote the different qualities of iron.
24. State how you would test a wrought iron and cast iron bridge girder; what load per foot run you would subject it to; and what is the weight of a platform loaded with men per square yard.
25. What is superheated steam, and what is the object of employing it? What is the advantage of working steam expansively?
26. Describe the materials employed in the manufacture of bricks; the mode of manufacturing and burning bricks; the names of the different qualities; and what constitutes good bricks.
27. Give the names of standard professional works of reference on the following subjects:—

Architecture.
Bridges of brick, stone, timber, cast and wrought iron, and wire.
Building materials.
Carpentry.
Canals of navigation and irrigation.
Drainage.
Engineering biography.
Engineering reports.
Embanking land from the sea and from rivers.
Foundations.
Harbours.
Iron (manufacture of).
India, reports on public works, and works of topography.
Law of contracts.
Lighthouses.
Limes, mortars, and cements.
Masonry.
Mining.
Machinery.
Preserving timber from dry rot and decay.
Road making.
Railways.
Surveying.
Specifications.
Strength of materials.
Steam engine, locomotive and stationary.
Tunnelling.
Tables for earthwork, quantities, and to facilitate calculations, &c.
Water supply to towns.

28. Explain the meaning of the following terms:—Abutment, adit level, ashlar, backing, balustrade, batten, batter, bay, bond, bracket, breaking joint, brest-summer, butting joints, buttress, caisson, camber, cantalever crank, catenary curve, chamber (lock), clamp, coffer dam, collar beam conduits, coping, cornice, counterforts, coursed masonry, cross beam, culverts, deflection, discharging arch, dove-tail, dry rot, eaves, entablature, extrados, fascines, façade, fender piles, flying buttress, footings, gable, girder, groin, groined arches, grillage, grout, Gunter's chain, grooved and tongued, hammer beam, haunches of an arch, headers, herring-bone work, hip roof, intrados, invert, joggle joint, key, lewis, malleability, neutral axis, pediment, pilaster, pontoon, puddling, purlins, puzzolana, quoins, rafters, rendering, retaining walls, ruling gradient, scantling, scarfing, soffit, spandrel, specific gravity, springing course, strut, templet, tensile strain, tie beam, torsion, truss, under pinning, wire gauge, water shed, spigot, and faucet joint.
29. Name some of the principal works of the following Civil Engineers:—Sir Cornelius Vermuyden, Sir Hugh Myddleton, James Brindley, James Watt, John Smeaton, John Perry, William Murdoch, Ralph Walker, R. Trevethick, Joseph Huddart, William Jessop, William Chapman, Robert Mylne, Thomas Telford, John Rennie, Alexander Nimmo, Sir Mark Isambard Brunel, George Stephenson, Robert Stephenson, M.P., Joseph Locke, M.P., Robert Stevenson of Edinburgh, Sir William Cubitt, Isambard Kingdom Brunel, Sir John Rennie, Sir John Macneill.
30. Explain the principle of the Artesian well, the cause of the water in some instances rising above the surface of the ground, the usual mode of construction, and the best water bearing strata.
31. Name the best kinds of stone for building, specifying those most durable for works under water.
32. Describe the characteristics of the different kinds of timber employed in building, and state their comparative cost and durability.
33. Name the different kinds of lime and cement used in building; describe their properties and specify those which are hydraulic. What is the chemical difference between ordinary and hydraulic limes? Explain what artificial hydraulic limes can be made, according to the experiments of Vicat and others; and state how you would test the quality of limes and cements.
34. Describe the advantages of the slide rest principle, and mention some of its most important applications to machinery.
35. Describe the means employed in Holland and other countries for embanking land from the sea and from rivers.
36. Explain the various means employed for improving the navigation of rivers; and describe some successful example, such as the Clyde.
37. Describe the usual means employed for raising water; state what per centage of useful effect can be obtained respectively from overshot, breast, and undershot wheels, and from the turbine; and describe their comparative advantages, and the head of water required.
38. Explain the different systems employed for supplying towns with water, and give examples.
39. Explain briefly the principal features of the system for the drainage of London now being carried out by Mr. Bazalgette.
40. Describe briefly the principal parts of the locomotive engine; and state the improvements introduced by Stephenson.

EXAMINATION PAPERS FOR 1864.

RAILWAY ESTIMATES.

Calculate the quantity of earthwork in the accompanying table; explain the different modes of calculating earthwork, how the Tab. Numb. is obtained; and give the names of Standard Books of Tables used to facilitate the calculation of earthwork.

Cuttings.

Base, 30ft. Slope, 1½ to 1.

No. on Section.	Depths.		Lengths in Links.	Tab. Numb.	Cont. C. Yds.	Total in C. Yds.	Price.	£ s. d.
1	0	3	5·00	1·83				
1	3	12	10·00	11·83				
1	12	12	25·00	21·33				
1	12	13	20·00	22·57				
1	13	8	25·00	17·91				
1	8	0	10·00	5·63				

Embankments.

Base, 30ft. Slope 1½ to 1.

No. on Section.	Depths.		Lengths in Links.	Tab. Numb.	Cont. C. Yds.	Total in C. Yds.	Price.	£ s. d.
1	0	7	10·00	4·80				
1	7	6	10·00	9·57				
1	6	17	10·00	20·69				
1	17	0	17·50	14·80				
2	0	8	17·50	5·63				
2	8	5	14·00	9·61				
2	5	0	8·00	3·24				

Fill up the prices and amount in the accompanying table for a railway estimate, and state when and at what distances usually it becomes desirable to throw stuff to spoil, and use side cutting. Base, 30ft.: slope, 1½ to 1.

No. on Section.	Contents in Cube Yards.	Material.	Where taken to.	Aver'ge lead in chains	Price per C. Yard.	Amount.
1	46·668	Blue Clay...	No. 1 Bank and Subsidence.	60		
1	20·000	....	No. 2 Bank and Subsidence.	50		
1	36·000	....	Stuff for burning into ballast for 3 miles.	80		
1	4·000	Blue Clay...	To widen Nos. 1 & 2 banks or to spoil.	40		

Make sketches of the undermentioned bridges, culverts, and cottage, in sufficient detail to enable you to take out the quantities; fill up the prices, adopting your own data; and carry out the amounts in the accompanying columns for railway estimate:—

No.	Description.	Road.	Span.	Quantity	Price.	Amount	Total Amount.
1	Public road bridge, askew < 70°, at 4 miles 5 fur. in 20ft. embankment	30	20				
	Brickwork in bridge...						
	Stonework in ditto ...						
	Backing up bridge, temporary road, culverts under roadway, &c., and metalling under bridge						
2	4ft. culvert at 4 miles $6\frac{3}{4}$fur. in 31ft. embankment						
3	Parish road bridge in 31ft. embankment, at 4 miles 7 fur.	30	15				
	Brickwork in bridge...						
	Backing up bridge culverts, metalling under roadway, &c.						
4	Parish road level crossing in $4\frac{1}{2}$ft. cutting at 5 miles 1 fur., including gates, culverts, and cottage						
	Excavated approach...						
	Metalling, &c.						
	Single fencing				£		

Fill up the quantities and make an estimate, giving your own prices, for one mile of double railway.

		£ s. d.	£ s. d.
tons of rails, 75lbs. to the yard..............................	at		
tons of chairs	„		
sleepers	„		
cube yards of ballast	„		
lineal yards double road laying, including pins and keys	„		
lineal yards double 4-rail fencing, including quick mound and ditch..	„		
Field gates and making good fences, say			
Trespass and compensation for damage by carting............			

Roofs.

5. Explain the objects of the following parts of a roof, viz., king post, queen post, tie beam, straining beam, rafters, purlins, braces, ridge piece, struts, &c.

6. Give the names of some remarkable examples of roofs in wood and iron, stating the span.

Irrigation.

7. In carrying out works of irrigation in tropical countries, state what are the chief circumstances requiring attention.

8. State what has been the average cost per acre to irrigate land in Piedmont, Lombardy, and India; and what is the average return on money thus invested, and the increase of produce due to irrigation.

9. Describe the different modes employed to irrigate lamps. Name the crops most requiring irrigation, specifying which require complete and which partial irrigation, and the length of time and seasons of the year when water is most required.

10. What is the maximum and minimum gradient per mile you would recommend for the main canals in works of irrigation?

Miscellaneous Subjects.

11. Describe the different methods in practice for making foundations under water. State the comparative advantages of the different systems, and make free-hand sketches to illustrate the subject.

12. State which are the best and which are the most difficult soils to form foundations on, and under what circumstances sand becomes a good foundation.

13. Make a free-hand design for a centre, of simple construction, for a brick semi-circular arch of 25ft. span.

14. Explain the objects of the following parts of a steam engine, viz., the throttle valve; the governor; the fly wheel; the parallel motion; the sun and planet motion; and the four-way cock; and illustrate the subject with free-hand sketches.

15. In what strata is coal, iron, lead, copper, tin, fire-clay most commonly found? What are the surface indications of the existence of minerals?

16. How is pig iron, wrought iron, and steel manufactured; and what is the object of employing the hot-blast? Give the letters or marks used in the trade and in specifications to denote the different qualities of iron.

17. Describe the materials employed in the manufacture of bricks; the mode of manufacturing and burning bricks; the names of the different qualities; and what constitutes good bricks.

18. Give the names of standard professional works of reference on the following subjects:

Architecture.
Bridges of brick, stone, timber, cast and wrought iron, and wire.
Building materials.
Carpentry.
Canals of navigation and irrigation.
Drainage.
Engineering biography.
Engineering reports.
Embanking land from the sea and from rivers.
Foundations.
Harbours.
Iron (manufacture of).
India, reports on public works, and works of topography.
Law of contracts.
Lighthouses.
Limes, mortars, and cements.
Masonry and stone cutting.
Mining.
Machinery.
Preserving timber from dry rot and decay
Road making.
Railways.
Surveying.
Specifications.
Strength of materials.
Steam engine, locomotive, and stationary.
Tunnelling.
Tables for earthwork, quantities, and to facilitate calculations, &c.
Water supply to towns.

19. Explain the meaning of the following terms, and illustrate the subject by free-hand sketches:—Abutment, adit level, ashlar, backing, batter, bay, bond, brestsummer, buttress, caisson, camber, cantalever, collar beam conduits, coping, cornice, counterforts, discharging arch, extrados, intrados, fascines, façade, flying buttress, footings, gable, groin, groined arches, grillage, grout, hammer-beam, headers, hip roof, invert, joggle joint, lewis, neutral axis, pediment, pilaster, pontoon, puddling, purlins, puzzolana, quoins, rafters, retaining walls, ruling gradient, scantling, scarfing, soffit, spandrel, strut, templet, tensile strain, tie beam, torsion, truss, under pinning, wire gauge, water shed, spigot, and faucet joint.

REVIEWS AND NOTICES OF NEW BOOKS.

Manual of the Steam Engine. By the Rev. J. A. Galbraith, M.A. Longman, Green, Longman, and Co. 78 pp., 12mo.

Considered as a mathematical treatise for the use of academical students, this little book possesses some merit; but it is scarcely adapted to the requirements of more practical readers. The author, in treating the question of tractive resistance of railway trains, accepts (page 41) 7lbs. per ton as the factor, which is inaccurate according to present practice. The lowest taken should be 10lbs. per ton, and very frequently it will be found to amount to 20lbs. per ton and upwards. We can recommend the work to those about to enter competitive examinations.

Engineers, Architects, and Contractors' Pocket-book for 1865. Lockwood and Co. 378 pp.

This is among the best of the numerous scientific Pocket-books, containing, as it does, all the information that can ordinarily be required in such a work, without that superfluity of matter which renders some others bulky and inconvenient. Much care has evidently been bestowed upon the preparation and arrangement of the articles.

The Builders and Contractors' Price-book for 1865. Revised by G. R. Burnell. Lockwood and Co. 286 pp., 8vo.

No one connected with the building trade should be without this Price-book; the information contained is indispensable. To fix rates for general work is a matter requiring much skill and delicacy, varying as contractors do in their prices; but Mr. Burnell has executed his task with much credit to himself.

Naval Armour. By James Chalmers. W. Mitchell, Charing-cross. 96 pp., 8vo.

This work, which is dedicated to Lord Palmerston, is a concise and clear review of the various methods of armour plating which have been tried, and of the results of the experiments during the contests between the defensive coating and the guns. The "Chalmers" system of coating is, of course advocated, and, as set forth by the author, appears to possess great advantages both in point of strength and economy.

Le Substituant du Condenseur à Surface, &c. (A Substitute for the Surface Condenser). New Application of Superheated Steam; with Remarks on Improved Apparatus for Evaporating Water. By Emile Martin. London: Barker and Sewell. 1865.

The pamphlet under notice is devoted to the description of the apparatus of the author (M. Emile Martin), a French chemist, for supplying distilled water to steam boilers. From a note appended by Mr. D. K. Clark, it appears that two important advantages might be obtained by the use of Mr. Martin's apparatus. First, an economy of fuel, due to the intercepting and economising of the waste heat of the flues by superheating the steam from the boiler; second, the advantage of delivering superheated steam in greater or less quantity from the apparatus to the boiler, and its thereby mixing with and drying the steam within the boiler. The author also adds various "considerations" on the generation of steam and economy of fuel. We may embrace an opportunity upon a future occasion of again noticing Mr. Martin's pamphlet.

NOTICES TO CORRESPONDENTS.

R. H. T. (Newcastle-on-Tyne).—We have written you fully upon the several points in your communications, and await your replies.

T. S., Engineer, and Others. (*The Winans Yacht.*)—We are not yet able to say anything additional to that which you will find in our last month's issue. You may rely upon our fulfilling our promise to give the particulars of the experimental trials, which it is anticipated will take place in the course of a couple of months or so.

Aliquis.—We have thought it better to send to you through the post the information you asked for. We shall, upon hearing from you, be glad to reply to any other queries you may wish to put.

A. M. L.—We have not at hand the particulars of the slide valves you mention; we will, however, give a description of them in our next, or, if time is of moment to you, send us your address, that we may send you the information by post.

J. W. N. —1. We will, by the appearance of the article in our last number, have satisfied the cravings of our inquiring readers on the other side of the Atlantic. 2. We hope to hear that the necessary facilities have been granted you, to enable the experiments on the co-efficient of resistance to be carried out thoroughly.

LIFEBOAT SERVICES.

It is gratifying to learn that, during the year which has just closed, the lifeboats of the National Lifeboat Institution saved 426 lives from various shipwrecks, in addition to contributing to the saving of 37 vessels. It also appears that, in addition to the above number, 266 lives have been saved during the same period by shore boats and other means from different wrecks on the coasts of the United Kingdom, for which the Institution had granted rewards; thus making a total of 692 lives saved from various wrecks in one year alone, mainly through the instrumentality and encouragement of the National Lifeboat Institution. For these joint services the Society has granted £1,000 in rewards, twenty-two honorary acknowledgments, silver medals, and votes on vellum. The lifeboats of the Society, during the past twelve months, have also put off in reply to signals of distress forty-eight times; but their services were subsequently not required, the ships having succeeded either in getting off from their dangerous positions, or had their crews saved by their own boats or other means. It often happened, on these occasions, that the lifeboat crews had incurred much risk and exposure throughout stormy days and nights. The number of lives saved by the lifeboats of the Institution, or by special exertions for which it has granted rewards, since its formation, is 14,260; for which services 82 gold medals, 742 silver medals, and £19,350 in cash, have been paid in rewards. When we remember that nearly every life saved by lifeboats has been rescued under perilous circumstances, it will at once be seen what great benefit has been conferred by the Lifeboat Institution, not only on the poor men themselves, but also on their wives and children, who would otherwise be widows and orphans. How inadequately can words express the aggregate amount of misery which the saving of so many thousands of lives must have prevented; it can only have been fully appreciated by the parties themselves, and by their relatives and friends, whose expressions of gratitude for such important benefits are of the most feeling character. Since the beginning of the past year (1864), the Institution has also expended about £14,770 on its various lifeboat establishments on the coast of England, Scotland, and Ireland; and since its first establishment the Institution has also expended £120,000 on its lifeboat stations.

PRICES CURRENT OF THE LONDON METAL MARKET.

	Dec. 31.			Jan. 7.			Jan. 14.			Jan. 21.			Jan. 28.		
COPPER.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
Best, selected, per ton ...	92	0	0	92	0	0	92	0	0	92	0	0	89	0	0
Tough cake, do.	88	0	0	89	0	0	89	0	0	88	0	0	87	0	0
Copper wire, per lb.	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0
,, tubes, do.	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1
Sheathing, per ton	98	0	0	98	0	0	97	0	0	96	10	0	95	0	0
Bottoms, do.	104	0	0	104	0	0	104	0	0	104	0	0	104	0	0
IRON.															
Bars, Welsh, in London, per ton	7	12	6	7	12	6	7	12	6	7	12	6	7	12	6
Nail rods, do.	8	10	0	8	10	0	8	10	0	8	10	0	8	10	0
,, Stafford in London, do.	9	2	6	9	2	6	9	2	6	9	2	6	9	2	6
Bars, do.	9	0	0	9	0	0	9	0	0	9	0	0	9	0	0
Hoops, do.	9	17	6	9	17	6	9	17	6	9	17	6	9	17	6
Sheets, single, do.	10	12	6	10	12	6	10	12	6	10	12	6	10	12	6
Pig, No. 1, in Wales, do. ...	4	10	0	4	10	0	4	10	0	4	10		4	10	0
,, in Clyde, do. ...	2	10	6	2	10	9	2	11	0	2	10	6	2	10	6
LEAD.															
English pig, ord. soft, per ton	20	10	0	20	10	0	20	10	0	20	10	0	20	10	0
,, sheet, do. ...	21	0	0	21	0	0	21	0	0	21	0	0	21	0	0
,, red lead, do. ...	22	0	0	22	0	0	22	0	0	22	0	0	22	0	0
,, white, do. ...	26	0	0	26	0	0	26	0	0	26	0	0	26	0	0
Spanish, do.	19	10	0	19	10	0	19	10	0	19	10	0	19	10	0
BRASS.															
Sheets, per lb.	0	0	9½	0	0	9½	0	0	9½	0	0	9½	0	0	9½
Wire, do.	0	0	9	0	0	9	0	0	9	0	0	9	0	0	9
Tubes, do.	0	0	9¾	0	0	9¾	0	0	9¾	0	0	9¾	0	0	9¾
FOREIGN STEEL.															
Swedish, in kegs (rolled) ...	15	10	0	15	10	0	15	10	0	15	10	0	15	10	0
,, (hammered)	16	0	0	16	0	0	16	0	0	16	0	0	16	0	0
English, Spring	19	0	0	19	0	0	19	0	0	19	0	0	19	0	0
Bessemer's Engineers' Tool	44	0	0	44	0	0	44	0	0	44	0	0	44	0	0
TIN PLATES.															
IC Charcoal, 1st qua., per box	1	7	0	1	7	0	1	7	0	1	7	0	1	7	0
IX ,, ,, ,,	1	13	0	1	11	0	1	13	0	1	13	0	1	13	0
IC ,, 2nd qua., ,,	1	5	0	1	5	0	1	5	0	1	5	0	1	5	0
IC Coke, per box	1	1	9	1	1	9	1	1	9	1	1	9	1	1	9
IX ,, ,, ...	1	7	9	1	7	9	1	7	9	1	7	9	1	7	9

Mammoth Cotton Press for India.—At the Soho Iron Works, Manchester, Messrs. Peel, Williams, and Peel publicly tested, on the 9th ult., a double cotton press, worked by steam power and made by them. Lord Stanley, M.P.; Lord John Hay, Mr. J. Pender, M.P.; Dr. Fairbairn, and a number of other gentlemen interested in mechanical progress for the extension of cotton cultivation, and increasing the facilities for its cheap and plentiful production, were present. The inventor and patentee, Mr. Isaac Mason, was in attendance, and superintended the operation of filling loose cotton into the press and packing it into a bale. He stated that he had been practically engaged for four years in pressing cotton in India, and having thus acquired a knowledge of the requirements of pressing establishments, and also the capabilities of the natives, he had designed the press which had been constructed by Messrs. Peel, and was then being tested. The double press exhibited was the first of a number now being constructed on Mr. Mason's patent of 1862. Single presses on his patent have already been in operation in Bombay, and have, we understand, been found to answer every expectation. The principle on which they are constructed is a compound arrangement of two most powerful agents—the screw and lever. Motion is communicated to the screws (which are cut right and left handed threads) by two eight-horse horizontal steam engines. A wrought iron crosshead is placed at each end of the screw, to which levers are attached, being those required for raising the lower follower, and which have a centre through them, to which is fixed one follower; the other levers work downwards, and through them is also placed a centre, to which two side rods are fixed; these side rods run up to the top of the press, a centre being also placed through them, to which the top follower is fixed. On the engines being set in motion and the crosshead drawn out to the extremity of the screws, the two crossheads are drawn towards the centre, and this causes the levers attached to the lower follower to rise, and at the same time the levers, to which the side rods and top follower are attached, to fall. As the followers approach each other the cotton placed in the box is compressed between them. One novelty in this arrangement is that, instead of using one follower only, which in presses of this kind would have to travel 12ft., two are used, and thus travel through double the space in the same time as would be required if only one follower (or presser) was used. In order to economise labour, a pair of these presses are placed together, end to end, the engines being fixed in the centre between them. One press will compress while the other is having its bale hooped or corded, and is being prepared for delivery. One set of hands can thus attend to and work the two presses. The space required for a pair of these presses is 50ft. long, 6ft. wide, and 30ft. high from the ground line; an additional 6ft. in width being required where the engines are placed. The simplicity and comparative lightness of the various component parts of these presses, although they are the largest ever yet constructed, make them well adapted for countries where, through want of proper means of transit, conveyance is difficult. The bale operated upon on the 9th ult. was compressed in little over two minutes. It weight was 458lb.; before being liberated from the press it contained 8·23 cubic feet, and after being covered, corded, and turned out of the press, it measured 10·98 cubic feet. To have produced equal results with a hydraulic press would have taken more than five times the engine power then used. The presses under notice weigh about 80 tons, are calculated to press 100 bales of cotton per day, and have been constructed for the Moffussil Cotton Pressing Company, India.

RECENT LEGAL DECISIONS

AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

Under this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least —less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

Liability of Shareholders.—Two persons, who were among the promoters of an intended company, signed the Memorandum and Articles of Association of it for twenty shares each, but did not further act, and received no allotment of shares or notice of calls, though calls were made; and, in fact, they heard nothing more of the company until it was ordered to be wound up. They were, nevertheless, registered as shareholders. The question was whether they were, under the circumstances, liable as contributories; and the Master of the Rolls held that they were. This was the case of the United Kingdom Shipowning Company.

Non-Liability for "Calls."—In the case of the General Discount Company *v.* Stokes, which was an action for calls, the defendant pleaded his bankruptcy and discharge, which had been obtained before the making of the calls. It was held by the Court of Common Pleas that the bankruptcy was not a defence to the action, as the defendant's liability to pay prospective calls was not "a liability to pay money upon a contingency which had not happened," within the meaning of Section 178 of the Bankruptcy Act, 1849, for which the plaintiffs could have proved under the bankruptcy.

Brown *v.* the Hadleigh Gas Consumers' Company (Limited).—This was a bill for the specific performance of an award. The plaintiff was a silk throwster, and had erected gasworks for the supply of his own factory, but in 1836 he enlarged his works, and had ever since supplied the town of Hadleigh with gas. In December, 1861, negotiations were entered upon which resulted in an agreement between the plaintiff and the defendants that the latter should purchase the plaintiff's works and plant. Disputes having arisen between the plaintiff and the defendants, the matters in dispute between them were referred to two arbitrators, who had power to appoint an umpire, which they had done. The umpire had awarded that the defendants should pay half the costs of the award, and that they should pay to the plaintiff £1,503 for the goodwill of the plaintiff's business and other matters. Performance of the award was resisted by the defendants on several grounds, but principally upon the grounds that the umpire had exceeded his powers in dealing with anything beyond the goodwill of the plaintiff's business, and that he had in some instances been attended by the plaintiff without the knowledge of the defendants. The Vice-Chancellor said he thought that the plaintiff had established his case in regard to the umpire having exceeded his powers. The evidence also showed that the arbitration had been conducted in some instances in the absence of, and unknown to, the defendants. Upon these grounds he thought that the bill must be dismissed with costs.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

Puddling Furnaces.—An invention which relates to an improved cinder cement for lining puddling furnaces has been patented for Mr. John Williams, of Montreal. The cement is composed of cinders, lime, salt, and sandstone. The cinders are to be from puddling furnaces, or from heating furnaces, where a good quality of sand has been used, or cinders from a squeezer, or iron scales from a rolling-mill, may be used. In all cases they are reduced to the size of fine shot; the lime should be of good quality, and the pulverised sandstone or fine sand should be free from clay or earthy matters. The proportions which give the best results are—cinders, 1 ton; lime, 4cwt.; and salt and sandstone, 2cwt. each. The whole is thoroughly well mixed and incorporated together by manual labour and machinery, such as a pug-mill, and sufficient water is added to bring the mass to the consistency of stiff clay or mortar. The mass is then left twelve hours to season, after which it may be used to line the furnaces.

Petroleum in California.—A New York paper states that Professor Silliman examined part of California in the summer, and found oil equal in quality to the best in Pennsylvania struggling to the surface, and running to waste down the river for miles. It has been regarded as a nuisance, rendering barren tracts of land of perhaps a mile square in the midst of a fine agricultural district.

Steam Omnibuses.—An omnibus drawn by a locomotive, instead of horses, is now running at Chantenay, in the south of France. It can be turned and stopped with ease; and both inside and outside passengers travel by it without fear.

Charcoal Superseded in the Manufacture of Steel.—At a *séance* of the Academy of Sciences, in Paris, M. Julien, formerly director of the Loriette Steel Works, annexed to those of Assailly, presented a note relative to the conversion of iron by means of graphite. He states that in the year 1858 he received from MM. Petit and Gaudet a ton of natural graphite from Germany, with an invitation to try it in place of charcoal. For this purpose he had made small iron boxes, in which he placed the bars to be converted, surrounded by graphite reduced to powder, and strongly compressed. They were then closed by a cover, and all air excluded. The boxes, placed in the midst of the furnace, gave a description of steel differing in no way from that in the other parts of the furnace. This fact is in direct opposition to the assertion of M. Caron on the one hand, and M. Fremy on the other. The graphite was pure, and in most of the essays previously calcined. The rest of the ton was employed at the foundry, instead of charcoal, to be mixed with the iron for spring steel. In 7,000 or 8,000 kilos. of ingots thus manufactured, there was no difference between them and ordinary steel. This is the less surprising, considering that, when he made these experiments, M. Krupp was said to use nothing else in his works. It is plain, then, that carbon alone enters into the conversion of iron into steel. As far as this goes, he is of the same opinion as M. Margueritte, but not so with regard to the conversion of iron by the oxide of carbon. Already, thirty years ago, MM. Laurent and Leplay presented a theory based on this fact. He regrets to say that reasons, of too great length to be detailed here, authorise him to affirm that the oxide of carbon (carbonic oxide gas) does not convert iron. If, then, M. Margueritte has obtained steel, and not burnt iron, by causing a stream of carbonic oxide gas to pass over iron heated to redness, that arises from his carbonic oxide gas, as is the case with common street gas, containing carbon in solution. Let the carbonic oxide gas, prepared as he indicates, be submitted to analysis, and it will be found to contain more carbon than enters into the composition of the gas.

A New "Severn Bore."—It is proposed, says the *Bristol Times and Mirror*, to tunnel under the bed of the Severn, for a distance of three miles; and through this subterraneous or rather sub-fluvial gallery to carry a railway, so as to connect the South Wales Union line with the Principality. The promoters and the engineer of the South Wales Union declare it can be effected, and, as the estimated cost, name £750,000. It is argued that the nature of the soil is particularly favourable to the work, being a substratum of marl, with a roofing of red sandstone. It has a rival in another project, namely, a bridge to span the river from Aust to Chepstow bank, to be two miles in length, and laid with a double line of rails. This structure is to be supported on piers, which, from sunken base to summit, shall be each as high as the London Monument, and with a span between each of 600ft., the estimated cost being £1,800,000.

The American Petroleum Trade.—Prof. Draper, of the University of New York, has just published a paper, embodying some very curious commercial details respecting this remarkable substance, from which it appears that the value of the quantity of American petroleum sent into the market during the year just ended amounted to no less than fifteen millions sterling, being fully one-fourth of the value of the largest cotton crop ever raised in the United States. Considering that the first of the wells from which the petroleum is obtained was sunk not more than four years ago, there is no more wonderful instance of rapid development in the whole history of commerce. In various parts of the world, during the past fifty years, fortunes have been made rapidly, but never more rapidly than by the lucky owners of the sites of the American petroleum wells. One of these fortunate gentlemen, a Mr. John Steele, is now deriving an income equal to £150,000 a year from a piece of land which four years ago did not yield annually more than as many pence. Farms which in 1859 would have been thought to have sold well if they had fetched £400 each, have since sold for sums varying from £120,000 to £200,000 each. There is a little strip of land, about twenty miles long, and averaging two miles broad, in Oil Creek Valley, in Western Pensylvania, which is now valued at £50,000,000 sterling, but which until 1860 would not have sold for a sixpence more than twenty shillings an acre, or a total for the whole slip of about £25,000. Its value has thus increased within four years twenty thousand fold!

Iron Manufacturing Amongst the Africans.—The nodules of iron are generally smelted in the forests, and brought in a lump to the smith, who by means of stone anvils and stones as sledge-hammers, converts it into a long rod; and finally, by a hand-vice, and grease from a small pot he carries, it is tied between two posts and drawn till it becomes a thread. It is now fit, after being once heated, for being twisted neatly with the finger and thumb round a few hairs from the tail of a cow, or the thicker hair of a giraffe. In this state it is worn in rings ornamenting the ankles of men and women, fifteen of them costing one string of beads, value a half-penny, and fifteen copper or brass ones being double price. Iron hoes, adzes, grass hooks, small knives, pincers, &c., are all made up by the natives in the above rude way, and this is the extent of their knowledge in ironwork.

The London Coal Trade.—For the month of December last the quantity of coal, coke, &c., carried into London by sea or conveyed by the various railways was 529,270 tons 18 cwt., against 511,215 tons 16 cwt. for the corresponding month of 1863. Of this large tonnage the sea-borne coal is 296,346 tons (against 339,532 tons in December, 1863), and it was in the following proportions:—Newcastle, 143,028 tons in 280 ships; Seaham, 10,784 tons in 44 ships; Sunderland, 85,262 tons in 194 ships; Middlesborough, 6,275 tons in 22 ships; Hartlepool and West Hartlepool, 34,944 tons in 115 ships; Blyth, 262 tons in 1 ship; from Scotland, 2,221 tons in 11 ships; from Wales, 2,492 tons in 8 ships; from Yorkshire, 6,356 tons in 16 ships; and the remainder consisted of 4,160 tons of small coal in 9 ships, and 562 tons of cinders in 4 ships. The railway supply for the month was considerably in excess of that for December, 1863. It reached 224,022 tons 8 cwt., while for December, 1863, it was only 162,457 tons 16 cwt. Of this large tonnage the London and North-Western carried 80,822 tons 14 cwt.; the Great Northern, 75,548 tons; the Great Eastern, 28,031 tons 2 cwt.; the Great Western, 23,261 tons; the Midland, 12,518 tons 14 cwt. to St. Pancras depot, and 1,420 tons 14 cwt. to King's-cross; the South-Eastern, 2,204 tons 7 cwt.; the South-Western, 143 tons 17 cwt.; and the Tilbury and Southend, 72 tons. For the year ending on the 31st of December last the sea-borne coal entered at London reached 3,116,703 tons; the railways brought 2,342,[illegible]0 tons 9 cwt., and by canal there came 9,226 tons—making a total of 5,468,045 tons 19 cwt. as the consumption of coal and coke for twelve months. As compared with 1863, there is a large increase on the railway returns, not less than 566,953 tons 5 cwt.; while, on the other hand, the canal traffic has declined by 323 tons 10 cwt., and the seaborne coal by 1,473 ships and 218,471 tons. The increased railway tonnage counterbalances to a much greater extent the loss upon the other sources of supply, so that the traffic generally in the course of 1864 shows an advance of 348,158 tons 14 cwt. more than in 1863, and the increase in 1863 was very large when compared with the tonnage of 1862.

FLOW OF SOLID BODIES SUBMITTED TO STRONG PRESSURE.—A very interesting paper was recently read before the French Academy, by M. Tresca. The subject was the "Flow of solid bodies submitted to strong pressure." It will be in the memory of those interested in the physical history of the earth that the celebrated theory of the movement of glaciers which was put forward some years since by Forbes, was based upon the supposition that in glaciers the particles of ice are not so firmly bound together as is generally believed, but that they have the power of flowing over each other. On this hypothesis, he regarded the motion of an icy sea not as simply the sliding of the entire mass through the valley, but as the movement of a great mass of particles which have not only travelled over the land beneath, but over each other also. In fact, that a glacier was a very slow flowing river, in which, as in a stream of water, the particles next the bank flowed less rapidly than those lying in the centre. It seemed hard to conceive that a substance whose particles possess such an intense power of cohesion as those of ice could be capable of flowing in the manner indicated; but the researches of M. Tresca show that even in metals the same phenomena appear. The results of numerous experiments showed him that, without undergoing any alteration of state, solid bodies flow from an orifice in exactly the same manner as liquids, when sufficient pressure is applied to them. The soft metals were those employed in his experiment, and from his numerous observations, he has arrived at the generalisation that there is a unity of constitution in all matter, and that masses of the most solid metals are formed of separate and mobile molecules.

LIVERPOOL EMIGRATION STATISTICS.—The Government emigration officials at Liverpool have just prepared their annual return, from which it appears that during the past year there have sailed from the port of Liverpool of vessels independent of the Act 220 ships, conveying 4,635 cabin and 3,013 steerage passengers. Of these 91 sailed to the United States, with 3,599 cabin and 1,858 steerage passengers, and the rest to various parts. In 1863 the number of passengers not under the Act was 14,455, and this year 7,648, so that there is a decrease of 6,797 on the year. Of ships sailing under the provisions of the Act, 279 ships, carrying 3,599 cabin and 96,403 steerage passengers were for the United States; to Canada there were 27 ships, with 768 cabin and 3,860 steerage passengers; to New South Wales three ships, with 1,138 steerage passengers; to Queensland six ships, with 35 cabin and 1,892 steerage passengers; to Victoria 29 ships, with 378 cabin and 9,661 steerage passengers; and to South America one ship, with 2 cabin and 61 steerage passengers. Of the passengers sailing to the United States 22,781 were English, 60,650 Irish, 2,280 Scotch, and 9,692 other countries. There is a decrease of passengers sailing under the Act of 5,740 compared with 1863, making a total decrease in the emigration of 1864, compared with 1863, of 12,537.

LAMP STANDARD AND VENTILATING SHAFT, SOUTHWARK-STREET, LONDON.—A lamp standard and ventilating shaft has been recently erected over the subway, Southwark-street, London. It is executed in cast-iron, for the Metropolitan Board of Works, by Messrs. Walter Macfarlane and Co., of the Saracen Foundry, Glasgow, and Bedford-street, London. This work shows, in a very marked degree, the improvement that is taking place in the cast-iron productions of our country. The erection consists of a red sandstone base, about 5ft. high, surmounted by ventilating shaft, lamps, &c., in cast-iron, about 27ft. high, the whole forming a handsome central feature to the street crossing. We must compliment Mr. Bazalgette, and all the parties concerned in this work. The cost of the lamp, without the stonework, will be about £255.

CHINESE STATISTICS.—According to a work on China recently published by M. d'Escayrac de Lauture, the Middle Empire is traversed in all directions by 20,000 imperial roads, most of which are badly kept. There is, nevertheless, a postal service, but of a very rude kind. The couriers who are despatched by the local functionaries are allowed to carry private letters for a trifling remuneration. Letters from Pekin reached Shanghai in fifteen or twenty days, and Canton in forty, fifty, and sometimes even sixty days. The postage of a letter from Pekin to Shanghai in 50c. The couriers change horses about every seven leagues. M. d'Escayrac de Lauture thinks that if the Government could be induced to grant a post-office contract to Europeans, it might be made a very profitable speculation, and would render great services to commerce.

THE ROYAL NAVAL RESERVE.—The return of the Registrar-General of Seamen and Shipping relative to the Royal Naval Reserve, dated Dec. 31, states that 21,154 applications have been received and 18,325 volunteers enrolled in the various ports. Of the above, 47 possess certificates of competency as masters, 689 certificates of competency as mates, 19 certificates of service as masters, and 61 certificates of service as mates. The force also includes 2,671 petty officers in the merchant service.

DUBLIN INTERNATIONAL EXHIBITION, 1865.—Referring to the paper which appeared upon this subject in our last, we are glad to be able to report that Scotland has taken up representation at the Dublin Exhibition with characteristic energy. The Provosts and Chief Magistrates of Edinburgh, Leith, Dundee, and Aberdeen, &c., head the movement. It is expected that Edinburgh will send as much to Dublin as to the last London International Exhibition. The committee at Edinburgh includes the following influential persons:—The Lord Provost, Bailie Cassels, Bailie Alexander, Bailie Hill, Bailie Handyside, Bailie Falshaw, Bailie Miller, Henry Callender, Adam Beattie, Charles Macgibbon, James MacKnight, John Kay, Thomas Dryborough, James Ford, the Master of the Merchant Company, the Chairman of the Chamber of Commerce, the Dean of the Faculty of Advocates, the Deputy Keeper of the Signet, the Preses of the Society of S.S.G., the Preses of the Society of Chartered Accountants, the Presidents of the Royal Scottish Academy, of the Royal Scottish Society of Arts, of the Royal College of Physicians, of the Royal College of Surgeons, the Provost and Magistrates of Leith, the President of the Merchant Company, and the President of the Chamber of Commerce of Leith. Turning to the Continent, we find that from Brussels the list of demands already numbers 110 applicants in the Industrial Department, and 117 artists. Two organs are offered, and a large number of other musical instruments. Forty of the best artists of Dusseldorf have given their adhesion, and a large number of the Scandinavian painters, headed by M. Adolph Tidemand. Munich will furnish cartoons of the most celebrated artists, and all the leading painters will contribute, including Kaulbach, Schwind, Piloty, Froltz, and Schmndolph. Austria is making strenuous efforts to be well represented at the Dublin Exhibition, and it is to be hoped that the new commercial treaty which is now being negociated with that empire will tend to a largely extended trade on both sides, when the existing fetters to commerce are removed. Austrian manufacturers did exceedingly well at the London International Exhibition in 1862, for, besides gaining great honour, extensive sales were effected. Already we hear that Chevalier de Wertheim and Co., the celebrated workers in metal, will have a very fine display, with photographs of their works; and that Neustadt, or Prague, will send works in the precious metals. The porcelain, by Fischer, which attracted so much notice in 1862, will be well represented. C. Kronig, of Vienna, will exhibit papier-maché furniture, in addition to objects in carton pierre, and fancy articles in wood. Messrs. Thonet Brothers exhibit bent wood furniture, for which they received a medal in 1862. Meerschaum pipes and amber carvings will be shown, and there will also be a good collection from Austria of musical instruments, glass, clocks, oil paintings, photographs, and photographic apparatus, wines, and agricultural produce.

NAVAL ENGINEERING.

NEW SHEARS.—An ingenious piece of workmanship has been recently turned out of the factory department in Woolwich Dockyard, where it was manufactured. It consists of the three legs constituting the new shears intended to supply the place of the wooden crane broken in February last, during the operation of hoisting one of the huge boilers from the paddlewheel sloop *Spiteful*, still under repairs in Deptford yard, and by which accident a number of men were killed and others severely injured. The new shear legs are built up of angle and plates of furnace iron of from 4ft. to 5ft. square, selected with great care, and riveted together so as to form a mass of immense solidity, and pronounced unequalled for the purpose by any other method yet introduced. The new shears will be so constructed as to obviate the necessity of back guys, and will remedy the defect fatal to the old shears—of giving one stay a greater strain than another. The back leg, according to computation, weighs about 30 tons, and is the largest of its kind yet made, being 144ft. in length. The removal was attended with considerable difficulty and delay on account of its length, its enormous weight on the truck causing the wheels to sink and uproot the pitched surface of the yard at every attempt to move forward, which was, however, effectually accomplished by Bray's traction engine, belonging to the yard. It would otherwise have required a team of at least forty horses. The system of manufacture is patented by Messrs. Summers, Day, and Co., of the Northam Ironworks, Southampton.

THE LARGE STEAM TRACTION ENGINE which has been sent into Chatham Dockyard by Messrs. Aveling and Porter, of Rochester, for use at that establishment, underwent a variety of tests on the 3rd ult., in order to test its working capabilities when employed in the ordinary service of the yard. It was first put to remove one of the large 6½-tons 6-in. armour-plates preparing for encasing the sides of the frigate *Bellerophon*. The plate was picked up at the factory and transferred to the other end of the dockyard, where it was deposited near the spot where the plate was to be fixed, the whole occupying but a very few minutes, while under the ordinary arrangements the operation would have tasked the energies of a number of labourers, assisted by a team of horses, for some hours. The engine was next taken to the centre wharf, and there lifted one of the disused screw propellers of the *Cadmus*, 21, 4,000 horse-power, weighing several tons. It was rapidly moved to the place intended for it, the engine conveying it at the rate of 6 miles per hour. In order to lift the heavy weights required to be moved by the traction engine, a crane is attached to it, which by a simple arrangement can hoist weight up to 6 tons. The advantages resulting from this arrangement were made manifest, the engine, among its other labours, being put to lift between two or three tons of old metal, which was effected in a very few minutes. The metal, still attached to the crane, was removed to another portion of the yard, which was again lowered to the spot intended for its reception. Altogether, the results of the preliminary trials of the working of the engine were pronounced very satisfactory. The engine, it should be mentioned, being required, among its other duties, to traverse the sides of the building ships amid highly combustible materials, is provided with a sparkcatcher, so that not a single spark can escape from the funnel. The fire-box is, at the same time, so contrived as to prevent any of the cinders from being scattered about. No apprehension of danger, therefore, appears to be felt in the least degree from the employment of the engine even when in the midst of shavings and chips.

THE SCREW GUN-VESSEL "TORCH," 5, 80 horse-power (nominal), having undergone repair at Chatham dockyard and been fitted for the first-class steam reserve, was on the 5th ult. taken to the measured mile at the Maplin Sands for the purposes of testing her engines. She is fitted with a pair of 80 horse-power direct-acting trunk engines by Messrs. Napier and Son, with most of the recent improvements. The vessel drew 9ft. 10in. forward, and 11ft. 11in. aft. The *Torch* is fitted with a Smith's propeller of 9ft. 10in. in diameter, with the leading corners cut off, and set at a pitch of 12ft. 4in. The wind during the trial was westerly, with a force of 3. Six runs were made at the measured mile with the following result:—First run—time, 6 min. 6 sec.; speed in knots, 9·830. Second run—time, 7 min. 46 sec.; speed, 7·725 knots. Third run—time, 6 min. 22 sec.; speed, 9·424. Fourth run—time, 7 min. 23 sec.; speed, 8·126 knots. Fifth run—time, 6 min. 32 sec.; speed, 9·183 knots. Last run—time, 6 min. 42 sec.; speed, 8·955 knots—giving the true mean speed of the ship 8·731 knots per hour. The mean pressure of steam during the trial was 20lb., and the load on the safety valve 24lb. The mean number of the revolutions of the engines was 98 per minute. At half-boiler power the mean speed attained was 6·857 knots per hour. After the completion of the runs the vessel was tried in making circles, when at full speed the complete circle was made in 4 min. 11 sec., and at half speed in 4 min. 31 sec.

THE "HIGHFLYER," 20, screw corvette, Capt. Pasley, made her trial on the 5th ult. at the measured mile in Stokes-bay, near Portsmouth, under the officials of the dockyard steam factory and reserve. She realised a mean speed of 9·48 knots with full boiler power and of 6·95 knots with half boiler power.

THE SCREW STEAMER "CADMUS," 21, 1,466 tons, 400 horse-power (nominal), Captain Alexander C. Gordon, having been fully equipped for sea, made her official trial of speed, at her deep sea draught of water, at the Maplin Sands, near Chatham, on the 11th ult. The *Cadmus*, with the whole of her stores, crew, &c., on board, had a draught of water of 17ft. 2in. forward, and 19ft. 11in. aft, the bottom of her midship port-sills being 10ft. 1in. above the water. The quantity of coals on board was about 300 tons. The engines are by Messrs. Penn and Sons, and are fitted with the latest improvements. The weather was favourable for the trial, there being a force of wind of 2 to 3, with scarcely any swell. On reaching the Maplin Sands six runs were taken over the measured mile at full boiler power, with the following results:—First run—time, 6 min. 32 sec.; speed in knots, 9·183; revolutions of screw per minute, 61; pressure of steam, 20lb. Second run—time, 4 min. 50 sec.; speed, 12·413 knots; revolutions, 61; pressure, 21lb. Third run—time, 6 min. 10 sec.; speed, 9·729 knots; number of revolutions, 61½, pressure, 21lb. Fourth run—time, 4 min. 58 sec.; speed, 12·080 knots; number of revolutions, 61; pressure, 21lb. Fifth run—time, 6 min.; speed, 10·000 knots; number of revolutions, 62; pressure, 21lb. Last run—time, 5 min.; speed, 12·000 knots; revolutions, 62; pressure of steam, 21lb., giving an average speed of 10·978 knots, or rather a knot per hour less than on the occasion of the former trial of the *Cadmus* a few weeks since. This falling off is to be accounted for from the circumstance of the mean draught of water of the *Cadmus* being 18ft. 7in., and on the occasion of the last trial 17ft. 6in., while in the early part of the trial the steam could be barely kept up to 21lbs. Two runs were afterwards taken over the mile at the half-boiler power, when the mean speed realised 9·105 knots, with a pressure of steam of 20lbs., and 59 revolutions of the screw per minute. At the termination of the speed trial the ship was tested in making circles, when the complete circle at half-boiler power was made in 5 min. 9 sec., the helm being put over to starboard at an angle of 25 deg., by six men in 2½ turns. With the helm hard over to starboard the complete circle with full boiler power was made in 4 min. 28 sec. The half circle at full boiler power was made in 2 min. 11 sec., with the rudder at 22 deg. From the order being given from the bridge to the engine-room the engines were stopped dead from full speed in 13 seconds, and started again in 5 seconds. The engines worked with remarkable steadiness, and there was an absence of hot bearings and priming. The actual work performed by the engines was 1,605 horse-power. The *Cadmus* is ventilated on Mr. Baker's principle, which has been applied so successfully to the vessels of the ironclad squadron, the average temperature of the stoke-holes during the trials being 82 deg., and of the engine-room 65 deg.; the temperature on deck was 47 deg

Naval Appointments.—The following appointments have taken place since our last:—T. E. Milles, Engineer to the *Asia*, for the *Helicon*; F. Lewis, Engineer to the *Blenheim*, for the *Amelia*; G. A. Wells, Engineer to the *Asia*, as Supernumerary; W. M'Dowall, Engineer to the *Dauntless*, for tender; C. R. James, Assist.-Engineer to the *Indus*, as Supernumerary; W. Brown, of the *Victoria and Albert*, promoted to be Chief Engineer; and W. Powell, of *Dromedary*, promoted to be Acting Engineer; J. Sharp, of the *Asia*, and W. Green, of the *Irresistible*, for the *Argus*; James Brough, of the *Aurora*, and G. Edwards, of the *Edgar*, for the *Trinculo*, promoted to First-class Assist.-Engineers; T. Pattison and G. J. Barber, ot the *Asia*, confirmed as First-class Assist.-Engineers; R. H. Lavers, Assist.-Engineer to the *Indus*, as Supernumerary; J. Hindley, Assist.-Engineer, to the *Dauntless*; C. F. H. Burt, Assist.-Engineer, to the *Wasp*; R. W. Allison and W. N. Sennett, Assist.-Engineers, to the *Princess Royal*; C. Wiggins, Assist.-Engineer to the *Fisgard*, as Supernumerary; G. S. Scholes, Engineer in the *Cumberland*, confirmed; W. J. Sullock, of the *Hawke*, promoted to be First-class Assist.-Engineer; H. Scott, Assist.-Engineer to the *Asia*, for the *Octavia*; P. T. Gruchy, Engineer, to the *Victoria and Albert*; J. Wright and C. E. Stewart, Assist.-Engineers to the *Indus*, as Supernumeraries; J. Murray, Assist.-Engineer to the *Asia*, for hospital treatment; W. Dennison, Chief Engineer, to the *Megæra*; G. Hunt (b), Engineer to the *Landrail*; G. Hunt (a) and A. Singer, Engineers to the *Magæra*; W. Pearson and W. B. Cotton, Assist.-Engineer, to the *Landrail*; J. P. Gardner, Assist.-Engineer to the *Asia*, as Supernumerary; N. Stearn, Engineer, and J. B. Stevens, Assist.-Engineer, to the *Osborne*.

MILITARY ENGINEERING.

National Armoury.—Our armoury at Springfield, Massachusetts, says the *New York Times*, is the largest and altogether the most productive establishment for the manufacture of small arms in the world. There are 2,600 workmen employed, and they complete about 1,000 muskets daily. It is under the direction of a principal, who is styled superintendent, and who has the chief management of the business of the armoury, and is aided by a master-armourer, who manages the mechanical operations, a paymaster, a storekeeper, a numerous corps of clerks, and also a foreman, or assistant master-armourer, to each principal branch of the work, and under him a foreman over every job. Each artisan puts his own private mark on the work he executes, when they examine and approve the various parts of the musket.

Testing Ordnance.—Major Palliser's gun, fitted under his improved system of strengthening the old ordnance by the insertion of an inner tube, fired on the 16th ult., 100 proof charges at the Woolwich butt, and has now got through 800 rounds most successfully. The test will be resumed shortly, when it is intended to fire the remaining 200 rounds, and complete the severe proof to which the gun was ordered to be subjected for the satisfaction of the select committee, namely, 1,000 rounds, with charges of 16lb. of powder, and shot weighing 100lb. each. The gun was fired in one of the cells built up for that purpose, and was suspended on a principle introduced by Mr. M'Kinlay, the proof master, which affords many advantages. The gun was slung pendulum fashion on two iron bars. At the back of the cell, which is bomb proof, was a stride rope stretched across, having two weights, weighing 1½ tons each, attached, in order to restrain the recoil of the gun. The gun in its forward motion is also held back by two check-ropes or backgyes attached to the weights before mentioned, and which operate in bringing it back speedily to a position for being reloaded. Another advantage of the system is that, in the event of the gun bursting, no carriages are destroyed, nor material of any kind injured beyond the gun itself.

The Parrott Guns.—The following facts concerning the bursting of the Parrott guns guns on the occasion of the recent attack on Fort Carlisle, Wilmington, are from Major Poore's letter to the *Boston Journal*:—"The unprecedented bursting of the Parrott guns used on board the fleet is a much more serious question for solution than the failure of the powder vessel. We have at present in the United States' navy 1,005 of these cannon, of different calibres, and, in fact, they are the only rifled guns used, except the bronze 12-pounders and 20-pounders of Admiral Dahlgren. The loss of these Parrott guns, prior to the attack upon Fort Fisher, had only been 23; of these six gave way at the breech, four were broken by the explosion of shells near the muzzle, three were cracked in the body, two were condemned for excessive enlargement at vent, seven were lost by wreck, and three were captured by the rebels. Yet, after this small percentage of loss by rupture and enlargement, these Parrott guns (cast at different times) proved more dangerous for those who fired them than to the garrison of Fort Fisher. No vessel can be taken successfully into action armed with pieces of which the crew are afraid, and which they must naturally be unwilling to fire. Commodore Wise, the able chief of the Naval Bureau of Ordnance, in his last annual report, gave the statistics of the Parrott rifled guns in the service, and went on to remark that 'no rifled gun has been considered perfect,' but that the bureau had sought in vain among the systems of European nations and the improvements of our own country for a better gun, taken as a whole, than the Parrott rifle. Said he—'It is true that reports are occasionally received as failures with the Parrott projectiles (also prepared at the West Point Foundry), but these are again counterbalanced by the most favourable reports; and it is certain that whenever a close attention is paid to details in loading and firing, these guns may be relied upon for range and accuracy. But if these details, from any cause, are not sufficiently attended to, the firing of no rifled gun can be considered safe or certain. At all events, whatever may be the defects of the Parrott system of rifled ordnance, no other has yet been produced which commends itself so strongly to the service; and until another and a better one is devised and subjected to the same ordeal, the bureau will continue to place its guns in the batteries of ships as important auxiliaries to the smoothbore pivots.' Special orders have been issued by Commodore Wise, impressing upon officers in charge of these Parrott guns the importance of exercising great care to keep the grooves cleared of all residuum and dirt. Moist sponges were to be used, and the base of every projectile fired was to be carefully greased. From the known character of the officers commanding the vessels upon which the guns exploded there is every reason to believe that these directions were observed, and that the guns were carefully and well loaded. Yet the department has received accounts of deplorable results of this battle-test, which can but impair the efficiency of our whole navy, and I learn that, immediately on the reception of the report of Commodore Porter, orders were issued to stop the casting of any more guns until a complete investigation had taken place."

STEAM SHIPPING.

The Steamer "Lelia."—This steamer was built by Messrs. W. C. Miller and Sons, and was a paddlewheel of 1,100 tons. Her length was 265ft., breadth 30ft., and depth 15ft. She is fitted with engines of 300 horse-power nominal, constructed by Messrs. Fawcett, Preston, and Co., and her paddles were constructed on the patent feathering principle. The ship left the landing-stage at half-past ten o'clock, and a cruise up and down the river. After sailing up the river as far as the Sloyne her head was turned, and she reached the Rock Lighthouse at 11.46 a.m., and the North-west Lightship at 12.39 p.m. After steaming round the North-west Lightship, she returned with the flood tide, leaving the lightship at one o'clock and reaching the Rock Lighthouse at 1.47 p.m. The distance from the North-west Lightship to the Rock is 14 miles. The *Lelia*, with 400 tons of dead weight on board, ran the measured mile in 3min. 20sec., and her average speed during the trip was about 18 miles per hour. Her engines indicated 1,950 horse-power, the pressure of steam being 35lb. to the square inch. The revolutions were 36 per minute. A few days after the above trial the *Lelia* started for her destination, and foundered in the Channel.

Shipbuilding on the Mersey.—During last year shipbuilding upon the Mersey attained a prodigious and unparalleled development, and at the present time there are upon the stocks ships exceeding in tonnage the whole amount added to the shipping of the port during the pressure of the last year of the Crimean war. The greater part of the shipping constructed by Liverpool builders during the year has been absorbed by the port, and during the same period Liverpool shipowners have kept in active operation some of the principal building yards of other parts of the kingdom. The 12 leading shipbuilders on the Mersey constructed in 1864 94 vessels, exclusive of several iron barges intended for shipment to the East. Of these 94 the majority, 59, are iron, 16 steel, 8 wood, and 11 composite: 40 are described as steamers, 5 of these as screw steamers, and 17 as paddle-steamers; 36 are described as sailing vessels; and 19 are not described in this respect at all. Thirty-five of the steamers have engines of the total horse-power of 6,565; but the steam-power of the remaining five is not stated. The total tonnage of the 94 vessels (adding 14 barges) is 76,300; 18 vessels and 12 barges are estimated at the total value of £230,000; and a rough calculation, founded upon this basis, taken in proportion to the whole number, gives something like a million and a half sterling as the probable value of the shipping built on the Mersey during the year. Among the greatest novelties in construction have been those connected with Mr. Jordan's patent, Mr. Robinson's method, and the water ballasting. The total number of men employed at the 16 building establishments on both sides of the river during the year has probably been about 11,000. The builders have already in hand for execution during the present year more than 68 vessels—exclusive of the work (amounting to 9,000 tonnage) at Messrs. Laird's, and her Majesty's ship *Agincourt*. As the aggregate tonnage of the 22 vessels whose burden is given is 21,562, it will be seen that this fleet will in itself be an important addition to the commercial navy. But orders are in hand, or at least contracts are mooted, for even more extensive works, and the confidence of the Mersey shipbuilders in the continuance of the demand for shipping is shown by their anxiety to extend their own producing powers. Some of them are moving from the Liverpool to the Cheshire side of the river, where more room near the sea—at and about Seacombe—is to be obtained; and new firms are mentioned as likely to commence operations before long on the Liverpool side, further south than the town has yet extended.

The Trial Trip of the "Gunga," steamer, built by Messrs. C. and W. Earle, recently took place down the Humber. The *Gunga* has been constructed for the Bombay and Bengal Steamship Company; she is 150 horse-power, and can carry about 1,800 tons of Calcutta cargo, independent of fuel. Her length between perpendiculars is 257ft., and her gross tonnage 1,201, and 900 register. The vessel attained a speed of 10 knots an hour, against a strong wind and tide.

The Percy Line of Steamers, Newcastle.—It is announced that negociations are pending between the Tyne General Ferry Company for the purchase of the above line of steamers; but that, until the arrangements are completed, the old company's steamers will run as usual.

The New Steamer "Anna Liffey," which is intended to ply between Dublin and Kingstown, made her trial trip on the 12th ult., from Dublin to Kingstown and Wicklow Head. The weather was not so favourable as could be desired, but the trip was, on the whole, very satisfactory.

Iron Shipbuilding on the Humber.—The shipbuilding trade of Hull is being carried on with vigour by the two firms engaged in that branch of industry, namely, the Humber Ironworks and Shipbuilding Company and Messrs. C. and W. Earle. In the year 1863 the operations now carried on by the first-named firm were conducted by Messrs. W. Samuelson and Co., and the number of ships launched from the yard was 20, of which eight were small tugboats to ply on the River Seine. The total capacity of these 20 vessels was 12,698 tons. In the same year Messrs. Earle and Co. built seven vessels, with a tonnage of 4,663; making a total of 17,361 tons. During 1864 the Humber Ironworks and Shipbuilding Company have launched five sailing ships and four steamers, with a total tonnage of 7,821. Messrs. Earle and Co. have during the same period turned out two sailing ships, one of 1,200 tons and the other 1,300 tons, and six steamers, the whole of which were upwards of 1,100 tons each. The total tonnage of these eight ships amounts to 9,479 tons, which, added to those built by the Humber Ironworks Company, represent a total tonnage for the year of 17,301, or only 60 tons less than in 1863, when ten more vessels were built. Most of the vessels built at Hull have been for Liverpool and London owners.

Trial of the Twin Screw "Louisa Ann Fanny."—The trial trip of the iron double screw steamship *Louisa Ann Fanny* down the Thames between Gravesend and the Maplin Sands took place on the 25th ult. The vessel has a builders' measurement of 972 tons. Her length between perpendiculars is 250ft., with a beam of 28ft., and a moulded depth of 15ft. 6in. Her machinery consists of two pairs of horizontal direct acting engines, with cylinders of 40in. diameter and 22½in. stroke, driving two three-bladed screws of 9ft. 2in. diameter and a pitch of 17ft. 3in., the distance from centre to centre of the screws being 10ft. 10in. Steam is supplied by two boilers, firing from forward and aft, the furnaces having 245ft. of bar surface. The *Louisa Ann Fanny* started on her trial trip at about fifteen minutes past noon from off Gravesend, drawing 9ft. 9in. of water aft, and 8ft. 9in. forward. The wind was north-easterly at about the strength of 3 at starting, but freshened very considerably as the mouth of the Thames opened, and the ship approached the dreary waste of waters below the Nore light-ship. The run from Gravesend to the Nore and thence to the Mouse light-vessel was accomplished in the most satisfactory manner, the engines working perfectly and without a hitch of any kind occurring, and the ship going evidently at a rate of speed that had never been equalled before, even by any sister twin screw. The ship maintained her great rate of speed down to the extent of her course, and the distance between the Nore and Mouse light-ships was accomplished in 24 min. 38 sec., equivalent to a rate of speed for the ship of 17¾ knots. The tide was going in favour of the ship at about 2 knots, and, allowing for this rate of tide, the true speed of the ship would therefore be, as nearly as could be definitely arrived at, 15¾ knots. The speed of the ship on a straight course having been ascertained, she was next tried in making circles, with the following results:—With the engines set to work in opposite directions, with the helm hard over to starboard, and two consecutive circles made, the ship turned literally on her centre in 4 min. 11 sec., and 5 min. 16 sec. With the rudder fixed amidships, and the engines reversed in their motions as before, the circle was made in 6 min. 40 sec., the diameter of the circle made being, as previously, very nearly, if not quite, within the ship's length. The average revolutions of the engines since leaving Tilbury had been 113, the pressure of steam 32lb., and the vacuum 26in. In running past the measured mile on the Maplin Sands the time was 3min. 30 sec., the tide being, according to the pilot's account (Mr. T. Leigh), about two knots in favour of the ship, but a stiff breeze, about 5 in strength, blowing against her. The indicated horse-power of the ship's engines, as given by the cards, was 1,650.

Trial Trip of the Screw Steamer "Limerick."—The screw-steamer *Limerick*, lately built by Messrs. J. Wigham, Richardson and Co., for the London and Limerick Steamship Company, recently underwent a trial trip, and although the weather in the early part of the day was very thick and hazy, it cleared up towards noon, when the measured knot, off Whitley, was run, going north, in 5 min. 20 sec., and returning 5 min. 15 sec., or about 11¼ knots per hour. The engines, which were made by Messrs. R. and W. Hawthorn, worked remarkably well, and both the vessel and her machinery gave the greatest satisfaction to those interested in the trial of the vessel.

Clyde Steamers and the Blockade.—The extraordinary briskness in the shipbuilding trade of the Clyde, says the *Glasgow Morning Journal*, during the past three years is, in a large extent, to be attribnted to the blockade of the Sonth American ports. The demand for swift-sailing steamers for the purpose of running the blockade has, in fact, put onr shipbuilders to the test, and we are glad to say they have heen equal to the emergency. The following table gives the total nnmber of Clyde-huilt vessels which have been engaged in this trade during the past three years:—

	Vessels.	Tons.	Destroyed.	Captured.	Still Running.	On way out.
1862	28	16,900	9	19	0	0
1863	30	12,770	6	16	8	0
1864	53	29,920	8	13	21	11
	111	60,590	23	48	29	11

As to the cost of this vast fleet, taking the average of £15,000 for each steamer—as high as £35,000 heing paid for some of those of the *Lord Clyde* class—the total sum expended at the Clyde for these hlockade-runners would be ahout £1,700,000. Besides the men employed in the building and engineering of these vessels, they were manned with crews varying from 20 to 50 men each, and taking the average at 30 hands, gives a total of 3,330 men taken from the Clyde for their navigation. Some of these remained with the steamers, the engineers in particular, till the loss or capture. Many returned again to go ont with other vessels, while a few found employment in Dixey or the North.

New Steering Apparatus.—On the 13th ult. there was a trial on board the Inman steamer *City of London*, of a new apparatus invented by Mr. John S. Gishorne, engineer, &c., of Liverpool, which promises to be of great assistance in the steering and control of vessels. On the bridge, immediately nnder the control of the officer in charge of the vessel, are two dials, with wires attached, communicating with and working, the one a drum in the engine-room, and the other a similar drum in the engine-honse. Round these drums revolve the directions, as "ahead," "astern," &c., to engineer, and "port," "starboard," &c., to the helmsman. The officer in charge has, therefore, only to pull a bell, and instantly to direct the needle of the dial to the intended order; the engineer or helmsman at once sees the order on the drnm, and, by pulling a counter bell, shows that he has attended to it. The plan of the arrangement is such that a wrong order cannot be given.

LAUNCHES.

The Launch of the "Ally" took place on the 11th ult., from the yard of Mr. Jas. Laing, Deptford, on the Wear. The *Ally* is of 1,468 tons, classed 18 years at Liverpool. She is the fonrth vessel built by Mr. Laing for the Diamond Company, and will run from London to Algoa Bay.

The "Queen of the Tyne" (s) was launched on the 12th ult., from the building yard of the Tyne Iron Shipbuilding Company. The vessel has been on the stocks about four months, and is of the following dimensions:—Length, 195ft.; breadth, 29ft.; and depth, 17ft. Her tonnage (builder's measurement) is 794. Her engines, which will be fitted in by Messrs. R. and W. Hawthorn, will be of 128 horse-power. She is a very finely modelled vessel, and has heen built for Messrs. Robert Girvin and Co., of Liverpool.

A Steamer for the Tyne General Ferry Company, named the *Lady James*, was launched on the 12th inst. from the Tyne Iron Shipbuilding Company's yard. The dimensions of the vessel are:—Length, 100ft.; hreadth, 14ft.; depth, 6ft. Her engines are 25 horse-power.

Messrs. Richardson, Duck, and Co., iron shipbuilders, of South Stockton, launched recently an iron screw steamer. She is classed A 1 for nine years at Lloyd's and is of the following dimensions:—Length over all, 282ft.; ditto between perpendiculars, 270ft.; breadth, extreme, 33ft. 10½in.; and depth of hold, 26ft. She is furnished with engines of 200 nominal horse-power, by Messrs. T. Richardson and Sons, of Hartlepool. Before leaving the ways she was named the *El Dakel, pro tem.* The vessel is to be brig-rigged, and is provided with three decks.

Launch of the "Morning Glory."—Messrs. R. Thompson and Sons, of Sunderland, have launched a fine modelled barque, named the *Morning Glory*. Length, 133ft.; breadth, 28ft. 2in.; depth, 18ft. 1in.; of 486 tons O.M., and 440 tons N.M. She is classed A 1 13 years, is fitted out for the Chili trade, and is sold to Messrs. Tully and Sons, of that port.

TELEGRAPHIC ENGINEERING.

The Atlantic Telegraph.—A coil of 279 miles of this cable has been shipped in H.M.S. *Amethyst*, for transmission to the *Great Eastern*, in the Medway. Upwards of one-third, or 900 miles, of the cable have now been manufactured at the works of the Telegraph Constrnction and Maintenance Company," formerly Glass, Elliot, & Co. The entire length will be 2,300 miles; hut allowing for slack, 2,400 miles will be provided. A very small space in the *Great Eastern* will be required for the whole, which will weigh about 17,000 tons. In about six months the line will be laid.

French Telegraph.—The French Council of State is about to introduce a new system of telegraphy into operation through France. Hitherto only two sorts of apparatus have been in general use, viz., the needle and the alphabetic index instruments. The new one, invented hy Caselli, is to be autographic, so as to produce the telegram in the handwriting of the sender. The tariff is therefore regulated, not according to the number of words, but after the size of the sheet employed, and is to be as follows:—30 square centimètres (4·35 square inches) pay six francs, and so on in proportion. the sizes being 30, 60, 90, and 120. On these sheets of paper the public will be allowed to figure any correspondence, trade-mark, or drawing—anything except secret writing.

A Miniature Telegraph Office, designed as a present to the Emperor of Russia, has been constructed hy a citizen of New York. It consists of a complete telegraphic apparatus, capable of transmitting messages between Boston and New York, all emhraced within the compass of a morocco case, 8in. in length, 6in. in width, in 3½in. in depth.

Communication between Guard and Driver.—The directors of the London and Sonth-Western Company have given instructions for a train of six carriages and two guards' vans to be fitted with the apparatus for providing telegraphic communication between passengers and guards, upon the same principle as that which was tested by Captain Tyler, of the Board of Trade. The train is intended to be worked for the ordinary traffic of the line.

Telegraphs at the Antipodes.—The mail from New Zealand brings the intelligence that the electric telegraph is already in active operation between the Bluff and Invercargill; and that the telegraph posts hetween Invercargill and Dunedin are already fixed, and that, as soon as the wires can be suspended, Dunedin will he put, *via* the Bluff, some thirty hours nearer than it is now to Australia and to Europe. This circumstance will necessitate the habitual calling at the Bluff of the Australian steamers, and the establishment of the overland route for travel, as well as for the transmission of news from Invercargill to Dunedin, will be the natural and certain result.

RAILWAYS.

New Coupling for Railway Carriages.—The object of this contrivance, which consists of a modification of the ordinary coupling, is to cut off the connection between the engine and carriages of a train whenever the engine runs off the rails, so as to prevent the rest of the train being dragged after it over embankments or bridges. The ordinary conpling consists of drawbars, hooks, and right and left-handed screws, so as to bring the buffers of the carriages in a train close together. There are also safety chains, one on each side of the main coupling. The improvement comes into action the moment the engine or tender happens to diverge at a certain angle from the line of railway, the main coupling is then thrown out of gear and released from its hold, the spring bolts are driven back by the springs into the void left by the drawbar being withdrawn, the safety chains are instantly liberated from the eyebolts on the frame of the carriage, and the engine or tender is thus completely separated from the rest of the train. It appears that accidents from engines running off the rails amount to more than 20 per cent. of the total number of accidents to railway trains. From the 1st of July to the 31st of December, 1860, there were 13 accidents from this cause in the United Kingdom, by which 6 passengers were killed and 43 injured. In the year 1861 there were 28 accidents of this kind, in which 24 passengers were killed and 95 injured. In the year 1862 there were 28 accidents, in which 18 were killed and 282 injnred; and in the year 1863 there were 21 accidents from engines and trains running off lines of railway, which resulted in the death of 15 persons and injury to 161 persons, making together in the conrse of 3½ years 90 accidents from engines and carriages running off the rails, causing in the aggregate the death of 63 persons, and more or less serious injury to 443 persons, besides involving destruction of rolling stock and large sums for compensation. This indicates to some extent the advantage of adopting the system of coupling patented by Messrs. Kirkman and Morres, of Parliament-street, and which appears to be very complete in every respect for the purpose intended. It is in course of being adopted on some of the passenger fast trains on the Great Eastern Railway, where accidents from that cause have heretofore been rather more frequent than on other railways.

London Railways.—The line of railway to nnite the London and North-Western with the Sonth-Eastern at Charing-cross is about to he commenced. It will be an underground line, and, indeed, will cross the present undergronnd on the New-road, at Tottenham conrt-road, on a still lower level. New streets will he formed in connection with this line, as we have noticed on previous occasions, opening up the close streets between Oxford-street and the Strand. This will be the third line of connection between the North and South of London lines, the three Thames bridges of connection being Blackfriars, Hungerford, and Kensington.

Metropolitan Railways.—The forty-seven railway schemes which will be submitted to Parliament in reference to London are said to represent no fewer than 151 separate lines and branches, with a total length of 349 miles. Of these, twenty-three relate to the south of London. The longest on the list is the London, Bucks, and East Gloucestershire, 59 miles 6 furlongs.

Railway Wooden Sleepers.—The wear and tear of wooden sleepers have led several of the railway companies in France and other Continental States to adopt iron ones. Of all the processes yet adopted for arresting the decay of wooden sleepers, not one has been found to succeed. They expect a great saving both of time and capital by the use of metallic bearings.

The French Commission for examining different questions relative to the service of railways has just issued its report. Among the improvements suggested is that of a more convenient disposal of the interior of the carriages. The American long carriage, with a communication from end to end, is preferred, with saloon, reading and smoking compartments, water-closets, &c.

The Parliamentary Deposits this year on account of new railway projects have amounted to £4,272,010, of which £189,235 was in cash, £258,500 in Exchequer-bills, and £3,824,275 in stock. This total is £2,050,879 less than that of last year.

Stamford and Essendine Railway.—The Marquis of Exeter, the principal proprietor of the Stamford and Essendine Railway, has taken the working of it into his own hands. The marquis has purchased new rolling-stock, and has commenced running the trains with officials of his own appointment, the agreement with the Great Northern for the working of the line having expired. The first-class carriages now bear the coat of arms of the marquis.

Railway Receipts for 1864.—The receipts for traffic on railways in the United Kingdom for the year 1864 amount to £33,182,490, and for 1863 to £30,498,660, showing an increase of £2,683,830, or about double the average increase per annum. The aggregate length of railways was 12,582 miles, against 11,904 miles in 1863, showing an increase of 678 miles. The receipts per mile averaged £2,646, against £2,632 in 1863; the working expenses were 47 per cent. against 59 per cent. in 1863. The increase in traffic on the Great Western over 1863 was £209,903. The proportion of traffic to the capital expended was 8·48 per cent. against 8·17 per cent. in 1863, showing an increase of a quarter per cent. So that the net return on the working of all, or nearly all, the railways of 1864 was equivalent to 4½ per cent. on the capital expended. This is the largest average return on the capital expended since 1847, when the rate averaged 4·69 or near 4¾ per cent. In the interval the lowest average reached was in 1850, when it touched 3·31 per cent.; it gradually rose to 4 per cent. in 1856, and from thence with some fluctuations, increased to 4½ per cent. in 1864.

The Mont Cenis Hydraulic Railway.—In consequence of the favourable results obtained at the experiments lately made at Ouslno, near Turin, in the presence of some engineers, of the new system of traction discovered by the Italian engineer, Signor Agudio, that gentleman placed himself in communication with Messrs. Fell and Brassey, the contractors for the Mont Cenis Railroad—not to be confounded with the Mont Cenis Tunnel, now being excavated by the Governments of France and Italy conjointly—and, according to the *Railway News*, has made an arrangement with them by which the locomotive power of steam is dispensed with as being too expensive in conveying the heavy trains up the steep gradients from Susa to the top of the mountain by the military road made hy the genius and indomitable perseverance of the Emperor Napoleon I., and the application of water is to be used as the motive power. For this purpose the railway will be continued from Susa to the village of Novalese, in the valley of Cenis, a distance of five kilometres. At this spot the water that flows down out of the lake on the summit of the mountain is sufficient to put in motion two hydraulic machines of 800 horse-power, which in three quarters of an hour will force up a whole train of carriages from Novalese to the Gran Croce, at an elevation of 1,200 metres, by means of an inclined plane of ten kilometres in length, with a gradient of 12 in 100, and curves of 500 metres radius. From the top of the mountain at Gran Croce the trains will he forwarded to Saint Michel by a locomotive with stop-wheels, the invention of Mr. Fell, C.E. The traction system invented by Signor Agudio can be completed and in working order in less than a twelvemonth, while the cost will bo only four millions of francs (£160,000) thus effecting a saving to the company of more than two million francs, which the construction of a railway to be travelled over hy a locomotive would cost in excess as compared with the inclined plano and hydraulic power. As the working expenses of the latter will ho considerably reduced, the Italian Government, in conjunction with the municipal authorities of Turin, propose to grant the company a subsidy of a couple of million francs, while King Victor Emmanuel has already publicly expressed his intention to grant a considerable sum out of his privy purse for the same purpose. With regard to obtaining a royal "concession" for this alteration of the original project, all the difficulties in the way havo heen successfully surmounted, and in all probability a very short time will elapse before the passage of the Mont Cenis will be effected by a railroad without the necessity of either tunnels or viaducts. Of the immense importance to Italy which this first practical proof of tho discovery must be may be inferred from the fact that in that kingdom there are no less than twelve railroad passes to be crossed in the Appenines and three over the Alps, the former of which have an average elevation of 600 metres, and the latter of 14,000 metres.

RAILWAY ACROSS THE PYRENEES.—The Committee of Engineers deputed to make an inquiry as to the mode best adapted for crossing the Pyreuees by a railroad has just concluded its labours. The general railway net of Spain comprises a central line intended to cross the Pyrenees. The Committee have examined the defiles and chief valleys lying between the port of Canfranc and the valley of Aran, both on French and Spanish territory, and gathered a number of highly interesting data, with reference to the various projects of tunnelling the chain of the Pyrenees. It appears that six lines would be practicable—across the valleys of Canfranc, Gavarra, Bielsa, La Glera, Toro, and Salan. Every one of them would join the Bayonne Railway off Toulouse. The first line would start from Huesca, and pass through Arragon and Galicia; the second, starting from the same point, would be carried along the Ara and Cinca; the third line starts from Monzon and crosses the Cinca; the fourth line also starts from Monzon, and passes by the Esera and Cinca; the fifth line starts from Lerida, and crosses Noquera, Ribagorzona, and Segra; and the sixth would start from the Lerida by Noquera towards Palleresa. The execution of any of these projects would, of course, involve difficulties, and necessitate very expensive engineering works, especially at the approaches of the Pyrenees. It will hardly be possible to select any of these lines, unless each of the projects be fully gone into, and thus the respective merits and demerits properly appreciated. Messrs. Arnas and G. Rodriqnez are engaged at present in drawing up their report, which, it is to be expected, will be snbmitted to the Spanish Government early in the present year.

RAILWAY ACCIDENTS.

ALARMING RAILWAY COLLISION.—On the evening of the 21st ult., an accident, unattended with loss of life, took place at the Bebington Station, on the Birkenhead and Chester Railway. It appears that a coal train which left Chester at 6.10 p.m reached Bebington about 7.40, and was in the act of shunting or crossing from the up to the down line, when the Great Western London express train, which left Chester at 7.10, was observed to be approaching. At the moment a goods train was passing the station on its way from Birkenhead, and it is said that the steam from the engine prevented the driver of the express train from seeing the signal lights. As soon as the danger was observed by the driver of the express train he immediately stopped his engine, but too late to avoid a collision. The concussion was so great that the engine and tender were turned over on their side, the leading wheels of the engine coming in contact with the down rails, and thus preventing the carriages from being precipitated over the embankment, which at this point is about 30ft. or 40ft. deep. The engine-driver, who stuck to his post, escaped with a few slight bruises, and none of the passengers, who numbered about 200, sustained any injury. Several of the waggons were smashed.

ACCIDENT ON THE LONDON AND NORTH-WESTERN LINE.—On the 21st ult., a collision took place on the London and North-Western Railway, about two miles from Bolton, causing the death of one person and serious injury to several others. There was a dense fog during the day, and the rails were covered with hoar frost, which made them extremely slippery, and rendered most of the trains somewhat late. At Daubhill station, on the Bolton, Kenyon Junction, and Liverpool line, a long luggage train was drawn up at a siding waiting for the 1.30 train from Liverpool to pass, and also for the train from Tyldesley due about a quarter of an hour later. As soon, however, as the Liverpool train had passed the goods train, from some unexplained cause, was permitted to proceed on its journey towards Liverpool. When about half-way between Daubhill and Chequerbent, and having passed under Pownall-bridge, it met the Tyldesley passgener train, and a serious collision was the result. The engines were locked together, the tenders were thrown over them, all the carriages were thrown off the line, some of them being upset and piled against the side of the cutting. One of the passenger carriages and the guard's van and several of the goods waggons were broken to pieces, and three of the goods waggons were piled on the top of each other.

DOCKS, HARBOURS, BRIDGES.

THE CLIFTON SUSPENSION BRIDGE.—This splendid bridge, which spans the Avon from the Gloucester and Somerset cliffs, was designed by Mr. Brunel, and has been recently opened. The following is a brief description of the work.—The chains at Clifton are made up of odd and even numbers, alternately 10 and 11, each bar of each link in the three chains being 24ft. long by 7in. broad, and 1in. thick. This gives a sectional area of about 460 square inches of iron in the chains, which, at the low estimate of 22 tons breaking strain to the square inch of iron, gives, in round numbers, a weight of 100,000 tons to break the bridge down. The towers are arched 48ft. wide by 30ft. thick, and 80ft. high. On the Bristol side they only go down some 10ft. or 12ft. to meet the rock, but on the opposite shore the shelving conformation of the strata requires a pile of masonry 100ft. high to meet the roadway above it. The bridge, which hangs from the chains over these towers, is made by the tie-rods 2in. in diameter and 8ft. apart—81 in number on each side of the structure. Each pair of tie-rods have suspended to them the cross girders which carry the floor of the roadway. These girders are 18in. deep and 33ft. long, and, like all the rest of the work, are of wrought iron. The carriage way is 20ft. wide, and the footways 5½ft. wide each. A division 3ft. high is formed between the roadway and footways by two long wrought iron girders 3ft. deep by 8in. wide, which, like two backbones, stiffen the bridge from end to end, and stop the vibration which fierce storms would otherwise assuredly occasion, as they once destroyed the bridge at St. John's. The curve, or rise, in the bridge is only 2¼ft. at the centre. The saddles, or rollers which let the chains move over the towers, meet the contraction and expansion. During a hot summer day the centre of the bridge has risen 4ft. from this cause, and the difference between the extreme of cold and heat makes an alteration of nearly 1ft. in the height of the centre. When tested with a load of 500 tons of stone on the bridge, the chains moved across their saddles and lowered the crown of the centre 7in., the chains passing over the saddles 1½in. on each side. When the load was removed the bridge returned to its normal position, nor did the most careful observation with levels detect the slightest change. To all the common modes of observation the whole structure seems as rigid as stone to the passage of ordinary traffic. There are two suspension bridges made of wire ropes of larger span than this bridge—the Niagara Bridge, and the other at Fribourg, in Switzerland; but the Clifton is the longest and highest chain bridge in the world, and the strongest suspension bridge ever erected. Its strength the following figures will clearly show:—

	Ft.	In.
Span of bridge	702	3
Versed sine of chains	70	0
	Sq. in.	
Sectional area of chains at piers	481	
Ditto at centre of chains	440	
	Tons.	
Weight of chains between the piers	554	
Weight of roadway	440	

	Tons.
The strain at the centre due to the weight of the chain	680
Ditto due to the weight of the roadway	597
Ditto to a load of 70lb. per square foot over the platform	817
Total strain	2,094

With this weight the ironwork of the bridge is in no place strained more than 4⅘tons per square inch, which is less than one-fourth of its strength. Taking the tensile strength of the chains at 22 tons per inch, the chains would require a strain of 10,000 tons to break. If the strain produced by the weight of the chains is deducted, viz., 1,277 tons, there remains a surplus strength of 9,723 tons. And as a weight of 600 tons upon the platform produces a strain of 817 tons on the chains, it follows that the bridge possesses a surplus strength, measured by weight placed upon the platform, of about 6,000 tons.

NEW RAILWAY BRIDGE AT BATTERSEA.—When completed, the new railway bridge of the London, Chatham, and Dover line, at Battersea, will be the widest in the world. The width of the existing bridge is 33ft. 9in., and the new portion 98ft. 9in., thus giving a total width of 132ft. 6in. between the parapets, or 52ft. 6in. greater width than that of the new Westminster Bridge. At present there are two lines of rails of mixed gauge, to which will at once be added two more, and width will be provided for another line, thus giving accommodation for five lines of rails. Upwards of 400 trains and engines pass over the Battersea Bridge per day.

MINES, METALLURGY, &c.

THE PROFITS OF GERMAN MINES.—It is generally anticipated that in the course of the present session of the Prussian Chambers attention will be directed to the forthcoming sale of the forges, mines, and other industrial works belonging to the State. Between 1853 and 1863, these establishments effected a total receipt of 28,742,175 thalers, against a total expenditure of 27,580,647 thalers, so that the nett profit was only 1,161,528 thalers. The extraordinary receipts amounted to 482,950 thalers, and the extraordinary expenses to 238,441 thalers, showing a profit of 244,509 thalers. This amount, added to the profits previously indicated, made a total of 1,399,969 thalers. This sum had, however, to support expenses of administration amounting to 505,149 thalers; so that the nett actual profits realised in the ten years were only 894,820 thalers. It should, however, be stated that the working capital was increased out of revenue from 5,567,679 thalers in 1853, to 6,362,163 thalers in 1863. When we examine the capital immobilised in all the establishments, we find that the return realised in the investment made by the State has been only at the rate of 1·90 per cent. per annum, a very meagre result.

GOLD MINING IN AUSTRALIA.—Some of the companies formed in Melbourne for working gold in various parts of the colony are paying dividends at the rate of 400 and 500 per cent. upon the capital invested.

COAL IN NEW ZEALAND.—There are many parts of New Zealand in which coal deposits have been found, and a mine has now been discovered at the Bay of Islands which produces a mineral that is considered to be of unquestionably better quality than any other produced in the southern hemisphere. The coal produced from the Kawakawa Mine is a thorough good black coal, which has now been proved by actual trial to be capable of raising steam in 1hr. 5min., whilst 1hr. 45min. is required when New South Wales Newcastle coal is employed.

ACCIDENTS TO MINES, MACHINERY, &c.

COLLIERY ACCIDENT AT WIGAN.—At the Douglas Bank Colliery, the property of Mr. Grant Morris, of Liverpool, a serious accident occurred, resulting in the death of five men, and the injury of three or four others. The colliery has been in course of opening for the past two years, but the shafts have not been quite finished. It appears that between eight and nine o'clock a blast was fired, and when time had been allowed for the smoke to clear off a party of eight was again lowered. The engineer, however, was surprised to find the hoppet stop a few yards from the bottom, and the rope slacken, and it was found impossible for even the two large engines to move it from its position. As the rope could not be dropped on the men, the necessary steps were at once taken to get on a new one, and, on the descent being made, the exploring party reported that the men and hoppet were buried in rubbish, the last range of brickwork (probably loosened by the last shot) having fallen to the bottom.

GAS SUPPLY.

THE BARNET GAS CONSUMERS are resolved to have a reduction in the price of their gas to 5s., while the gas directors hesitate to give more then one-half the required reduction.

THE MAINSTONE GAS COMPANY have agreed to lower their price to 4s.

AT CANTERBURY, a reduction from 5s. 6d. to 5s. is announced.

THE MARLBOROUGH GAS COMPANY have reduced the price of their gas 2s. 6d. per 1,000ft. To consumers of 30,000ft. the cost will now be 6s. 6d. per 1,000ft.; under that quantity, 7s. 6d.; whilst to those who use 5,000ft. and under, the cost will be equalised by a charge of 1s. per quarter for the use of the meter.

BIRMINGHAM GAS CONSUMERS' COMPANY.—At a recent meeting of this Company, the secretary stated that since the movement was commenced for the formation of the Company, several reductions in the price of gas had been made by the two gas companies, the average of which was about 21½ per cent. below the price usually charged. And in addition to this reduction in price, they would be, and were, supplied with gas 40 per cent. better in illuminating power than before.

WALSALL.—The supply of gas at Walsall is by the town commissioners. They have just announced a further reduction in price to an average of 2s. 6d. per 1,000; the street lamps 2s. 6d. per 1,000.

IN CORK THE GAS CONSUMERS' COMPANY have reduced the price of their gas 4s. per 1,000 cubic feet; and for street lamps, £3 each, to be lighted the whole year round. The Company is paying 8 per cent. The original capital of the company was £40,000.

THE DIRECTORS OF THE HULL GAS-LIGHT COMPANY have resolved to supply gas at 3s. 9d. per 1,000 cubic feet.

THE DIRECTORS OF THE SUNDERLAND GAS COMPANY have reduced the price of their gas to 4s. per 1,000 cubic feet, with discounts for cash—12½ per cent. under 50,000ft., 20 per cent. under 50,000ft., and 25 per cent. above 200,000ft.

LONDON GAS.—The gas movement which was set agoing in past years, and which has already so greatly reduced the price and improved the quality of gas throughout the country, is being renewed in London, where meetings of gas consumers are being held for the purpose of either forcing a reduction of price to 2s. 9d. per 1,000 cubic feet, from the present companies, or establishing municipal gas works on the Manchester principle. The announcement of an intention on the part of the Imperial Gas Company, which has a monopoly of the Paddington, Marylebone, St. Pancras, Islington, and Hackney gas supply, to apply to Parliament for power to raise £1,735,000 has startled the London gas consumers, who know pretty well what that means; and they are organising an opposition to the company's design.

THE CANTERBURY GAS COMPANY have announced an intention to reduce their price from 5s. 6d. to 5s., but the citizens are dissatisfied, and insist on a reduction to the Maidstone price of 4s. A rival company is talked of.

THE WORCESTER GAS COMPANY have reduced the price of their gas to 4s. and also made a considerable reduction at the same time in the price of their coke.

THE PARA GA COMPANY (LIMITED).—The report of the directors has been issued. From this report it appears that the contractors, Messrs. Peto and Aird, have nearly completed the works at Para, in Brazil, and that the city has for some time been lighted with gas. Messrs. Peto and Aird have been paid £81,547 for the works, and the expenses of the engineer, Mr. Thomas Rumball, amount to £3,666. The capital of the company was £100,000, and they have still a balance of £4,226 at their bankers. The income of the company from the supply of gas to the Government and the city is not yet available, and the directors only recommend a dividend of 5 per cent. per annum for the last half-year. The streets, churches, and private dwellings are all being lighted up with gas. The affair promises very well.

THE CITY OF ALEXANDRIA has been lighted by gas, the works having been erected by a French company. The lamplighter is nightly followed in his rounds by a crowd of wondering Arabs, who insist that the marvellous blaze following the touch of his torch must be provoked by the will of a *genie*, or "djinn." Heretofore, a municipal regulation required everybody going abroad after nightfall to carry his own lantern, but this is no longer necessary.

SHEPPY GAS CONSUMERS' COMPANY.—The directors of this company have resolved to reduce the price of their gas from 5*s.* to 4*s.* 6*d.*; and the directors of the Hythe and Sandgate Gas and Coke Company have also announced their attention of making a further reduction of one shilling per 1,000ft. The price will be then 6*s.* 6*d.*, and the allowance of discount at the rate of 6*d.* per 1,000ft. on prompt payment will further lessen the sum to 6*s.*

WATER SUPPLY.

THE WHITCOMB RESERVOIRS, GLOUCESTER.—The surveyor having reported to the Waterworks Committee of the Town Council that a considerable leak had been discovered in the embankment of the lower reservoir, supposed to arise from some defect in the mains supplying Gloucester, either in the joints or in the bursting of a pipe, he was authorised to open down to the supply main, and found that a defective joint in one of the pipes had caused a leakage equal to 10,000 gallons a day. It was resolved that the surveyor should put in a culvert, 4ft. 6in. in diameter and 10 yards long, over the supply main, so as to enable him at all times readily to examine the main and make any repairs necessary, and also to put in a drain from the screen vault. The council have confirmed the resolution of the committee.

BRADFORD WATERWORKS.—Mr. Ferrand, M.P., has addressed a letter to Sir George Grey, in which he complains that orders have been given by the Bradford corporation to refill the Doe Park Reservoir before an inspection has been made by a civil engineer. The repairs have been made under the sole superintendence of the borough surveyor. Mr. Ferrand alleges that the reservoir is still in an unsafe condition. The mayor of Bradford replies that he thinks the public need be under no alarm after the result of Mr. Ferrand's complaints last session, and gives an assurance that the waterworks committee know their responsibility, and will discharge their duty.

APPLIED CHEMISTRY.

UTILISING REFUSE TINNED IRON.—Some improvements in treating and utilising refuse tinned iron and other combined metals has been provisionally specified by Mr. N. O. André, of Paris. He proposes to subject the cuttings to the action of nitrous or nitric vapours, or any other gaseous acids, with a view to the re-employment of the metals, especially tin, such scraps forming the refuse of various existing manufactures or products. The metal refuse is first poured into a vertical column from five to ten yards in height, and of a size proportionate to the amount of products to be treated. This column is divided into compartments of about fifteen inches in depth by means of wood divisions moving in a horizontal plane. The metal is put in at the top of the column, care being taken to introduce the wood divisions above each compartment when filled, so that the total weight of the metal shall not rest on the bottom, but be divided into as many fractional parts as there are compartments. The acid vapours are then introduced at the lower part of the column (nitrous vapours for example), and on the other hand steam is introduced at the same point, which, becoming partially condensed, renders humid the substances contained in the column. The gaseous acids oxidise the surfaces of the refuse metal, and ultimately attack the iron, and this action is allowed to continue in order to insure the oxidation of all the foreign metals; and when the operation has sufficiently advanced, the bottom compartment of the chamber is emptied, and the divisions above mentioned successively withdrawn from the bottom upwards, so as to empty the contents of each compartment into the next below it which has become vacant, while the upper one is charged with a fresh quantity of materials. The refuse, which is now covered with a pasty oxide, is washed in several waters and sorted, while if there be any oxide still adhering it is again washed in acidulated water and then rinsed. The sorting is effected with greater or less care according to the purpose for which these clean iron scraps are intended. The acids are reduced and melted in a crucible enveloped in charcoal in the ordinary manner. In order to obtain the tin in a perfectly pure state the oxide is washed in nitric and acetic acids. If the metal scraps have been treated by means of the vapours of hydrochloric acid with a view to obtain the whole or part of the tin in the state of protochloride or bichloride it may be precipitated in a metallic state by means of zinc. The iron scraps or solder which may have been imperfectly deprived of tin or other metal are introduced a second time into the column, or they may be employed in chemical operations where the presence of small quantities of lead or tin is not prejudicial.

USE OF PETROLEUM AS STEAM FUEL, BY B. H. PAUL.—The report published by the Commission, as the result of their labours, was calculated rather to excite curiosity than to afford satisfactory information, and they have not, so far as I am aware, made public any further data which would afford a means of arriving at an opinion on this subject. The proposal to use petroleum as steam fuel in ships became, almost of course, a subject of consideration in this country, and an idea prevailed that this invention might possibly supersede in importance all the recent improvements connected with the naval or mercantile marine. It was anticipated that not only naval warfare, but even navigation itself, might be completely revolutionised by this invention. It was reasonable enough that a project put forward with such pretension as was the case in respect to the use of petroleum as fuel for steam vessels, should be considered in a country where every improvement relating to steam navigation is of high importance; but it is surprising that no one should have disabused the public mind of the erroneous impressions produced by the statements as to the use of petroleum as fuel; for to any one conversant with the composition and characters of petroleum, as compared with coal, this proposed application of it was obviously absurd. Lately little has been heard of this project until a notice appeared in the *Times*, under the head of "Naval and Military Intelligence," that experiments are being conducted at the Woolwich Dockyard, with the view of testing the capability of petroleum to supersede coal and other fuel on ship-board, &c. In this notice it was stated that the oil was so utilised "as to be equal for steam purposes to five tons of coal!" How much of the oil was equal to five tons of coals was not stated, but it may be fairly supposed that any one unacquainted with the subject would infer that one ton of oil was meant. Now, what are really the facts of the case as to the comparative advantages of petroleum and coal as fuel. In the first place, one of the chief alleged advantages of petroleum over coal was that it would lie in a small compass and make less demand upon space and tonnage than coal does. Since with petroleum in the place of coal, two-thirds of the space now required for fuel in a steam vessel would be saved, steam ships might keep at sea three times as long as at present. Then, coal depots would be unnecessary for steam packets on the longest lines of ocean navigation; and since no stokers would be needed in using petroleum, a whole army of employés might be dispensed with. Now, the specific gravity of coal is from 1·24 or 1·44 to 1·6, while that of petroleum is from 0·800 to 0·850, consequently the weight of a cubic foot of these materials would be, respectively, about as follows:—

	Lbs.	Lbs.	Lbs.
Coal	77·4	90	100
Petroleum	...	50	53

But since petroleum, being liquid, lies in a more compact manner than coal, in estimating the spaces occupied by these materials, allowance should be made for the interstices or empty spaces between the lumps of coal. Taking this as amounting to one-third of the whole bulk of a heap of coals—which is a liberal allowance—the contents of a cubic foot would be as follows:—

Coal	52	60	70
Petroleum	50	53	...

So that the spaces occupied by equal weights of coal and petroleum would be about as 1 is to 1·2 or 1·4. Then the relative heating power of equal weights of coal and petroleum would depend upon their respective chemical composition, which may be compared as follows for 100 parts:—

	Coal.	Petroleum.
Carbon	83	85
Hydrogen	5	15
Ash, &c.		
	100	100

Accordingly, the relative heating power of equal weights of coal and of petroleum would be in the following ratio:—

	Coal.	Petroleum.
Calorific power	1·02	1·50

And the spaces occupied by quantities of petroleum and of coal, having equal heating power, would be in the ratio of 1 to 1·16. This difference in favour of petroleum is in itself too small to admit of any advantage being gained in regard to stowage, and it is more than doubtful whether there be any other advantageous difference between petroleum and coal for fuel. It must also be considered how far the difference between the prices of petroleum and coal would have the effect of neutralising the above, or any other advantage to be gained by the use of petroleum as fuel. The price of petroleum varies from £15 to £20 per ton, while that of coal used for steam vessels is under £1 per ton at any part of the British coast, and even at the coaling stations in the East it does not exceed £2 10*s.* to £3 10*s.* per ton. These considerations alone appear to me to decide the question as to the practicability of using petroleum as steam fuel under any possible circumstances, for even in the case most favourable for the comparison of petroleum with coal, the cost of equal quantities of heat produced from these materials, would be in the ratio of £15 to £4. In addition to this, the highly inflammable nature of petroleum must be considered. Its storage on board a ship would require the use of air-tight vessels, and even then there might be considerable risk of the production of explosive mixtures of the petroleum vapour and air. But what would be the condition of a vessel of war provided with petroleum as fuel, if a shot penetrated the vessel containing the petroleum, and allowed it to escape in proximity to the boiler fires? Taking all these circumstances into consideration, I think there cannot be any doubt as to the entire fallacy of supposing that petroleum can be substituted for coal as fuel; and though this conclusion is sufficiently evident from the data I have adopted as to price, &c., it must also be remembered that the tendency is rather to a rise in the price of this commodity, than otherwise.

DISCOVERIES IN ELECTRO-PLATING.—M. Weil, a French chemist, announces a new method of depositing metals. The baths he employs consist of metallic salts or oxides in alkaline solutions by means of tartaric acid, glycerine, albumen, or other substances, which prevent the precipitation of the oxide by the fixed alkali, in some cases with, and in others without, the aid of zinc or lead, and at various temperatures, according to circumstances. He claims, also, to be able, by like means, to give variety of colour to articles covered with copper by his process. M. Weil says that the most important application of his discovery is the deposit of copper and the bronzing of iron (cast as well as wrought) and steel, without the preparatory dressings with conducting substances, which are necessary in proceeding according to the ordinary methods before the object is placed in the bath and submitted to galvanic action. This, if it bear the test of practice, is a very important fact. Iron and steel tins coated with copper may, says Mr. Weil, be afterwards silvered or nickelised by his process.

NEW BLASTING POWDER.—M. Nabel proposes to make use of pyroglycerine (explosive glycerine) to increase the force of gunpowder for blasting purposes. It is said that experiments, made in the presence of a commission, prove that such a mixture is three times as effective as gunpowder alone. The cartridges made use of were of zinc; these were filled with gunpowder, and as much pyroglycerine was added as the powder would absorb. The detonation is said to be much less than that of gunpowder alone; but, on the other hand, the danger from accidental explosion is much greater, and, moreover, pyroglycerine is a powerful poison.

SOLUBILITY OF GOLD IN ACIDS.—A solution of chloride of gold, when heated in the same manner with sulphuric acid, forms a solution similar to that of gold in a mixture of sulphuric and nitric acids. It is precipitated by water. The solution, whether formed by heating gold with nitric and sulphuric acids, or by heating chloride with sulphuric acid, gives a deposit of metallic gold on continuing the heat, and when all the nitric acid is driven off the whole of the gold is deposited. Nitric acid in excess prevents the precipitation by water; but the gold dissolves better when the sulphuric acid has a little water with it, and only a small quantity of nitric acid.

RUBIDIUM.—According to the latest experiments of Prof. Bunsen in connection with the preparation and properties of this metal, it appears that it may be reduced from carbonated acidiferous tartrite of oxide of rubidium (in a manner similar to the reduction of kalium): 75 grains of that salt will yield 5 grains of pure metal melted to a compact mass. It is very light, like silver, its colour is white, with a yellowish *nuance*, hardly perceptible. On contact with air it covers itself immediately with a bluish gray coating of suboxyd, and is inflamed (even when in large lumps) after a few seconds, much quicker than kalium. At a temperature of 14° Fahr., it is still as soft as wax; it becomes liquid at 101·3° Fahr., and in red heat it is transformed into a greenish-blue vapour. The specific gravity of rubidium is about 1·52. It is much more electropositive than kalium, if combined with the latter to a galvanic chain, by acidiferous water. The rubidium, thrown on water, will burn and show a flame of the same appearance as that exhibited by kalium.

NEW BLASTING POWDER.—The *Bulletin de la Société Chimique* announces the extensive use of a new blasting gunpowder in mining. Its combustion is slow, but complete. The following analyses show why it is cheaper than ordinary powder:—

Soluble salts	74·55	74·32
Nitrate of potash	56·22	56·23
Nitrate of soda	18·30	18·09
The treatment of sulphide of carbon produced—		
Dissolved sulphur	9·68	7·61
Carbon remaining	14·14	15·10
Moisture	1·78	·11

It is a coarse-grained powder, in which one part of potash nitre is replaced by nitrate of soda. In the first instance, one part of nitrate of soda for one part of nitrate of potash was used, but it was afterwards found best to employ a third of nitrate of soda.

LIST OF APPLICATIONS FOR LETTERS PATENT.

We have adopted a new arrangement of the Provisional Protections applied for by Inventors at the Great Seal Patent, Office. If any difficulty should arise with reference to the names, addresses, or titles given in the list, the requisite information will be furnished, free of expense, from the office, by addressing a letter, prepaid, to the Editor of "The Artizan."

Dated December 26th, 1864.

3212 J. Parkinson—Lamps for railway carriages
3213 J. Wolstenholme—Cutting pipes and bars of metal

Dated December 27th, 1864.

3214 H. Hicklin & C. Pardoe—Construction of coke ovens
3215 W. E. Gedge—Administering douches and injections
3216 G. Alton—Machinery for flanging plates and strips of metal
3217 G. Alton—Curving flanged boiler and other metal plates
3218 W. Buttrum—Signalling between passengers and guards of railway trains

Dated December 28th, 1864.

3219 J. Dodge—Rolling, shaping, and forging file blanks
3220 H. Johnson—Top notches and runners for umbrellas and parasols
3221 J. Cleaver—Portland cement
3222 J. R. Breckon & R. Dixon—Construction of coke ovens
3223 A. P. Blanchet—Applying steam power to the cultivation of land
3224 J. Bardies—Pianos
3225 J. Thornton & W. Thornton—Producing looped fabrics
3226 W. Holms—Treating warp yarns used for weaving
3227 W. H. Preece & A. Bedborough—Signalling in railway trains

Dated December 29th, 1864.

3228 R. H. Leese—Machinery for cutting at one operation mitre and dovetail joints
3229 J. D Morrison—Painless dentistry
3230 G. Edwards—Pneumatic apparatus for raising materials
3231 D. Sutherland—Preparing charges for and in charging ordnance
3232 J. Millar—Locomotive steam engines
3233 M. A. Muir & J. McIlwham—Fastenings for railways
3234 J. Truswell & W. Truswell—Indicating the level of water in steam engines
3235 S. Saville—Separating wool from refuse and mixed fabrics
3236 T. R. Harding—Manufacture of pins and buckles
3237 J. Dodd—Mules for spinning
3238 J. H. Johnson—Sewing machines
3239 W. Nalder & A. Belcher—Steam engines
3240 R. Cail—Projectiles
3241 P. C. P. L. Prefoutaine—Storing goods and liquids
3242 B. Baugh—Enamelled wares

Dated December 30th, 1864.

3243 E. Shufflebotham—Girders for railways and for other purposes
3244 E. Perce—Geographical globes
3245 A. S. Macrae & A. Bayley—Burners of hydrocarbon fluid lamps
3246 A. C. Robb—Brushing the hair
3247 E. Couprant—Rotative motive power
3248 H. A. Bonneville—Shoes for horses and other animals
3249 H. A. Bonneville—Presses
3250 T. Bouch—Construction of roofs for sheds and similar structures
3251 W. H. Brown—Cast steel and other metallic tubes
3252 L. P. E. Max—Treating oils and hydrocarbons

Dated December 31st, 1864.

3253 J. Ladley—Carding engines
3254 W. E. Newton—Machinery for making horse shoes
3255 P. A. Roger—Smoke consuming furnaces
3256 T. Richardson—Manure
3257 F. J. Endres—Musical apparatus, printing on paper the music while being executed on keyed instruments
3258 R. Quin—Cases for jewellery and for other articles
3259 T. Du Boulay—Carriages propelled by manual power
3260 C. W. Siemens—Obtaining and applying motive power

Dated January 2nd, 1865.

1 W. Muir—Construction of public houses and other houses of entertainment.
2 T. A. Macaulay—Sewing machines and apparatus belonging thereto
3 M. R. Leverson—Treating apatite and other mineral phosphates.
4 E. Bevan—Jacket or protector for metallic and other vessels
5 J. F. Parker & J. Tanner—Oxygen gas
6 J. Smith & J. Williamson—Lubricating the axles of waggons
7 J. Spencer & N. Broomhead—Carpets and hearthrugs
8 J. R. Crompton—Machinery for smoothing and finishing paper
9 R. Irvine—Treating pitch obtained from the distillation of palm oil and other fats in candle making
10 F. Gye—Mounting pictures

Dated January 3rd, 1865.

11 M. Benson—Lift and force pumps
12 W. G. Helsby—Rendering enamelled glass more useful in photography
13 G. Mascart—Sewing machines
14 H. Lloyd—Perambulators
15 L. D'Aubreville—Paper
16 T. J. Ashton—Pneumatic apparatus applicable for all purposes as a douche for affusion and for enemas
17 L. Goldberg—Belt
18 G. Hodgson & J Pitt—Drilling apparatus for hand or steam power

Dated January 4th, 1865.

19 E. Kirby—Elastic packings for pistons
20 W. Payton—Apparatus for measuring water or other liquids
21 J. Knowles & J. Banks—Mules for spinning
22 W. Clark—Electro-magnets
23 W. Ager—Fan blowers
24 D. Vericchio—Spring mattresses
25 J. F. Jones—Machines for making paper board
26 G. Kent—Apparatus for cleansing and polishing knives
27 N. Thompson—Stoppers for bottles, also for ordnance
28 W. H. Roy—Means of checking the receipts of railway clerks

Dated January 5th, 1865.

29 W. Watson—Apparatus for the propelling of vessels
30 C. Pickworth—Communication between passengers and guard and driver of a railway train in motion
31 G. H. Davies & J. W. Jones—Improved means of advertising
32 J. W. Brauford—Washing, squeezing and mangling
33 J. M. Kirby—Apparatus for generating steam and heat
34 J. Skelton—Plough
35 J. E. Wilson—Locomotive engines, and in the springs of railway carriages
36 A. V. Newton—Sewing machines, and mechanism for driving the same
37 J. C. Amos & W. Anderson—Construction of tubular boilers
38 G. A. Buchholz—Hulling grain and reducing granular substances
39 T. Pickford—Preparing and keeping aerated beverages

Dated January 6th, 1865.

40 J. E. Vigoulete—Carbonaceous minerals
41 J C. Bayley & D. Campbell—Lamps for burning the vapour of volatile fluids
42 J. Lebaudy—Boiling grain sugar in vacuo
43 J. A. Castree—Looms for weaving
44 B. Dobson, W. Slater, & R. Halliwell—Ginning cotton
45 J. Craw & J. Macaulay—Weaving ornamental fabrics
46 A. Reynolds—Smelting zinc ores
47 W. C. Thurgar—Keeping the substance of eggs fresh
48 C. de Bergue—Locomotive engines
49 G. Haseltine—Shaping and trimming the heels of boots and shoes
50 T. Richardson & M. D. Rucker—Treating guano
51 J. Robertson—Furnaces, and flues for the consumption of fuel
52 E. Tyer—Apparatus used in train signalling on railways
53 G. Reymond—Escapements for watches and other time keepers
54 H. Ames—Ordnance of wrought iron

Dated January 7th, 1865.

55 G. B. Galloway—Communication between passengers while travelling
56 B. W. Bentley & W. H. Bailey—Finishing photographs
57 E. Beanes & W. Finzel—Construction of vacuum paus
58 J. Atkins—Metallic bedsteads
59 W. Baker—Manufacture and refining of iron and steel
60 J. J. Blackham—Broock and other like fastenings
61 T. Horrex—Hair brushes
62 J. F. Jones—Machinery for the manufacture of paper board

Dated January 9th, 1865.

63 A. Barlow—Jack and slubbing frames
64 J. H. Johnson—Cleaning rice, coffee, and other grains or seeds
65 J. Welsh—Method of lighting street and other lamps
66 L. Weber—Bits for horses
67 J. Colkin—Taps
68 W. Davies—Manufacture of cavendish and other tobacco
69 R. A. Lightoller & G. H. Lightoller—Preparing fibrous materials for spinning
70 B. P. Bidder—Theodolites
71 F. Wiese—Preserving from fire hooks and other articles

Dated January 10th, 1865.

72 E. Pettit—Ornamenting photographs
73 S. S. Brown—Lint
74 J. C. Brown—Machines for cutting match splints and toothpicks
75 E. W. Ladd & L. Oertling—Hydrometers
76 W. Bayliss—Standards for strained wire or rod fencing
77 H. Chamberlain—Manufacture of compressed bricks
78 A. Meyer & M. Meyer—Breech-loading fire-arms
79 T. B. Belgrave—Preserving meat
80 W. Clark—Manufacture of pulp for paper
81 D. Gattafent—Artificial fuel

Dated January 11th, 1865.

82 J. F. Spencer—Working the valves of steam engines
83 H. Coutanche—Reefing sails
84 A. F. Lendry—Topograph
85 W. E. Gedge—Cutting iron pipes
86 W. E. Gedge—Pincers for gas pines
87 W. E. Gedge—Elastic mattress or bedstead
88 R. A. Brooman—Engraving upon glass and siliceous substances
89 J. Ramsbottom—Steam hammers
90 R. Tempest—Machinery for spinning and carding cotton
91 C. M. Bathisa—Registering apparatus
92 J. F. Heather—Construction upon new principles of keys and locks
93 A. G. Lock—Extracting and purifying fats from bones
94 A. Cooper—Consumption of smoke
95 R. Chidley—Construction of railway carriages
96 J. G. Jones—Condensing atmospheric air

Dated January 12th, 1865.

97 I. Goodlad—Communication between railway passengers and guard
98 J. Fuller—Coverings of telegraph conductors and cables
99 E. T. Hughes—Elastic mattresses
100 W. Russ—Distributing liquid manure
101 F. Barnes, D. Hancock, & E. Cope—Electro-magnetism as a break power for railway and other carriages
102 R. A. Brooman—Teaching music
103 M. Henry—Furnaces
104 G. Gaze—Checking money taken by servants
105 R. F. Moll—Cleaning ships' bottoms
106 G. H. Daw—Breech-loading fire-arms
107 J. B. Hill—Communication between railway passengers and guards

Dated January 13th, 1865.

108 J. Knight—Crinoline skirts
109 F. G. Mulholland & T. Dugard—Bearings for mechanical purposes
110 W. S. Longridge & J. Mash—Furnaces
111 W. Brookes—Steam engines
112 A. J. Sax—Impregnating air for hygienic purposes
113 R. Lewis—Generating steam
114 J Weeks—Umbrellas
115 W. Ager—Cleansing grain
116 T. G. Paguuo—Paving of roads
117 W. Wilkins—Manufacture of looped fabrics in warp machinery

Dated January 14th, 1865.

118 A. Paul & E. Paul—Steering apparatus
119 G. Davies—Preventing incrustation in boilers
120 W. H. Richards—Sleeve links
121 R. Lea—Communication between railway passengers and guard
122 R. A. Brooman—Ascertaining the strength of liquors
123 A. V. Newton—Machinery for pressing and cutting tobacco
124 W. Ansell—Breech-loading fire-arms
125 T. Bourne—Fog and storm signals
126 G. Colven—Ornamental flower box
127 J. Young—Producing gases in a heated state
128 J. Lilley—Compasses
129 F. C. Fourgeau—Construction of roofs or coverings for buildings

Dated January 16th, 1865.

130 J. B. Farrar & J. Hirst—Preparing wool and other fibrous substances
131 W. Edwin—Working stage scenery in theatres
132 H. J. Rogers & J. M. Scholfield—Closing the mouths of bottles
133 W. Rowbottom—Mules for spinning
134 J. Marshall—Presses for the expression of fluids from substances
135 R. A Brooman—Driving rolls
136 J. B. Cotter—Construction of shells, and in the powder to be used therewith
137 J. Betteley—Shipbuilding
138 G. T. Bousfield—Breech-loading fire-arms
139 J. S. Edge—Breech-loading fire-arms

Dated January 17th, 1865.

140 R. A. Brooman—Phosphates of lime for agricultural purposes
141 F. H. Lakin—Manufacture and construction of piano-fortes
142 S. J. Best & J. J. Holden—Charging and drawing gas retorts
143 J. Robinson & J. Smith—Planing and otherwise shaping wood
144 C. T. Judkins—Sewing machines
145 W. J. Cunningham—Converting reciprocating motion into rotary motion

Dated January 18th, 1865.

146 F. P. H. Cahuzac—Dressing woollen and other tissues
147 W. Jeffreys—Working switches and signals of railways
148 A. B. Bull—Reefing sails
149 E. Deane—Bedstead for camp purposes
150 S. Ballard—Cooking apparatus
151 J. W. Gregg—Street and other lamps
152 W. E. Newton—Breech-loading fire-arms
153 J. Burch—Looms
154 J. Coulter & H. Harpin—Smoothing the surface of stones
155 W. R. Foster—Packings of pistons and piston rods of pumps and engines

Dated January 19th, 1865.

156 S. F. V. Choate—Facilitating the working of submarine cables
157 C. D. Abel—Construction of watches
158 T. Mayor—Apparatus for preparing cotton
159 A. W. Preder—Coupling steam engines
160 M. Beltzhoover—Purifying metallic ores
161 D. D. Parcot—Oars
162 E. Williams—Throstle worsted spinning and doubling frames
163 G. F. Bradbury—Sewing machine shuttles
164 R. Mallet—Permanent way of railways
165 J A. Shipton & K. Mitchell—Forging metals
166 W. C Hicks—Steam engines
167 T. C. Durham—Locomotive engines
168 T. Labrousse & J. Keily—Dyeing leather
169 W. Clark—Boots

Dated January 20th, 1865.

170 D. Munro and T. Wright—Painting Venetian blinds
171 G. A. Clark—Projectiles
172 J. Turney and G. Wood—Glazing skins or hides
173 J Hewes—Heating furnaces
174 L. Balms—Raising and carrying earth
175 C. Searle—Securing studs in shirt fronts
176 B. F. Stevens—Vulcanizing compounds
177 W. Clark—Taking up and delivering parcels in railway trains while in motion
178 J. Snell and W. Renton—Facing textile fabrics
179 W. Mather—Communications between railway passengers and guards
180 W. Clay—Working hydraulic lifts
181 W. E. Newton—Hammers and pile drivers

Dated January 21st, 1865.

182 H. A. Dobson—Carriage steps
183 T Lester—Steam engines
184 J. G. Wilson—Construction of permanent ways of railways
185 A. I. L. Gordon—Clasps
186 J. H. Wilson—Pumps
187 C. D. Abel—Transmitting letter bags to and from railway trains whilst in motion
188 J. Suider—Fire arms, and in ammunition for the same
189 M. Robinson—Shaping the elastic dents of expanding and contracting combs

Dated January 23rd, 1865.

190 J. Edie—Boots and shoes
191 C. B. W. Koehl and W. Gunttier—Ginning and cleaning cotton
192 P. M Parsons—Treating articles of cast iron
193 J. Badcock—Suspension of curtains
194 E. Atkinson—Apparatus for containing and dispersing scents
195 E. Templemore—Window-blind cord check
196 A. Drevelle—Rendering soundless articles for domestic purposes
197 J. B Wood—Floor-cloths
198 A. Sheldon—Drying paper in sheets
199 T Brown—Folding seats
200 W. E. Newton—Machinery for mowing and reaping
201 M. A. Dietz—Petroleum and coil oil burners and glasses
202 B. King—Manufacture of manure

Dated January 24th, 1865.

203 A. C. F. Derocquigny and D. Gance—Sewing machines
204 C. T. Wells—Glass ridges for the cultivation of grapes
205 R. R. Riches and C. J. Watts—Grinding corn and other substances
206 J. Rovere and H. A. B. Huguet—A new electric pile
207 G. Haseltine—Means for preserving fruit and other eatables
208 J. Bailey—Embossing presses
209 W. Woodward, R. Woodward, J. Woodward, and A. Woodward—Furnaces for melting metals and smelting ores

Dated January 25th, 1865.

210 T. Steel—Lowering boats and disengaging them from their tackle
211 A. Stevenson—Mills for grinding grain and other substances
212 R. A. Brooman—New thread for weaving and other uses
213 J. Marshall and H. Mills—Ordnance and gun barrels of cast steel
214 C. Roques—Brushes, and in the apparatus connected therewith
215 S. L. Fuller, A. Fuller, and C. Martin—Construction of carriages
216 O. Gossen—Adjusting the weight of railway carriages and engines

Dated January 26th, 1865.

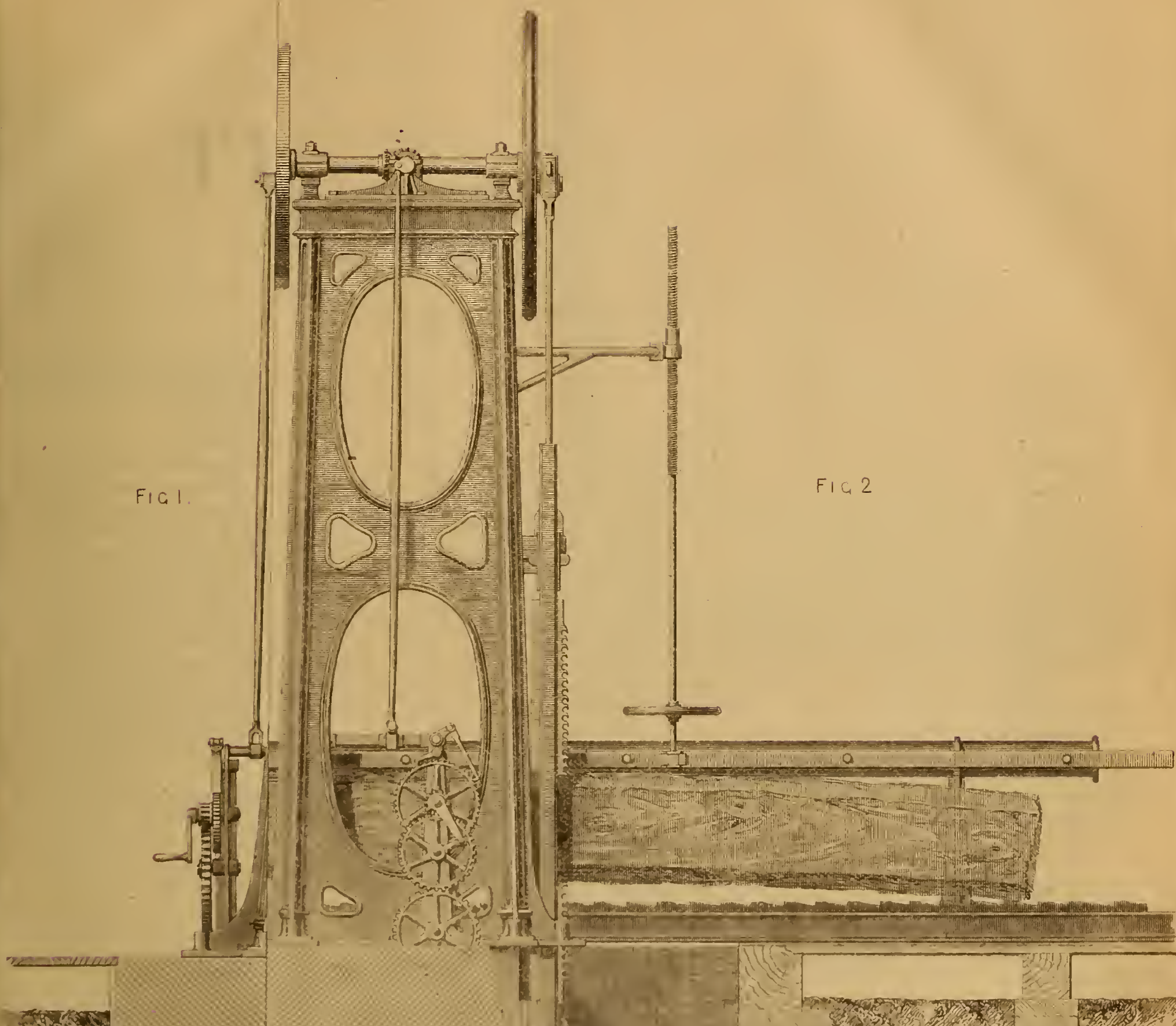
217 W. Paton—Packing for steam joints and stuffing boxes
218 D. Gay—Photo-sculpture, and in apparatus to be employed therein
219 C. D. Abel—Prevention of deposits in steam boilers
220 W. Smith—Compressing coal dust and other materials fit for burning
221 G. Haseltine—Manufacture of syrup
222 J. H. Pepper and T. W. Tobin—Illusory exhibitions
223 S Sharp and D. Smith—Elastic valve and high pressure tap
224 R. Mushet—Lining the sides and bottoms of puddling furnaces
225 J. Harrison—Cleansing ships' bottoms at sea, and in the machinery employed therein
226 A. A. Croll—Purification of coal gas
227 H. W. Ripley—Colouring wool
228 J. Hamilton—Propelling vessels
229 J. G. Willans—Iron and steel
230 C. Falck—Ice safes
231 W. Creasy—Machinery for thrashing, heating, and dressing flax
232 G. Dibley—Preparing and fixing plates or sheets of metal
233 J. E. Massey—Ships' logs and sounding machines
234 W. Clark—Pencil cases, usually termed ever pointed pencils


RIVER MERSEY
FROM A SURVEY BY CAPTN H.M. DENHAM, R.N. F.R.S.
1836.
FIG. I.
GARSTON
OTTERS POOL
CARSTON SANDS
A
DINGLE POINT
FACE OF LIVERPOOL DOCKS
DEVIL'S BANK
EASTHAM SANDS
RIVER MERSEY
PLUCKINGTON BANK
SHELF
FORT
QUARANTINE GROUND
EASTHAM
WALLASEY POOL
BIRKENHEAD
ROCK FERRY
BROMBRO' POOL
TRANMERE POOL
SCALE OF NAUTICAL MILES
FIG. 2
FROM A SURVEY BY LIEUT W. LORD, R.N.
1852.
OCLET BANK
DUNGEON BANKS
dries 10 FT
dries 13 FT
dries 9 FT
GARSTON SANDS
dries 14 FT
INCE BANKS
dries 12 FT
LIVERPOOL
DEVIL'S BANK
dries 6 FT
dries 3 FT
dries 10 FT
EASTHAM SANDS
STANLOW BANKS
dries 15 FT
dries 13 FT
dries 13 FT
dries 15 FT
STANLOW POINT
PLUCKINGTON BANK
ROCK LIGHT HOUSE
RIVER MERSEY
NEW BRIGHTON
EGREMONT
BIRKENHEAD
ROCK FERRY
BROMBRO'
EASTHAM
REFERENCE
FLOOD STREAM
EBB DO

AL FRAME

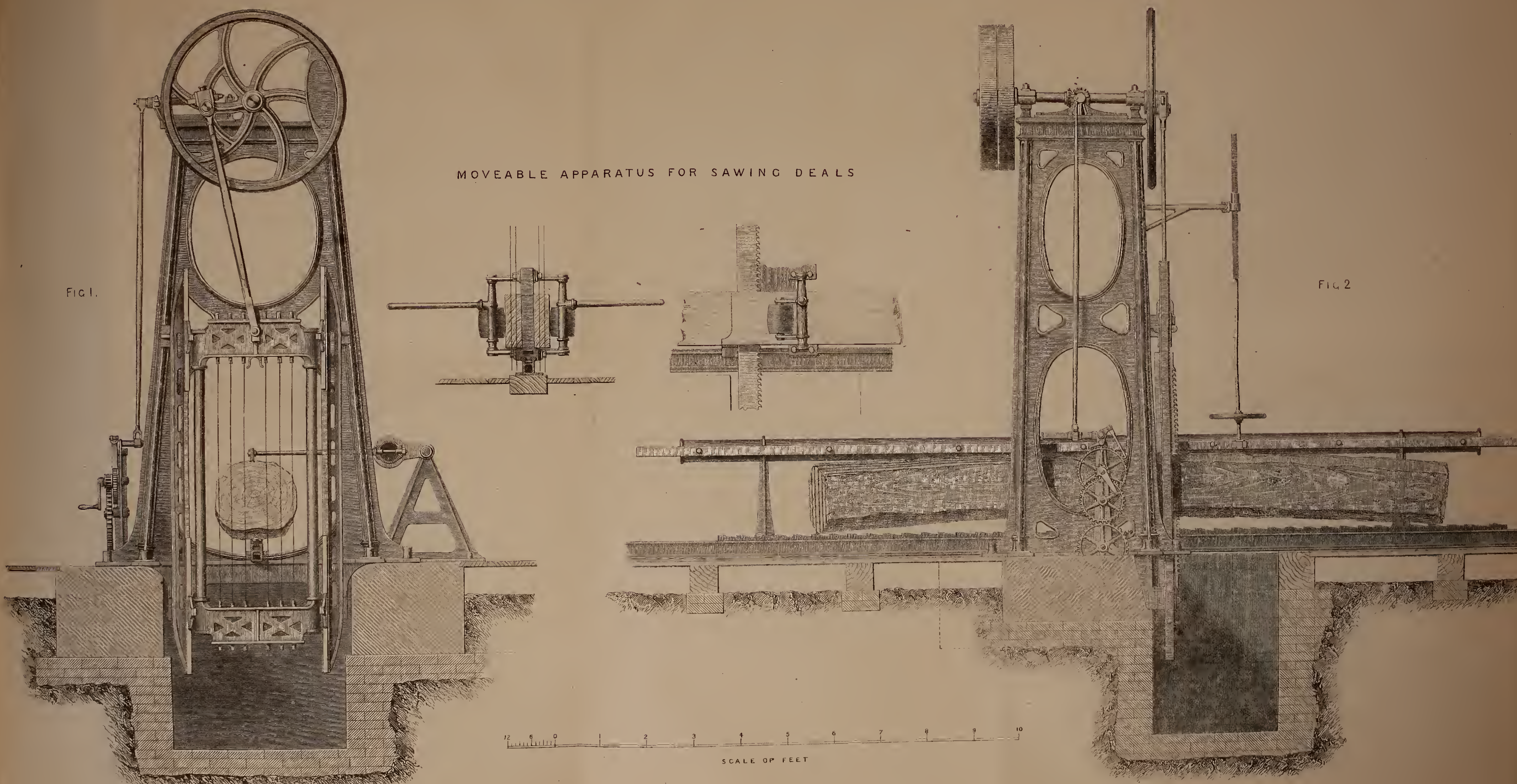
FIG 1.

FIG 2



W. Smith C.E. direx.

NORMAND'S PATENT STRAIGHT TIMBER AND DEAL FRAME



W. Smith. C.E. direx.

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MARCH 1st, 1865.

HISTORICAL AND DESCRIPTIVE SKETCH OF THE MERSEY DOCKS AND HARBOUR.

By J. J. Birckel.

(*Illustrated by Plate* 275.)

In order to give our readers as comprehensive an idea as possible of tbe nature of the ground upon which these works are sitnated, we shall now lay before them snch abstracts of a paper, " On the Geology of the Country around Liverpool," furnished us by Mr. G. H. Morton, F.G.S., as may serve to elucidate the part of the subject immediately before us, namely, the inquiry into the nature of the foundations upon which' the dock and river wall are reared, and such portions of it also as may be otherwise of interest in connection with the main subject of this work. We will, however, first give, for the information of those of our readers who may not be acquainted with geological technicalities, a brief statement of the order of succession of geological systems and formations with tbeir terminology, in order to enable them thoroughly to understand the subject matter of the paper referred to; and for tbis short digression we think it scarcely necessary to offer any apology to those who are already acquainted with geological science.

That science teaches that the matter of which this globe is composed was originally in a total state of fusion, and that solidification and condensation followed as the natural result of cooling. Deposit of sedimentary matter contained in the waters of condensation then took place, while, from time to time, tbe seething masses of the kernel disturbed the then condition of the still thin crust of the earth by upheavals and depressions, causing those breaks, in geologic language termed faults, which may be said to have been *the* great difficulty with which geologists have had to contend. At a later period, life—in its simplest form at first—showed itself, subject undoubtedly to the same general law by which it is governed at present, namely, rise, progress, and decay, while at the same time it continued to be modified in kind form, and character, by the various natural agencies at work, such as the periodical decay of organic matter itself, the continuous cooling of the surface of the globe, and the simultaneous deposit of sedimentary matter, from its waters; all these causes, let us not forget, controlled always by the directing hand of Providence, until at length man bimself appeared upon the face of the earth—a modifying agency and local providence himself—to develop its *then* hidden powers, and to enjoy the goodly fruits thereof.

It had for a long time been assnmed by geologists tbat the succession of species both in tbe animal and in the vegetable kingdom had been, in former ages, of sudden transition, and had been generally preceded and caused by some great and violent revolution upon the earth's surface; but *that* belief, which was a natural result of as yet imperfect knowledge in the perusal of the book of nature, is now gradually losing ground, and the conviction more and more obtains among students of geology that the succession of periods and of species has, from the earliest date of the earth's existence, been subject to the same law as now, and that it is only by gradual and imperceptible changes tbat tbe various transitions between periods, and the mutations in species, have taken place.

Such being the case, the reader will readily perceive that the geological division of tbe earth's crust into periods, systems, formations, and tbeir subdivisions, does not necessarily indicate a succession of absolutely disjointed periods; and that although they are severally and chiefly known, either by the absence of, or by the kind and the species of the remains of organic life that are found imbedded in them, yet are these subdivisions only established for the facility of study, and for the readier application to the practical uses of life, of the deductions drawn therefrom.

The following table exhibits, in chronological order, from the most recent downwards the succession of the formations of tbe earth's crust, with their respective approximate computed thickness, their general characteristics, and the uses to which respectively they have been put in the arts or manufactures. But, from what has previously been said, the reader will readily conceive that the series is not necessarily complete everywhere, if at all, at any single point, but, on the contrary, that certain formations may be missing in different districts, owing to the temporary and local elevation of the surface of the land beyond tbe reach of tbe primary causes of accumulation, or owing to denudation after deposit, either by tbe action of ice or of water:—

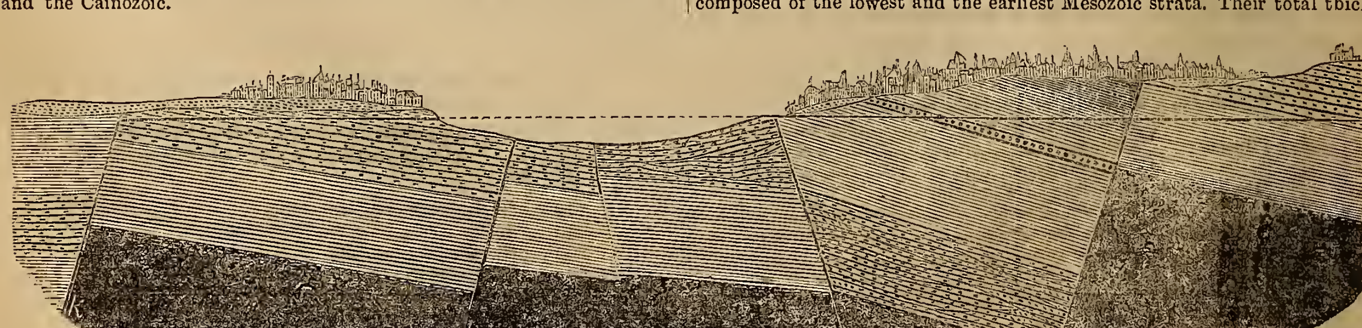
Periods.	Systems.		Formations.	Thickness. Ft.	General characteristics and uses.
Cainozoic period.			Modern deposits		Peat, shell marl for manure, brick clay.
	Pleistocene.		Drift and gravel beds, Boulder clay	100	Loam or brick earth, flint gravel, brick clay.
	Pliocene.		Mammaliferous crag	10 to 40	The phosphatic nodules of the red crag used for agricultural purposes, as superphosphate manure.
			Red crag	30	
			Coralline crag	30	
	Miocene.		Wanting in England.		
	Eocene.	Upper	Hempstead series	170	Marls, brick clay, ironstone.
			Bembridge series	110	Shelly marls, building limestone.
			Headon series	200	Glasshouse sand, do.
		Middle	Barton beds	300	Clay, septaria for cements, sands of extensive heaths.
			Bagshot series	1200	White pipeclay, alum clay.
		Lower	London clay	200 to 520	Tile clay, iron pyrites for copperas and vitriol.
			Woolwich beds	100	Coarse pottery clay, foundry sand.

Periods.	Systems.	Formations.	Thickness. Ft.	General characteristics and uses.
Mesozoic, or middle period.	Cretaceous.	Maestricht beds	110	Quarried for building.
		Upper chalk	300	Chalk for lime, flints for roads, glass, and porcelain.
		Lower chalk	400	Grey chalk for lime or hydraulic cement.
		Upper green sand	130	Building stone, fire stone for furnaces.
		Gault	100	Clay for bricks and tiles, phospbatic nodules.
		Speeton clay	130	Pottery clay.
		Lower green sand	250	Good building stone, pure fuller's earth.
	Wealden.	Weald clay	150	Tile clay, marbles used in churches.
		Hastings sands	600	Building sandstone, marls and clays.
	Purbeck.	Purbeck beds	150	Building limestone, Purbeck marbles.
	Upper oolite.	Portland rock and sand	150	Good building stone (used for St. Paul's).
		Kimmeridge clay	400	Clay for drain tiles, impure coal.
	Middle oolite.	Upper calcareous grit	40	Building stone (Headington quarries).
		Coralline oolite	30	Building stone, lime, road material.
		Lower calcareous grit	40	Rough sandy limestone.
		Oxford clay	400	Clay for bricks, septaria for cement.
		Kelloway rock	30	Calcareous and ferruginous freestone for building.
	Lower oolite.	Cornbrash	10	Coarse rubble stone, corn land, clay.
		Forest marble and Bradford clay	50	Coarse marble, roofing tiles, pottery clay.
		Great oolite	120	Bath stone.
	Lower oolite.	Stonesfield slate	9	Flaggy silicious limestone for roofing tiles.
		Fuller's earth	50 to 150	Rubble stone, fuller's earth of inferior quality.
		Inferior oolite	80 to 250	Coarse building stone, Collyweston roofing slates, ironstone.
	Lias.	Upper lias shale	50 to 300	Alum made from shale, jet, hydraulic cement.
		Marlstone and shale	30 to 200	Building stone, Yorkshire ironstone.
		Lower lias and bone bed	100 to 300	Clay for bricks, blue lias limestone for hydraulic cement.
	Triassic, or new red sandstone.	Keuper	550 to 800	Useful building stone, salt, gypsum.
		Mushelkalk (absent in England)	— —	
		Bunter	600 to 1150	Good building stone: the soil of this system is generally very fertile.
Paleozoic, or ancient period.	Permian.	Red sand and marl	50	Good and durable building stone.
		Magnesian limestone	300	Lime for agricultural purposes.
		Marl slate	60	Calcareous slate, sometimes bituminous.
		Lower red sandstone	200	Useful building and paving stone.
	Carboniferous.	Coal measures	3000 to 12,000	Great sources of coal, iron ore, fire-clay.
		Millstone grit	600	Building stones, millstones, grindstones, ironstones.
		Mountain limestone	500 to 1400	Black and coloured marbles, building stones, iron and lead ores.
		Limestone shales	1000	Black band of Scotland.
	Devonian, or old red sandstone.	Upper Devonian	3000	Building and paving materials, rich fertile soil.
		Middle Devonian	to	Caithness flags and paving stones.
		Lower Devonian and tilestone	8000	Roofing slates, limestone and marble.
	Silurian.	Ludlow rocks	2000	Building materials, layers of soapy clay used as fuller's earth.
		Wenlock rocks	1800	Building stone, flux for iron smelting.
		Woolhope series	3050	Clays, argillaceous limestone burnt for manure.
		Llandovery rocks	2000	Argillaceous sandstones, shales (of little use).
		Caradoc and Bala rocks	8000	Good building stones and roofing slates.
		Llandeilo rocks	5000	Road materials, limestones for burning.
		Lingula flags	4000	Flagstones and trap rocks for road stones.
	Cambrian	Longmynd and Cambrian rocks	20,000	Roofing slates, slabs for cisterns.
Hypozoic or Metamorphic.		Clay slate, mica schists		Roofing slates.
		Gneiss, quartz rock		Lead ore, copper veins.
		Granite, syenite, porphyry, basalt, lava, pumice		Bridges and hydraulic architecture.

With these prefatory remarks, we will now proceed with our subject, reminding our readers that we quote freely from Mr. Morton's pamphlet.

The section, Fig. 1, exhibits the position of the strata of the valley of the Mersey from Bidston Hill, in Cheshire, to Edge Hill, on the Liverpool side; and the vertical section, Fig. 2, exhibits the whole of the strata known to be developed in the district, and shows that they belong to each of the three great periods of the earth's history, viz., the Paleozoic, the Mesozoic, and the Cainozoic.

The local strata, however, represent a small portion only of each of these eras, though the rocks which they furnish are of a very distinct lithological character. The lowest strata constitute the coal formation or coal measures forming the upper part of the carboniferous system, and belong to the Paleozoic period; they are computed here at a thickness of about 4,800ft. The Trias is the next system in ascending order, and is divided into two distinct formations, the Bunter and the Keuper, the former being composed of the lowest and the earliest Mesozoic strata. Their total thick-



BIRKENHEAD. FIG. 1. LIVERPOOL EDGE HILL.

ness here is computed at about 1,700ft. The Cainozoic period furnishes the Pleistocene formation composed of the superficial sand and clay covering the old and more solid rocks; its average thickness is about 100ft.

The three subdivisions of the coal measures in the vertical section, Fig. 2, are the result of observations in the immediate vicinity of Prescot, chiefly by the Government Geological Surveyor, Edward Hull, Esq., B.A., F.G.S. This arrangement is common to the whole of the Lancashire coal-field, which has, no doubt, been formed or deposited at the same time and under the same circumstances as other coal-fields. The upthrow of the underlying mountain limestone and millstone grit, with subsequent denudation, has often separated the wide-spread superior strata into more limited areas, while the overlying Trias has often obscured the continuation of the vast deposit of carboniferous rocks.

The lower coal measures, also called the *Gannister series*—a provincial term, alluding to the hard, silicious beds which often form the floor of the coals—constitute the lowest strata in the district; and the deepest stratum can be seen in Knowsley Park, in the Stand quarry, the highest ground about Liverpool (being 318ft. above the sea), where the section exposed is a series of grayish grits resting upon black shales. Rather higher in the strata, near Flag Delph, a bed of coal crops out, and was worked nearly one hundred years ago. It is singular that traces of iron smelting should occur at the same place.

The middle coal measures commence above the Huyton sandstone, and consist of many alterations of strata, which may be co-ordinated with other parts of the coal-field by means of the workable coal-seams. The strata are composed of yellow, grey, and red sandstones, shales, generally grey or black, and numerous beds of coal, the latter resting in every case on a layer of clay containing *stigmaria.*

Of the upper coal measures very little is known. The subdivision, however, consists of all the strata between the Felcroft or Lyon's Delf coal, and the Permian, or Trias. It cannot be seen along the line of section (Fig. 1), but it is well developed, and open for investigation to the south of St. Helen's, near Sutton Station, and partially at Whiston, where there is a small area thrown up with a bed of limestone 4ft. thick. The strata consist of peculiar red and mottled marls, with grey and brown sandstones, shales, and thin partings of coal, and constitute the highest carboniferous rocks in the neighbourhood.

The Permian system, which usually overlies the coal measures, does not occur in any sections nearer than Sutton and Wigan; so that there are no means of ascertaining whether it is present between the Carboniferous and Triassic strata around Liverpool without actual borings. There is, however, a small patch of coal measures in *Croxteth Park*, about two and a half miles long by half a mile broad, which is thrown up by a considerable fault running from S.S.E. to N.N.W. in the longest direction of the area. This section cannot now be seen, having been covered up; but the fact is of importance, for the Trias there rests upon the coal measures, without any appearance of Permian strata. Coal was obtained many years ago in lower beds in that area, a little to the west; but the drift everywhere covers the strata from view. The nearest places where the Permian strata have been discovered are near St. Helen's, where the deep shaft of Edge Green Colliery passes through 182ft. of Permian sandstone and marls; also at Bispham and at Sutton, where similar strata of about the same thickness have been observed; and as no evidence of such rocks occurs near, or within the district under consideration, their absence is very probable. Considering, also, that the nearest overlap of the coal measures at *Croxteth* is by the Trias, without any appearance of the Permian, the latter has not been introduced into any of the sections, though it is quite possible that it may be present over a considerable extent of the coal strata, and have been denuded about *Croxteth* before the deposition of the Trias.

The next system in ascending order is the Trias, which is very fully developed in this neighbourhood. It is so-called from its threefold division in the typical district of Germany, where it is most fully developed. These three divisions or formations are the Keuper, the Mushelkalk, and the Bunter—the middle one being absent in the British Isles. The Keuper admits of subdivision into two and the Bunter into three parts, which each possesses such distinct lithological characters as will identify them over the whole area of the Triassic strata. These subdivisions are adopted in the Government geological survey, and may be tabulated as follows:—

			Thickness near Liverpool.
Trias.	Keuper.	Red marl	100 feet.
		Keuper sandstone	450 „
	Bunter.	Upper soft red and variegated sandstone	400 „
		Pebble beds	350 „
		Lower soft red and variegated sandstone	400 „
		Total	1700 feet.

The lower soft red and variegated sandstone, usually of a bright red colour with streaks of white, is generally very soft, but the strata vary considerably, and occasionally become tolerably hard. The pebble beds consist of coarse hard brown or dull red sandstone, divided at irregular intervals by layers, a few inches thick, of clay and whitish shale, and containing numerous pebbles and fragments of clay. The upper soft red and variegated sandstone is a very friable deposit of a similar lithological character to the lower soft red previously described. The upper beds are yellow, those immediately beneath a uniform red, while lower down the colour is varied by streaks and patches of white sandstone. These three subdivisions occur all along the line of section, Fig. 1, the faults running generally from north to south, and the dip of the strata being from west to east. The lowest of them may be seen in Toxteth Park, east of Sefton-street, cropping out from underneath the pebble beds (see Fig. 3), and

FIG. 3.—Section showing the Lower Soft Red and Variegated Sandstone at Toxteth Park

the southernmost docks may be said to have been quarried into this series, the stone furnished by them having there been used to a considerable extent as backing for the walls. The upper subdivision of the series also is visible on the Cheshire side of the river at Wallasey, and on the west side of Flaybrick, Bidston, and Oxton hills. The stone is extensively quarried at Flaybrick, both for the use of the building trade and for the dockworks at Birkenhead, which generally rest upon that subdivision of rocks. The strata there, however, seem to have suffered most singular disturbance anterior to the deposit of the Boulder clay by which they are covered; for whereas the northern river entrances to the great float rest entirely upon rock, and to a considerable extent are cut out of it, while the south wall of the *low water basin*, distant only some 800ft. from them, rests entirely upon piles—the rock having neither been reached by trial borings nor by the piles, although their lowest point must be at a depth of 70ft. below high water mark nearly—yet about a quarter of a mile to the southward of that wall, and almost in a right line from it, there is a very productive quarry, worked by the Dock authorities or by their contractors, and yielding a very good stone, which has been variously used on those works.

In the Keuper formation, the upper subdivision, or the red marl, is the repository of the rock salt in Cheshire and Worcestershire, and the lower subdivision forms the underlying strata in each of those counties. The Keuper sandstone in the neighbourhood of Liverpool consists of a series of white, yellow, and red sandstones, divided at irregular intervals by beds of shale and clay from an inch to many feet thick. The base of the formation is a conglomerate containing quartz pebbles and fragments of clay in a light matrix. About the centre of the series there is a band 50ft. thick of brown and grey flagstones, alternating with red and grey shales and beds of clay. The highest strata of the subdivision present exactly the same lithological characters as this middle shale band, until succeeded by the overlying red marl series. The section, Fig. 4, shows the order of succession of the prominent zones of the Keuper in Liverpool, their thickness, and portions absent in consequence of denudation or unknown from being too deep for observation. The base of the formation is well exposed just inside the railway tunnel in Lime-street Station.

The grey and yellow sandstones, interstratified with shaly clay, present some resemblance to the usual strata of the coal measures, though the entire absence of the black shale is a very important difference. It is no doubt from these similar lithological characters that many practical miners, some who ignore geology, have asserted that coal would be found by boring in the Keuper beds. Such opinions have caused money to be thrown away in hopeless searches at Waterloo and at several places in Wirral. There is little doubt that coal might and will hereafter be obtained from beneath the Trias in this neighbourhood, but it must be by boring through the lowest strata, and not by trials in the highest beds far above all chance of success.

The superficial accumulations of clay and sand which cover the older and more solid rocks belong to the Pleistocene era, and are of very recent origin, compared to the more consolidated strata, previously described. This formation is usually divided into pre-glacial and post-glacial deposits, but near Liverpool it is found that there are no true pre-glacial strata represented, and that the series may be divided into these two subdivisions, namely, the glacial and the post-glacial. Before, however, proceeding to describe these deposits it may not be uninteresting to mention that the denudation of the Triassic rocks by the action of icebergs floating in the glacial sea, as indicated by the polished, worn, and striated appearance of the bared rock, has been fully established in two distinct localities, namely, in Toxteth Park, near the Dingle, and near the New Road, Kirkdale, where fully 500 square yards of it are exposed.

The glacial deposits can be seen to advantage on both sides of the Mersey, and may be divided into three distinctly marked subdivisions, as follows:—

Upper drift sand	Strata of yellow sand.
Boulder clay	Unstratified reddish brown clay, with boulders.
Lower drift sand	Strata of yellow drift sand and gravel.

The greatest thickness of the whole is about 100ft. The lower drift sand seems almost always beneath the Boulder clay, where the latter is of any considerable thickness, and on the shore, to the south of the Dingle, this subdivision composes the lower half of the cliffs bounding the river. The same order may be seen near Egremont, on the Cheshire shore, and it may be regarded as extending over the whole district. Nests or patches of gravel are distributed through the sandy strata, frequently containing fragments of shells; and general observations lead to the conclusion that its thickness is equal to that of the Boulder clay above.

The Boulder clay, extensively used for brickmaking, is remarkably uniform in its character throughout the neighbourhood. It is a dark reddish brown stiff clay, seldom if ever exhibiting any traces of stratification, and always containing numerous pebbles and boulders, which are composed of igneous and aqueous Paleozoic rocks, varying in size from that of a pea to immense blocks 6ft. in diameter. The Boulder clay seldom exhibits indications of having been deposited in shallow water, but the data we possess for assuming a general depression of the British Islands, and more particularly of places near this part of the country, tend to favour the idea of its having been formed in deep water. The numerous oulders and stones embedded in the clay embrace a considerable variety, onsisting of quartz, granite, syenite, porphyry, greenstone, basalt, and others, and their primary character indicates, as might have been expected, a northern origin.

The upper drift sand reposes upon the Boulder clay, and is a deposit of stratified sand without shells or pebbles, but is of very limited extent, and uite local.

Respecting the post glacial deposits, it may be said that the elevated ridges of sandstone which traverse the district from north to south are generally uncovered by drift, while the depth of the intervening valleys has been diminished by thick accumulations, such as have been described. The river Mersey occupies what was once the deepest of these valleys; and though there have been promontories of rocks at the Dingle, New Brighton, and Eastham, these have never extended to any great distance; and an examination of the shores shows the position of the rocks to be naturally low. In most places the land slopes gradually towards the water, and leads to the conclusion that a wide low valley existed there ever since its elevation at the end of the glacial epoch. The sections and strata about to be described tend to prove, firstly, that a subsidence of about 50ft. has taken place; secondly, that there are *several* successive old forest or land surfaces with beds of silt between them; and, thirdly, that the oldest of these submarine forest beds overlies the Boulder clay.

Along the coast, from Crosby to Liverpool, there are indications of the peat or forest bed which is well known to exist there, and to be covered by drift sand. On entering the valley of the Mersey it dips considerably, and is 35ft. below the high water mark of an ordinary spring tide, as is shown by the section, Fig. 5, which was opened in 1847 during the construction of the North Docks, near Bootle; the section discloses a bed of peat, with the trunks of trees, hazel nuts, and other vegetable remains, resting on the sandstone rock, and covered by a considerable thickness of recent clay and sand. In the year 1829, in excavating below the site of the Old Dock, previous to the erection of the Custom-house, an arrangement of strata as shown in Fig. 6 was disclosed at that place, showing two successive forest beds, the lowest of which rests upon the sandstone rock 40ft. below high water mark.

In 1858, an opportunity was afforded of examining strata of the same kind on the Cheshire side of the Mersey, where evidence of subsidence was again very clearly visible. The section, Fig. 7, is taken from across the mouth of Wallasey Pool, which occupies an ancient valley, the bottom and sloping sides of which have been covered with trees. The valley afterwards became filled with water, and a deposit of mud formed over the bed of the Pool, 10ft. thick in the middle, gradually thinning off at the sides; the trees had grown in the bed immediately above the Boulder clay, their roots and two or three feet of their trunks remaining *in situ*, until torn up by the excavators in the year before mentioned. The following sections of the submarine forest beds at Leasowe are not only of considerable interest, but they may be examined at the present time, for they are well exposed, and there is no difficulty in visiting them. The section, Fig. 8, is parallel with the sea coast from Leasowe Lighthouse to the south-west beyond Dove Point, a distance of nearly a mile and a half. The other two sections, Figs. 9 and 10, cross each end of the former, and are drawn upon a larger scale. This part of the coast is very interesting, from its strong resemblance to the strata of the coal measures. The old land surfaces are one over another, with a vegetable growth indicating pauses in the subsidence, and each covered by accumulations of silt deposited during the gradual sinking of the land. The lowest submarine forest bed at this place is 8ft. below the level of an ordinary spring tide. The following is a description of these sections:—

K, Leasowe Lighthouse.
J, Embankment.
i, Dove Point land mark
h, Hills of blown sand
g, Sandy earth with recent shells, 2ft.
f, Peat bed, 1ft.
e, Blue silt, 1ft.
d, Submarine forest bed, with portions of trees *in situ*, 3ft.
c, Blue silt traversed with vegetable fibre, 2ft. 6in.
b, Submarine land surface, with a few remains of trees, 1ft.
a, Boulder clay.

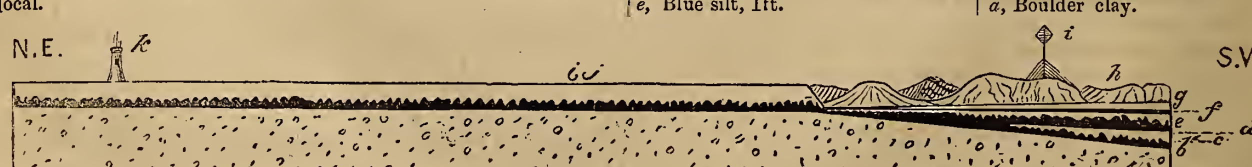


Fig. 8.—Sections along the Cheshire Coast from the Lighthouse, Dove Point, Leasowe.

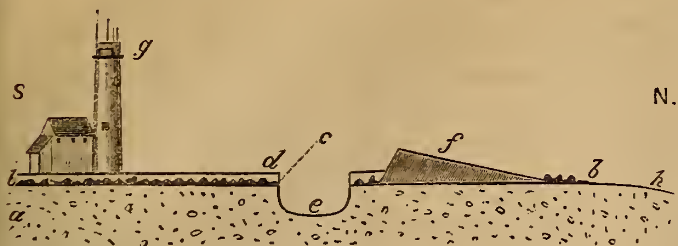


FIG. 9.—At Leasowe Lighthouse.

h, Sea shore covered at high water.
g, Leasowe Lighthouse.
f, Embankment.
e, Old clay pit.
d, Present surface of the land, 1ft.
c, Drift sand, 2ft.
b, Submarine forest bed, 2ft.
a, Boulder clay.

In Fig. 10, *j* is the sea shore, and in all other respects the description of the section corresponds with that of Fig. 8.

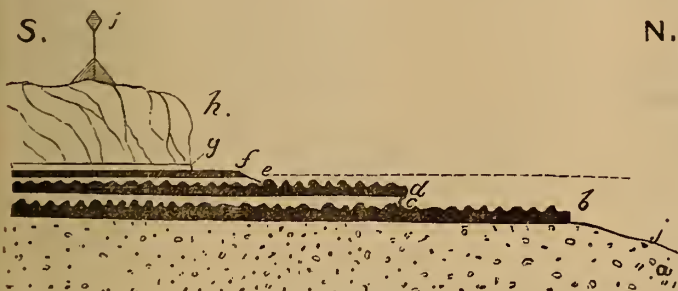


FIG. 10.—At Dove Point.

Approaching the embankment from Dove Point, the lower old forest beds gradually amalgamate, and then both are represented by one carboniferous bed, the three feet of silt between having thinned out until lost. The surface of the Boulder clay, upon which the lowest bed rests, at Dove Point, shows signs of gradual subsidence, which caused an eruption of the sea over the low-lying land which then silted up the hollow; and a new forest of more vigorous growth succeeded, which, in its turn, was also destroyed. On this old land surface, but not below it, have been found implements, ornaments, and coins of Roman, Saxon, and early English manufacture. Another bed of silt (a bluish mud) next occurs; then a bed of peat, which shows clear evidence of its having been subject to inundations.

These sections indicate a subsidence of nearly 50ft. over the whole district; for when the old land surface beneath the Custom-house was covered with vegetation, it must have been sufficiently above the sea level to afford the necessary sea drainage for the growth of trees. Whatever the precise amount of the depression in the district under review, there can be little doubt that it was uniform over its whole extent. The difference in the depth of submersion indicated in the several sections merely shows that the land was of a rounded, uneven surface, like that still above the sea. The lowest parts would be covered by water first, so that when the old forest bed of the valley of the Mersey was submerged, the higher land of Leasowe must have been 32ft. above the level of the sea. The most important of these changes—the origin of the estuary of the Mersey by the cruption of the sea, in consequence of the subsidence of the land—occurred probably before the occupation of Britain by the Romans. The subsidence of the old forest beds of Leasowe, Dove Point, and Formby was, no doubt, of much more recent date, certainly within the Historic period.

From the above inquiry into the nature and position of the strata in the valley of the Mersey and the neighbouring district, it must at once be perceived that the engineers of these works have, in preparing their foundations, had to grapple with the difficulty of working upon entirely uncertain ground, a difficulty which they must have felt, especially in making out their estimates. In the subjoined table we give the precise nature of the foundations of the greater number of the docks and portions of the river wall corresponding to them, and we also affix the actual cost of some of them. The sketches, Figs. 11 and 12, illustrate the systems of piling

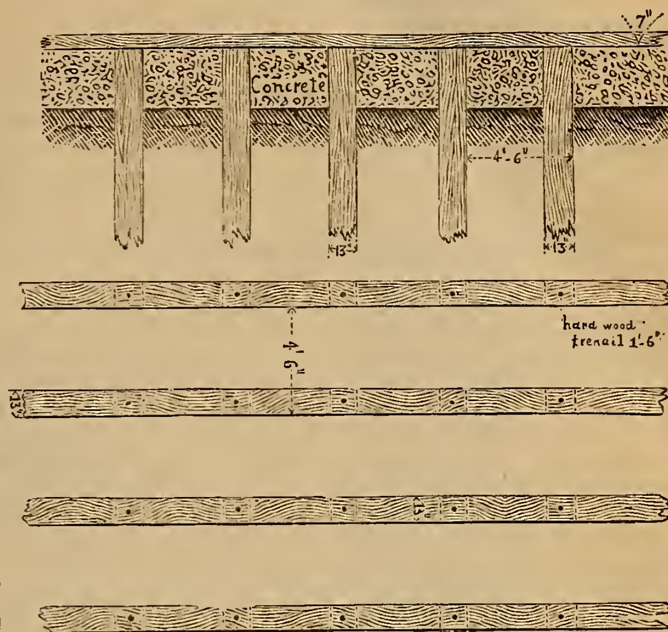


FIG. 11.

as adopted on these works: in places where the ground is very bad, the tops of the piles are bound together by timbers both lengthways and crossways; but where it is more coherent the timbers run lengthways only, and in each case a bed of concrete, about 3ft. thick, is laid between the piles to provide a monolythic bearing to the footings of the walls. The piles have been variously driven by manual labour, by horse, and by Nasmith's machine; the average cost of driving is 7*d.* per foot, to which must be added the price of the timber for the whole cost of piling. The cost of the concrete is about 8*s.* per cubic yard, and the cost of excavations varies from 6*d.* to 2*s.* 6*d.* per cubic yard, according to the distance to which the material has to be carted.

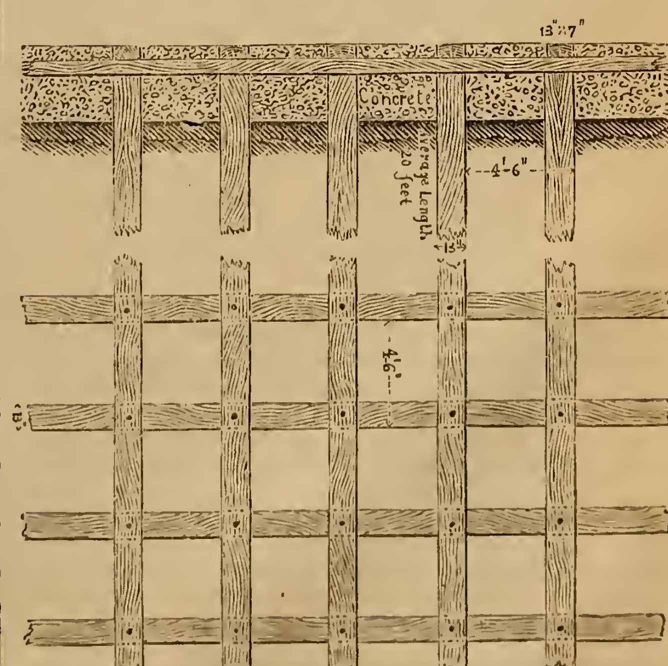


FIG. 12.

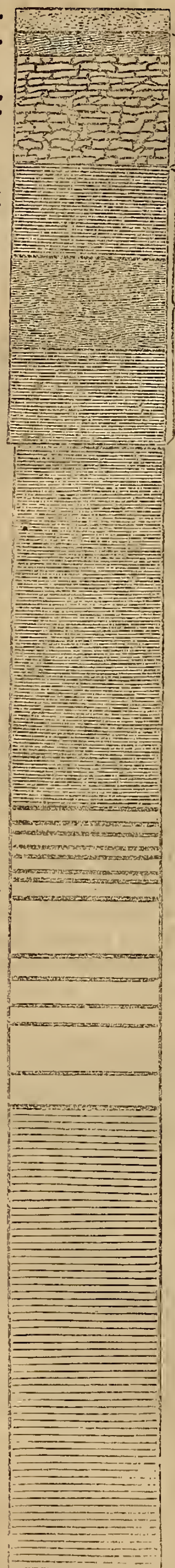


FIG 2.—Vertical Section of the Strata around Liverpool. By G. H. Morton, F.G.S.

THICKNESS:—*Trias, 1,700ft.; Coal Measures, 4,800ft. Total, 6,500ft.*

SCALE—$\frac{1}{8}$*in. to every hundred feet.*

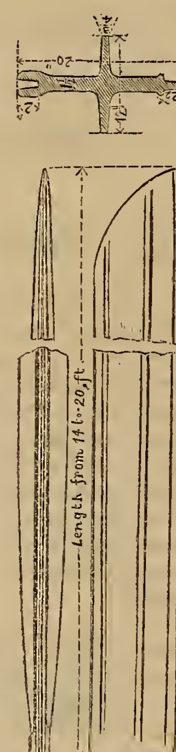


FIG. 13.

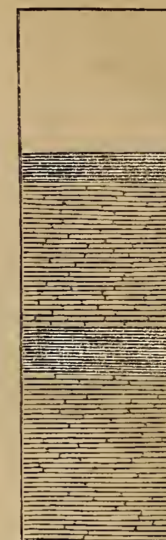


FIG. 4.—Vertical Section of the Strata of the Keuper Formation in Liverpool. The unshaded portion indicates the Strata being denuded or unknown in Liverpool.

SCALE—1*in. to every* 100*ft.* THICKNESS—550*ft.*

FIG. 5.—Section through Strata of North Docks.

FIG. 6.—Section through Strata of old Dock filled up in 1826—30.

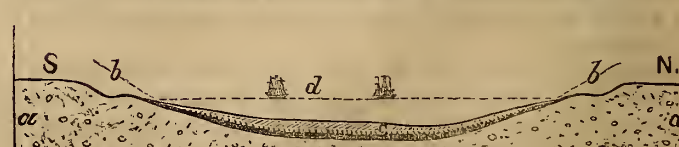


FIG. 7.—Section across Wallasey Pool, showing the Submarine Forest Bed.

d Water......................... 19 feet.
c Blue Silt, with Mammalian Remains .... 10 „
b Submarine Forest-bed.
a Boulder Clay.

Fig. 13 illustrates the cast iron piles generally used for sheet piling where the sea has to be dammed off for the construction of works facing the river, which cannot be done by tide work. These piles are almost invariably drawn again when the dam is removed.

TABLE DESCRIBING THE NATURE OF THE FOUNDATIONS OF THE VARIOUS DOCKS.

Name of Dock.	Foundation.	Cost. £	s.	Observations.
LIVERPOOL :—				
River wall, North Extension	Marl.	...		...
Carriers' Docks	Rock.	...		...
Canada Basin and Dock	Clay.	...		...
100ft. Lock	Piles.	...		...
Huskisson Dock	Clay.	235,577	3	Exclusive of land.
Sandon Dock and Graving Docks	Do.	1,104,910	3	With river wall.
Wellington Dock	Do.			
Bramley Moor Dock	Part rock.			
Nelson Dock	Do.			
Stanley Dock	Rock.			
Collingwood Dock	Do.			
Salisbury Dock	Do.			
Clarence Dock and Graving Docks	Part rock, p't drift sand	684,669	10	Do.
Trafalgar Dock	Do.			
Victoria Dock	Rock.			
Waterloo Dock and Half-tide	Do.			
Prince's Dock	Do.	...		...
Prince's River Wall	Piles.			
George's Dock and Basin ...	Part rock, p'rt marl, river entrances on piles	79,986	4	Enlarging and reconstructing.
Canning Dock East Wall ...	Rock.	65,183	18	...
Canning Dock Graving Docks	Piles in quicksand.			
Albert Dock & Warehouses East Side ...	Rock.	514,475	8	With warehouses whose area is 21,390 sq.yds.; No. of piles (beech), 13,792.
Albert Dock & Warehouses West Side ...	Piles.			
Albert Dock & Warehouses River Wall...	Do.			
Salthouse Dock	Rock.	45,838	19	Deepening & rebuilding.
Wapping Dock	Do.	557,000	0	Parl'mentary estimate.
King's Dock	Do.	25,734	4	Deepening & altering.
Queen's Dock	Do.	...		...
Coburg Dock	Do.	55,524	6	Alterations.
Brunswick Dock ... East Side and Graving Docks,	Do.	...		...
Brunswick Dock ... West Side......	Piles in drift sand	341,799	18	...
Toxteth Dock	Rock.	39,717	0	...
Harrington Dock	Do.	...		...
South Graving Docks	Do.	...		...
BIRKENHEAD :—				
Morpeth and Egerton Docks	Rock.	...		...
Low Water Basin	Piles in silt.	...		Parl'mentary estimate, including enlargement of Morp'th D'k; expenditure likely to be exceeded.
Northern Entrances	Rock.	...		
Intermediate Dock	Do.	...		
Inner Entrances	Do.	1,750,000	0	
Great Float	Part piles, part clay.	...		
Lock and Sluices	Piles in silt.	...		
100ft. Passage	Do.	...		
Graving Docks	Part clay, part silt.	...		...

In Plate No. 275 we now give the river surveys by Captain Denham and Lieutenant Lord, R.N., alluded to in our Paper of January, 1865, to which we refer our readers again, as also to that of November, 1864. By the aid of these, and by a comparison of the several surveys now published, our readers will be enabled to follow the gradual changes which have taken place in the upper estuary since 1836.

(*To be continued.*)

NORMAND'S PATENT STRAIGHT TIMBER AND DEAL FRAME

(*Illustrated by Plate* 276.)

This Plate is one of a series we purpose giving, illustrating the machinery invented and manufactured by Messrs. Normand, of Havre, for sawing straight and curved timbers. We defer giving the descriptive particulars relating to the several views in the accompanying Plate, until the appearance in an early issue of the varieties of Messrs. Normand's machines adapted for sawing curved, ship, and other timbers.

DESCRIPTION OF AN ARRANGEMENT FOR ADJUSTING A CLOCK TO WITHIN A SMALL FRACTION OF A SECOND.

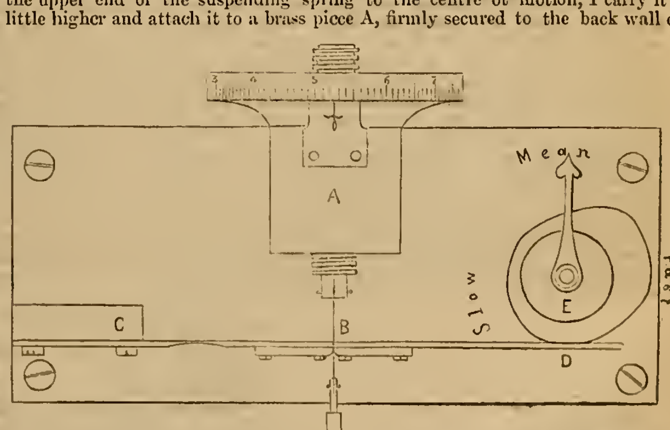
BY EDWARD SANG, C.E., F.R.S.E.*

If a time-keeper be half an hour fast or slow, we put it right by taking hold of the index and turning it back or forwards as far as is needed. Seeing, then, that it is quite easy to correct an error of half an hour, and that every hour consists of thirty-six hundred seconds, it must, by the rule of three, be thirty-six hundred times easier to correct an error of half a second. On trying, we find it to be a very different affair, and discover that we should have used inverse instead of direct proportion. Even an error of half a minute is not quite readily corrected, because we must keep the minute in accord with the seconds hand. For this adjustment we stop the clock, set the indices a little forward, and set the clock agoing again at the proper instant. But when we have to correct an error of two or three tenth parts of a second, the difficulty becomes considerable; yet this is a correction which has frequently to be made.

The principal clock of an observatory is generally regulated to show sidereal time, and is touched as little as possible; its error is allowed to accumulate, because we can much more easily interpolate or compute its error in advance when it is left to itself, than if we were to put it forward so many seconds one day and so many another.

But with a clock which is to show true time, the case is very different; no matter how small its error may be, if we know the amount of that error we must endeavour to correct it, and this more particularly in those clocks which are employed to control others by means of induced magnetism. Now we experience no difficulty in constructing and regulating a clock to keep time within one second per day; and hence, practically, the problem is to adjust the beat to within a fraction of a second. In the case of controlling clocks, it is also essential to make the alteration so gradually as to avoid throwing the controlled clocks out of time.

The arrangement which I have to describe is very simple. Instead of fixing the upper end of the suspending spring to the centre of motion, I carry it a little higher and attach it to a brass piece A, firmly secured to the back wall of



the clock case; the spring being previously passed through an adjustable slit B, in a steel lever C D. The end C of this lever is screwed firmly to a brass stud at C, while the end D presses against the edge of a cam E; to the axis of which an index is attached. The periphery of this cam consists of three circular arcs of equidifferent radii, with short intermediate slopes, so that, on turning the cam round, the end D of the lever has three distinct positions, corresponding to the indications *mean rate*, *gaining*, *losing*.

In order to avoid the risk of any shake, the lever is not jointed at C, but is made flexible, yet left sufficiently strong to resist the horizontal pressure of the suspending spring.

When the index is directed to the words *mean rate*, the spring presses upon the intermediate of the three circular arcs, and we then regulate the pendulum to mean time. If after this is done the index be turned to the word *gaining*, the spring at D is lowered by the difference between the two radii, and consequently the slit B is lower proportionally. By this means the effective length of the pendulum is lessened and the clock gains upon its mean rate, while, if the index be turned to the word *losing*, the pendulum is lengthened and the clock goes more slowly.

* Read before the Royal Scottish Society of Arts, and awarded the Makdougall Brisbane Biennial Prize, value ten sovereigns.

By properly proportioning the difference between the radii and the distances C B, C D, we can cause a gain or loss in any prescribed time; in the pendulum exhibited the change is one second in forty minutes.

Suppose now that the clock has been compared with the sidereal clock, and found to be thirteen-hundredths of a second fast, we turn the index to *losing*, allow it to remain there for five minutes twelve seconds, and then replace it at *mean rate:* by this operation the clock is put back to true time. An analogous operation enables us to set it forward.

Such being the general arrangement and action, it may be proper to point out some details for insuring precision and comfort in the use of the apparatus. The first of these is, that the spring rests upon arcs which have been carefully made concentric with the axis of the cam, in order that it may not be requisite to set the index accurately to any point, a range of even sixty degrees producing no change upon the position of the lever. The second is, that we are enabled, by attaching the upper end of the pendulum spring to a movable piece, to regulate the mean rate of the clock without stopping it; the movable piece is, in the specimen exhibited, guided by a screwed nut with divided head; each division corresponding to a change of four-tenths of a second in the daily rate.

DESCRIPTION OF A READY MODE OF MEASURING THE DISTANCE OF A SHIP FROM A LANDMARK OR HEADLAND WHILE NAVIGATING ALONG A LEE SHORE.

By Richard Adie, F.R.S.S.A., Liverpool.*

The danger to human life and property from the miscalculation of the distance of a ship from the land was forcibly illustrated in the recent inquiry, at the instance of the Board of Trade, into the loss of the ship *Desert Flower.* In this case the officers were at their posts, the land was plainly seen, but the distance was so much over-estimated, that the result was the loss of the ship. And in the more recent wreck of the steamer *Bohemian,* on the North American coast, the accounts of that disaster, in so far as they have reached this side of the Atlantic, ascribe the loss to a similar cause. Sea-faring men, on long voyages, from their rapid changes of latitude, are called on to judge of distances under trying circumstances, unknown to landsmen residing on shore. They may have been navigating the Indian seas, where they had to estimate distances under a tropical atmosphere; on their return voyage to Britain they may, as the modern practice often is, never see land until they make the English or Irish coast, when they are called on to judge of the number of miles distant in a less transparent atmosphere. The tendency of their Indian experience will be to make them commit the dangerous error of over-estimating, as in the case of the *Desert Flower.* These considerations have induced me to offer, through the medium of your Society, a description of a ready mode of obtaining the distance of a ship in motion from a headland, landmark, or lighthouse.

The great length of modern sea-going vessels favours the adoption of a base line laid down on board the ship, which should in all cases be of a fixed length for each vessel. I propose to have a base line beginning in the vicinity of the steering wheel to run forward in the direction of the bowsprit head. The length of line available for a base must be regulated by the size of the ship and the convenience of the sites selected for obtaining observations therefrom; but it ought never to be shorter than 100ft., while in many cases nearly double this length may be used. From the two extremities of this base, the cap, or highest fixed point of the bowsprit, or some other fixed object in the vessel, as far ahead as possible, must be visible, and is used as one of the objects to be observed, while the other object is the headland whose distance is sought. Two observers, with quadrants in their hands, are now to take their places at either end of the base line, and on a signal being made by one of them, or by a third party counting numbers aloud, they are at the same moment of time to observe the angle which the object previously selected on shore makes with the fixed object determined on at the head of the ship.

Let A B represent the base line on board the ship of say 100ft.

C the position of bowsprit head or other fixed object.

D the land mark.

When the angles C A D and C B D are read at the same second of time, their difference will truly tell the distance of the ship from D. The exact distance cannot be got at without a trigonometrical calculation, or by the inspection of an elaborate set of tables constructed for the purpose. This would be out of place at a time the ship's officers should be on deck, neither can I think that such minuteness would be required. The first step would be for the officers to educate themselves to the use of their base, and try the measurements on objects at various distances likely to be met with in practice; from these they would obtain a series of differences of the angles at A and B, which would guide them correctly to judge of the distance, while the experience they would thus acquire would tend to give them confidence in the use of the method. I tried a measurement of this kind on an esplanade on the Mersey with a 100ft. base and a ship in the stream; the angle C B D read 40° 40′, and the angle C A D 39° 30′, difference 1° 10′, indicating, for the purposes of navigation, a very near object. After a little practice, I believe that all that the officer in command would want would be to hear the value of the first angle called over to him, and the number of minutes it differed from the second, in the same way that the fathoms and half fathoms are now given him by the man casting the lead. When the number of minutes approached to 60, the object would be dangerously near; but if they were reported to be one-third, or a quarter of that amount, then the distance from the landmark would be known to be safe.

The accuracy of this method of obtaining a distance while the ship is steaming or sailing depends on two things:—First, the reading oft the angles at A and B, to which the junior officers of a ship are usually well trained. Second, to reading them by signal at the same second of time. The importance of this condition will at once be seen, when it is considered that the point A arrives at the place B has occupied in five or ten seconds of time, depending on the length of the base line and speed of the ship.

I submit the above mode of measuring distances from on shipboard as one of facile application, and which requires only what is already to be found in every sea-going vessel. Of its value, the trial by various hands must be the ultimate guide for coming to a correct conclusion.

I have proposed above a single base line for each ship, commencing near the steering wheel, but it will be evident that in many cases a twin base line of equal length on larboard and starboard side would be useful to measure distances on opposite sides.

* Read before the Royal Scottish Society of Arts.

ON THE ELEMENTS OF PHYSICAL WORK, VIS-VIVA, FORCE, VELOCITY, TIME, POWER, AND WORK.*

By John W. Nystrom.

The difference between *force, power,* and *work,* appears to be not very generally understood, as we often find the power employed and the work accomplished, confounded with each other, and that even by men of science, experience, and high standing; such as in the case of a steam hammer being said to "strike a blow of so many tons," which is substantially parallel with saying that a bushel can be so many feet in length. Professor Tyndall speaks of heat as if it was only motion, and he also converts heat into work. If motion can be converted into heat, and heat into work, then work must be convertible into motion; which is substantially the same as to convert gallons into square feet or linear inches.

Although the physical constitution of heat is not yet known, one thing appears to be certain, namely, that heat, like work, is a function of at least three simple elements, of which velocity (motion) is one.

The heat question will be referred to at the end of the article, in the development of our subject.

In geometry we have three fundamental elements, expressed by the terms, *length, breadth,* and *thickness,* employed to represent to our mind the nature of those several properties of space; we have in like manner in physics, three fundamental elements, expressed by the terms *force, velocity,* and *time,* employed to convey to us the laws of physical work.

Quantity is that which can be increased or diminished by homogeneous parts.

Element is that which cannot be dissolved into two or more different quantities.

Function is the product of two or more different elements.

Force, velocity, and *time* are elements.

Power, space, and *work* are functions.

Force is the first element of work, like length in geometry. It is recognised as pressure, and measured by weight. Physical forces will herein be denoted by the letter F, and the weight of a mass or body by M.

Velocity is the second element of work, like breadth in geometry. It is the continuous change of position, recognised as motion, as denoted by the letter V.

Time is the third element of work, like thickness in geometry. It implies a continuous action, recognised as duration, and denoted by T.

Power is a function of the two first elements, *force,* F, and *velocity,* V, like area in geometry is a function of length and breadth. Force in motion produces power, like a line in motion produces a surface. Power cannot exist without the two elements force and velocity, as a surface cannot exist without length and breadth. Power is denoted by $P = F V$, measured and expressed in foot-pounds, which means a force of so many pounds moving a distance of so many feet per unit of time. One unit of power is "a force of one pound moving with a velocity of one foot per second." This unit or foot-pound has also been called effect. James Watt assumed the power of a horse equivalent to 33,000 pounds raised one foot in one minute, which is equal to 550 pounds raised one foot in one second, or 550 effects. The power of a horse is considered equivalent to that of eleven men, or the power of one man equal to 50 effects.

Space is a function of the second and third element; *velocity,* V, and *time,* T, like a cross-section of a solid, is a function of breadth and thickness. Space is here denoted by $S = V T$.

Work (*vis-viva*) is the product of the three elements, *force,* F, *velocity,* V, and *time,* T; and may be likened to a solid in geometry which has three dimensions. Work, denoted by $W = F V T$, is produced by the duration of power for a certain time, as a solid is produced by a plane in motion. Work is the product of power and time, like a solid is the product of area by thickness. *Work* cannot be produced without the three elements *force, velocity,* and *time,* as a *solid* cannot exist without the three elements, *length, breadth,* and *thickness.*

Work appears to be the most confused function in physics, and has been denominated by a great many conventional terms, as *vis-viva, living force, energy, power, momentum, effect,* &c. None of those terms express what is meant by the formula assigned to them, namely, $M V^2$, which means the physical work, concentrated in a moving mass, or the work required to set a body in motion.

* From the Journal of the Franklin Institute.

When the formula is given, we need not care what it is called, if we only know what it is; but unfortunately, when a function is denominated by a wrong and improper term, we are apt to misconceive or misapply its meaning, which has actually been the case with the improper terms for *power* and *work*.

The latin work vis (force) and viva (living) means "living force," which in fact is *power*, and expressed by F V; but when we exercise this living force for a certain duration of time, it becomes a different function, namely, $M V^2$, which is *living power* or physical work, and not merely living force. It may now be remarked that, "a living force cannot exist without some duration of time because a living force is a force in motion, and motion requires time.

A steam engine of 100 horse-power, running one day, will produce a certain amount of work; let the same engine run for only half a-day, when it will produce only half the work of a whole day; but the power was still 100 horses. Let it run for only an hour, a minute, a second, or for an infinitely short period of time, the engine is still 100 horses, but did no work. For that infinite small space of time, the living force was there and produced the full power F V = 100 horses, but did no work $M V^2$. In illustration of this, let a solid cube of paper represent the work $M V^2$; then the base of the cube, or the bottom sheet, which we will consider to have no thickness, will represent the power F V. Take away the sheets one by one from the top of the cube—which is to reduce the time or thickness—until only the bottom sheet is left; then there is no more solidity of the cube, and no more work $M V^2$ left; but the power or living force F V, represented by the base of the cube, is undisturbed.

There are two reasons why the true meaning of physical work has hitherto been so obscured, namely, *first*, that the primitive formula for work F V T or M V T, has been concealed by the formulas for the law of gravity, by which the time, T, has been transformed into velocity, V, and the work represented by M V V or $M V^2$. Sometimes the space S has been inserted for V T, when the work has been called foot-founds, F S. We have now in scientific works two kinds of foot-pounds, without proper explanation of their difference. The foot-pounds of power means so many pounds raised so many feet per unit of time; while the foot-pounds of work means so many pounds raised through a space, S, independent of time, because the time is included in the space S = V T.

The *second* reason why it has been obscured is, that we have no established unit by which to measure physical work. We speak about *vis-viva* the same as we would speak about length without reference to miles, feet, or inches, but merely conceive it to be long, longer, and longest; short, shorter, and shortest.

It is therefore found necessary, in the development of the subject, to establish a unit for work, and assign to it a name.

Let us assume the work accomplished by one horse-power in a time of one hour, to be the unit for physical work; which will be the same as that of eleven men working one hour, or that of one man working one day of eleven hours. In order to clearly distinguish this unit from that of power, let it be called a "workmanday," which means a man's day's work. Let us further designate the quantity of physical work, or number of *workmandays* with the letter W. A workmanday expressed by force and space, without regard to time or velocity, will then be 550 × 3,600 = 1,980,000 foot-pounds, or 2564·7668 units of heat. At least we will adopt this unit, name, and signature, until better shall be established by higher authority. We can now understandingly proceed to develope the physical laws of the elements of work.

All kinds of work can be estimated in workman-days, such as building a house, steamboat, or bridge, digging a canal, ploughing the ground, throwing a bomb or projectile, fighting a battle, steam-boiler explosion, &c.

Momentum is the product of two or more elements.

Static momentum is a function of force and lever, or force multiplied by the length of the lever it acts upon.

Dynamic momentum is power, or the force multiplied by its velocity.

Momentum of power is physical work, or power multiplied by time.

Momentum of physical work is the cost in money, or the work multiplied by its price.

Momentum of work of art is the product of physical work and the skill of the artist.

Momentum of work of science is the product of physical work by primitive knowledge.

Notation of Letters.

S = space in feet, passed through by the force, F, in the time, T.
F = force or pressure, expressed in pounds avoirdupois.
V = velocity or motion, expressed in feet per second.
T = time of operation in seconds.
P = power in foot-pounds, of one pound raised one foot per second.
H = horse-power of 550 pounds raised one foot per second.
W = physical work, expressed in workmandays, of 1,980,000 foot-pounds, or 2564·7668 units of heat.
M = weight in pounds of a moving mass, or the weight of a mass acted upon by mechanical force.
g = acceleratrix of gravity, being 32·166 feet per second, the velocity which a falling body attains at the end of its first second.
G = acceleratrix of the combined gravity and mechanical force.
v = angle with the horizon of the direction of the moving force and mass as on an inclined plane. When the direction rises above the horizon, use the top sign, and when it deeps under use the lower sign.
L = number of labourers employed (not workmandays).
D = number of days of eleven working hours.
N = number of horses (not horse-power).
n = number of blows of a steam-hammer, or pile-driver.
f = friction and other incidental elements opposing the force, F, or moving mass, M, in pounds.
Co-efficients 550 × 3,600 = 1,980,000.
" 32·166 × 550 × 3,600 = 63,888,680.

I beg to remark here, that with a binary arithmetic and metrology, the co-efficients 550 and 3,600 would disappear in the formulas, and 28 of the following formulas would also be dispensed with, say nothing of the labour and confusion it would save.

The first formula gives the theoretical value, while the last ones containing f include friction and other incidental circumstances.

Formulas for Mechanical Work.

Space in feet passed through in the time T.

$$S = V\,T. \quad S = \frac{P\,T}{F}. \quad S = \frac{550\,T\,H}{F}. \quad S = \frac{550 \times 3600\,W}{F}.$$

Force or pressure in pounds:—

$$F = \frac{P}{V}. \quad F = \frac{550\,H\,T}{V\,S}. \quad F = \frac{550 \times 3600\,W}{V\,T}. \quad F = \frac{550 \times 3600\,W}{S}.$$

Velocity in feet per seconds:—

$$V = \frac{S}{T}. \quad V = \frac{P}{F}. \quad V = \frac{550\,H}{F}. \quad V = \frac{550 \times 3600\,W}{F\,T}.$$

Time of duration in seconds:—

$$T = \frac{S}{V}. \quad T = \frac{S\,F}{P}. \quad T = \frac{S\,F}{550\,H}. \quad T = \frac{550 \times 3600\,W}{F\,V}.$$

Power in foot-pounds:—

$$P = F\,V. \quad P = \frac{F\,S}{T}. \quad P = 550\,H. \quad P = \frac{550 \times 3600\,W}{T}.$$

Horse-power:—

$$H = \frac{P}{550}. \quad H = \frac{F\,V}{550}. \quad H = \frac{F\,S}{550\,T}. \quad H = \frac{3600\,W}{T}.$$

Work in workmandays:—

$$W = \frac{F\,V\,T}{550 \times 3600}. \quad W = \frac{F\,S}{550 \times 3600}. \quad W = \frac{P\,T}{550 \times 3600}. \quad W = \frac{H\,T}{3600}$$

Number of labourers (not workmandays):—

$$L = \frac{W}{D}. \quad L = 11\,N. \quad L = \frac{F\,V}{50}. \quad L = \frac{F\,S}{550 \times 3600\,D}.$$

Number of horses (not horse-power):—

$$N = \frac{L}{11}. \quad N = \frac{W}{11\,D}. \quad N = \frac{F\,V}{550}. \quad N = \frac{F\,S}{11 \times 550 \times 3600\,D}.$$

Number of days of 11 hours each:—

$$D = \frac{W}{L}. \quad D = \frac{W}{11\,N}. \quad D = \frac{50\,W}{F\,V}. \quad D = \frac{F\,S}{550 \times 3600\,L}.$$

Work, in workmandays.

$$W = D\,L. \quad W = H\,D\,N. \quad W = \frac{F\,V\,D}{50}. \quad W = \frac{F^2\,V\,S}{50 \times 550 \times 3600\,L}.$$

Examples for Mechanical Work.

EXAMPLE 1. A steam engine of H = 145 horses is to hoist a weight of F = 34,368lbs. Required how high S = ? Will the weight be lifted in T = 25 seconds.

3rd formula for space.

$$S = \frac{550\,T\,H}{F} = \frac{550 \times 25 \times 145}{34368} = 58\text{ft. the answer.}$$

EXAMPLE 2. How much coal F = ? can a steam engine of H = 36 horses hoist up from a mine of S = 256ft. deep, in ten hours, or T = 36,000 seconds.

2nd formula for force.

$$F = \frac{550\,H\,T}{S} = \frac{550 \times 36 \times 36000}{256} = 2784375\text{lbs., or 1243 tons.}$$

EXAMPLE 3. A force of F = 378 lbs. moving uniformly through a space of S = 3675ft. in T = 490 seconds. Required how much power P it will exert.

2nd formula for power.

$$P = \frac{F\,S}{T} = \frac{378 \times 3675}{490} = 2835 \text{ foot pounds.}$$

That is 2835 lbs. will be moved 1ft. per second.

EXAMPLE 4. The pressure on a steam piston is to be F = 31,350 lbs. Required how fast it must move to generate a power of H = 456 horses.

3rd formula for velocity.

$$V = \frac{550\,H}{F} = \frac{550 \times 456}{31350} = 8\text{ft. per second.}$$

EXAMPLE 5. What horse-power H = ? is required to accomplish the same amount of work in T = 43,860 seconds, that W = 132 workmen could accomplish in one day?

4th formula for horse-power.

$$H = \frac{3600\ W}{T} = \frac{3600 \times 132}{3600} = 10{\cdot}82 \text{ horse-power.}$$

How much work W = ? is accomplished by a steam engine of H = 164 horses, working T = 3496 seconds?
5th formula for work.

$$W = \frac{H\ T}{3600} = \frac{164 \times 3496}{3600} = 159{\cdot}36 \text{ workmandays.}$$

Or it would require 159·36 workmen for a whole day to do the same amount of work.

Example 6. The pressure on a steam piston is F = 2864lbs., moving with a velocity of V = 6ft. per second during 10 hours, or T = 36,000 seconds. Required how much work will be accomplished?
1st formula for work.

$$W = \frac{F\ V\ T}{550 \times 3600} = \frac{2864 \times 6 \times 36000}{550 \times 3600} = 312{\cdot}44 \text{ workmandays.}$$

Example 7. How many workmandays W = ? are required to hoist up F = 843,640lbs. of iron to a height of S = 45ft.?
2nd formula for work.

$$W = \frac{F\ S}{550 \times 3600} = \frac{843640 \times 45}{550 \times 3600} = 1917{\cdot}3 \text{ workmandays.}$$

Example 8. What time is required for an engine of H = 96 horse-power to raise a weight F = 495,000lbs. to a height of S = 48ft.?
3rd formula for time.

$$T = \frac{S\ F}{550\ H} = \frac{48 \times 495000}{550 \times 96} = 450 \text{ seconds.}$$

Formulas for Work under the action of Gravity.

Space passed through in the time T:—

$$S = \frac{g\ T^2}{2} = \frac{V\ T}{2}. \quad S = \frac{P\ T}{2\ M}. \quad S = \frac{4 \times 550^2\ H^2}{2\ g\ M^2}. \quad S = \frac{550 \times 3600\ W}{M}.$$

A mass in motion, or falling vertically:—

$$M = \frac{2 \times 550 \times 3600 W}{g\ T}. \quad M = \frac{550 \times 3300 W}{S}. \quad M = \frac{2 \times 550 H}{\sqrt{2\ g\ S}}. \quad M = \frac{550 \times 3600 W g}{V^2}.$$

Velocity at the end of the time T in feet per seconds:—

$$V = g\ T = \frac{2\ S}{T}. \quad V = \frac{2 \times 550\ H}{M}. \quad V = \sqrt{2\ g\ S}. \quad V = \sqrt{\frac{550 \times 3600\ g\ W}{M}}.$$

Time of duration in seconds:—

$$T = \frac{2 \times 550\ H}{g\ M}. \quad T = \sqrt{\frac{2\ S}{g}}. \quad T = \sqrt{\frac{550 \times 3600 \times 2\ W}{g\ M}}.$$

Power in foot-pounds:—

$$P = \frac{M\ T\ g}{2}. \quad P = \frac{M\ V}{2}. \quad P = \frac{M\ 2\ S}{T}. \quad P = 550 \times 3600\ W \sqrt{\frac{g}{2\ S}}$$

Horse-power:—

$$H = \frac{M\ T\ g}{2 \times 550}. \quad H = \frac{M \sqrt{2\ g\ S}}{2 \times 250}. \quad H = \frac{M\ V}{2 \times 250}. \quad H = \frac{3600\ W}{T}.$$

Work, in workmandays:—

$$W = \frac{M\ V^2}{550 g \times 3600}. \quad W = \frac{M\ S}{550 \times 3600}. \quad W = \frac{P \sqrt{\frac{2\ S}{g}}}{550 \times 3600}. \quad W = \frac{H \sqrt{\frac{2\ S}{g}}}{3600}$$

Number of labourers (not workmandays):—

$$L = \frac{M\ S\ n}{550 \times 3600\ D}.$$

Working days of 11 hours each:—

$$D = \frac{M\ S\ n}{550 \times 3600\ L}.$$

Number of horses (not horse-power):—

$$N = \frac{M\ S\ n}{11 \times 550 \times 3600\ D}.$$

Work in workmandays:—

$$W = \frac{M\ S\ n}{550 \times 3600}.$$

Examples for Work under the action of Gravity.

Example 9. A steam hammer weighing M = 13,450lbs. falls from a height of S = 7ft. Required how much the hammer can do in each blow?
2nd formula for work.

$$W = \frac{M\ S}{550 \times 3600} = \frac{13450 \times 7}{550 \times 3600} = 0{\cdot}04755 \text{ workmandays,}$$

and 0·04755 × 11 = 0·523 hour.
That is, one man working 0·523 of an hour can accomplish the same work as that of each blow of the steam hammer. The horse-power of the hammer in its fall is found by the second formula, but this is not the horse-power acting on the mass of iron to be forged on the anvil. If we know the time from when the hammer first touched the iron until it stops, then the horse-power could be found by the fourth formula. The cooler the iron is, and the more resistance presented to the blow, the greater will the horse-power be; but the correct measure of the capacity of a hammer is the workman-days, or its weight multiplied by the height of its fall.

Example 10. A steam hammer of M = 10,000lbs. falling a height of S = 4ft. Required the average horse-power acting in the fall?
2nd formula for horse-power.

$$H = \frac{W \sqrt{2\ g\ S}}{2 \times 550} = \frac{10000 \times \sqrt{2 \times 32{\cdot}166 \times 4}}{2 \times 550} = 164 \text{ horses.}$$

Example 11. From what height S = ? must a mass M = 31,800 lbs. fall to accumulate a work of W = 3·6 workmandays.
4th formula for space.

$$S = \frac{550 \times 3600\ W}{M} = \frac{550 \times 3600 \times 3{\cdot}6}{31800} = 224{\cdot}15\text{ft.}$$

Example 12. How much work is accumulated in a mass of M = 26,800 lbs., and with a velocity of V = 60ft. per second?
1st formula for work.

$$W = \frac{M\ V^2}{550\ g \times 3600} = \frac{26800 \times 60^2}{550 \times 32{\cdot}166 \times 3600} = 1{\cdot}515 \text{ workmandays.}$$

or it would require one man to work 1·515 × 11 = 16·66 hours, to wind up the mass M so high that it would in its fall attain the velocity V.

Example 13. Required how high S = ? the mass M in the preceding example must be raised, in order to attain a velocity of V = 60ft. per second in its fall?
3rd formula for space.

$$S = \frac{V^2}{2\ g} = \frac{60^2}{2 \times 32{\cdot}166} = 55{\cdot}96\text{ft., the answer.}$$

Example 14. What mass M = ? can be raised up S = 68ft. by W = 16 workmandays.
2nd formula for mass:—

$$M = \frac{550 \times 3600\ W}{S} = \frac{550 \times 3600 \times 16}{68} = 465{,}882\text{lbs.}$$

Example 15. How much work is required to raise M = 3,137,800lbs. to a height of S = 80ft.?
2nd formula for work.

$$W = \frac{M\ S}{550 \times 3600} = \frac{3137800 \times 80}{550 \times 3600} = 12{\cdot}678 \text{ workmandays.}$$

Example 16. How many labourers are required to do the work W = 12·678 in D = 3 days.

$$L = \frac{12{\cdot}678}{3} = 4{\cdot}226 \text{ labourers.}$$

Example 17. How many labourers L = ? are required to strike n = 1000 blows in D = ½ or half-a-day with a pile-driver? the ram weighing M = 2,000lbs. and lifted S = 1·5ft. in each blow?

$$L = \frac{M\ S\ n}{550 \times 3600 \times 0{\cdot}5} = \frac{2000 \times 1{\cdot}5 \times 1000}{550 \times 3600 \times 0{\cdot}5} = 3 \text{ men.}$$

Example 18. How many days are required for N = 2 horses to draw up from a mine M = 18,948,000lbs. of coal? The depth of the mine is S = 250ft.

$$D = \frac{M\ S}{550 \times 3600 \times 11\ N} = \frac{18948000 \times 250}{550 \times 3600 \times H\ 2} = 47{\cdot}295 \text{ days.}$$

(*To be continued.*)

THE ROYAL SOCIETY.

ON THE CHEMICAL CONSTITUTION OF REICHENBACH'S CREOSOTE.—PRELIMINARY NOTICE.

By Hugo Muller, Ph.D. Communicated by Warren de la Rue, F.R.S.

This substance, which has been discovered by Reichenbach amongst the products of destructive distillation of wood, has been repeatedly the subject of chemical investigation, but owing to the difficulty attending its purification, the chemical nature of creosote remained doubtful until 1858, when Hlasiwetz published his elaborate research on this subject.

Up to that time Reichenbach's creosote was frequently confounded with phenol (phenylic alcohol, carbolic acid); and, indeed, the latter had very nearly supplanted the true creosote in its application. Hlasiwetz first prepared the creosote in a chemically pure state, and ascertained its chemical formula to be $\overline{C}_8 H_{10} \overline{O}_2$, and showed that this substance, although having some characteristic properties in common with phenol, was a distinct chemical substance, and otherwise in no way related to this body.

At the time of publication of Hlasiwetz's memoir I was myself engaged with the investigation of creosote prepared from wood tar; and such results as I had then arrived at completely coincided with those obtained by Hlasiwetz.

Having a considerable quantity of pure material at my disposal, I took up this subject again, with the view of obtaining some insight into the chemical constitution of creosote, and I think I am now able to lay before the society a few results which may serve as a contribution towards the solution of the questions at issue.

I will reserve a full description of my experiments to a future occasion, and confine myself in this communication merely to the description of one reaction, which I consider best calculated to illustrate the results I have obtained.

When pure creosote, boiling constantly (in hydrogen) at 219° C., is brought into contact with concentrated hydriodic acid and heated to boiling, it is acted upon, iodine is set free, and iodide of methyl distils over. As the free iodine interferes with the result of the reaction, I varied the experiment by substituting iodide of phosphorus for hydriodic acid, in the following manner: the creosote is shaken up with a small quantity of water, of which it dissolves a certain portion, then ordinary phosphorus is introduced, and the whole gently warmed. The iodine is now added in small quantities at a time, care being taken that there is always an excess of phosphorus after the iodine has been converted into iodide of phosphorus. If the temperature is now gradually raised to about 95° C., the reaction makes itself manifest by the evolution of vapour of iodide of methyl, which distils over, and which is condensed in an ice refrigerator. As soon as the reaction diminishes, fresh portions of phosphorus and iodine are added, and the experiment so continued until the substance in the retort becomes gradually thicker and thicker, and viscid if allowed to cool.

The distillate collected in the receiver consists mainly of iodide of methyl mixed with some unaltered creosote, from which it is readily liberated by distillation, and agitation with a solution of caustic alkali.

The residue contained in the retort, on being mixed with water, now readily dissolves, with the exception of a small quantity of a heavy brown oil which contains unaltered creosote. The aqueous solution is mixed with a large quantity of water and partly saturated with carbonate of barium, the clear liquid filtered off and precipitated with acetate of lead, the white precipitate well washed and decomposed with sulphuretted hydrogen. The sulphide of lead having been filtered off, the aqueous solution is now carefully evaporated at a low temperature, when a thick heavy liquid is obtained, which in its reactions so closely resembles pyrocatechine or oxyphenic acid, that one would be inclined to consider it identical with this substance if it were not for the apparent impossibility of obtaining it in a crystalline form.

I am still engaged with the determination of the composition of the latter substance; but, from its chemical nature, so far as I have made myself acquainted with it, and from other considerations, I think it more than probablo that this substance bears the closest analogy to oxyphenic acid ($\overline{C}_6 H_6 \overline{O}_2$), and is in all probability its homologue.

The described decomposition of creosote may be expressed in the following way:—

$$\underbrace{\overline{C}_8 H_{10} \overline{O}_2}_{\text{Creosote.}} + HI = \underbrace{\overline{C}H_3 I}_{\text{Iodide of methyl.}} + \overline{C}_7 H_8 \overline{O}_2.$$

According to which creosote may be considered as methylated oxytolylic acid, or oxykressylic acid.

This view gains in probability if we consider the general properties of creosote, and the fact that a lower homologue of creosote, together with free oxyphenic acid, exists amongst the product of distillation of wood. Hlasiwetz has moreover shown that guaiacol is identical with this lower homologue of creosote, which it resembles in every respect.

If the constitution of creosote ($C_8 H_{10} O_2$) turns out to be as stated above, guaiacol ($C_7 H_8 O_2$) may be regarded as methylated oxyphenic acid, and we may therefore expect to obtain by the action of hydriodic acid upon this substance, iodide of methyl and oxyphenic acid.

I am about to carry out the latter experiment.

RESEARCHES ON THE COLOURING MATTERS DERIVED FROM COAL-TAR.—No. IV. PHENYTOLYLAMINE.

By A. W. Hofmann, LL.D., F.R.S.

The discovery of diphenylamiue among the products of decomposition furnished by the destructive distillation of aniline-blue (triphenylic rosaniliue) which I have lately communicated to the Royal Society (Proceedings, June 16, 1864), naturally suggested the investigation of analogously constituted bodies in a similar direction. My attention has in the first place been directed to the study of a compound which, from its mode of formation, ought to be designated as toluidine-blue.

When a salt of rosaniline (the acetate for instance) is heated with double its weight of toluidine, phenomena present themselves which are similar to those observed in the analogous experiment with aniline. In the course of a few hours the rosaniline passes through all the different shades of violet, and is ultimately converted into a dark lustrous mass, which dissolves in alcohol with a deep indigo blue colour. This substance is the acetate of tritolylrosaniline. By treatment with alcoholic ammonia, aud subsequently addition of water to the solution, the free base is easily obtained, from which the several salts may be prepared by the usual processes. I have examined only one of these salts, viz., the hydrochlorate. Repeatedly crystallised from boiling alcohol, this salt is obtained in small blue crystals insoluble in water, which at 100° C. contain

$$C_{41} H_{38} N_3 Cl = C_{20} \left.\begin{matrix} H_{16} \\ (C_7 H_7)_3 \end{matrix}\right\} N_3, HCl.$$

The formation of toluidine-blue is thus seen to be perfectly analogous to that of aniline-blue.

$$C_{20} H_{19} N_3, \left.\begin{matrix} C_2 H_3 O \\ H \end{matrix}\right\} O \div 3 \left[\left.\begin{matrix} C_7 H_7 \\ H_2 \end{matrix}\right\} N \right]$$

$$= 3 H_3 N + C_{20} \left.\begin{matrix} H_{16} \\ (C_7 H_7)_3 \end{matrix}\right\} N_3, \left.\begin{matrix} C_2 H_3 O \\ H \end{matrix}\right\} O.$$

I have not examined in detail the properties of this new series of colouring matters. Generally speaking they are more soluble than the corresponding phenyl-compounds, and therefore less easily obtained in a state of purity.

When one of these salts (the acetate for instance) is submitted to dry distillation, water and acetic acid are evolved in the first place; then follow oily products, which, as the temperature rises, become more and more viscid and ultimately solidify into crystalline masses, ammonia being abundantly evolved during the latter stages of the process. Unless the operation has been carried out on a rather large scale, a comparatively small amount of a light porous charcoal remains in the retort. The oily distillate contains several bases. Those boiling at a low temperature are almost exclusively aniline and a little toluidine. The principal portion of the products boiling at a higher temperature is a beautifully crystallised base which is easily purified. By pouring cold spirit upon the interwoven crystals, a brown mother liquor containing other bases is readily separated; the residuary substance has only to be crystallised from boiling alcohol in order to procure a compound of perfect purity.

The chemical deportment of the new substance is very similar to that of diphenylamine. Like the latter it unites with acids, forming salts of very little stability, splitting up into their constituents under the influence of water, of heat, and even by mere exposure *in vacuo*. In contact with nitric acid the crystals at once assume a blue colouration, with an admixture of green, but nevertheless so similar to the analogous colour reaction of diphenylamine, that by this test alone the two substances could not possibly be distinguished. The two bases differ, however, essentially in their solubility, their fusing and boiling-points, and lastly in their composition. The new base is far less soluble in alcohol than diphenylamine; it fuses only at 87° C., while the fusing-point of diphenylamine is 45° C.; the boiling point of the new base is 334·5° C. (corr.), at which temperature it distils without any decomposition, while diphenylamine boils at 310° (corr.).

The results of analysis lead to the formula—

$$C_{13} H_{13} N.$$

A hydrochlorate, crystallising in little plates, and obtained by the addition of concentrated hydrochloric acid to an alcoholic solution of the base, when dried over lime, was found to contain—

$$C_{13} H_{13} N, H Cl.$$

Formation and chemical deportment characterise the new base as the mixed secondary monamine of the phenyl and tolyl-series, as phenyltolylamine*—

$$C_{13} H_{13} N = \left.\begin{matrix} C_6 H_5 \\ C_7 H_7 \\ H \end{matrix}\right\} N.$$

In consequence of the simultaneous existence in the molecule of the new base of the radicals phenyl and tolyl, its deportment under the influence of dehydrogenating agents became of considerable interest; and indeed, having recognised the nature of the compound, my first experiment consisted in submitting it to the action of corrosive sublimate. Both substances unite to form a dark brown mass which, after having been heated, dissolves in alcohol with a mag-

* It deserves to be noticed that the percentages of carbon in diphenylamine, phenyltolylamine, and ditolylamine nearly coincide.

	Diphenylamine.	Phenyltolylamine.	Ditolylamine.
Carbon	85·21	85·24	85·28
Hydrogen	6·51	7·10	7·61

The percentage of hydrogen, however, unequivocally distinguish the three compounds. The analysis of phenyltolylamine furnished the following numbers:—

	I.	II.
Carbon	85·10	85·1;
Hydrogen	7·30	7·33

nificent violet-blue colour. The compound thus produced exhibits the behaviour of the colouring matters generated from rosaniline by substitution. Owing to the peculiar properties of this class of substances, it would be difficult to prepare the new compound in sufficient quantity for a detailed examination; but judging from its mode of generation, it will probably be found to be tolyldiphenylrosaniline—

$$\left.\begin{matrix} C_{20}\ H_{16} \\ (C_6\ H_5)_2 \\ C_7\ H_7 \end{matrix}\right\} N_3,\ H_2\ O.$$

A few additional experiments performed with phenyltolylamine may still briefly be mentioned.

Chloride of benzoyl attacks this substance, especially on application of heat. The production of the reaction remains liquid for a long time, but, when appropriately treated with water, alkali, and spirit, it ultimately solidifies, and separates from boiling alcohol in well-formed crystals—

$$C_{20}\ H_{17}\ N\ O = \left.\begin{matrix} C_6\ H_5 \\ C_7\ H_7 \\ C_7\ H_5\ O \end{matrix}\right\} N,$$

which are more soluble than the corresponding diphenyl-compound.

The benzoyl derivative is very readily converted into nitro substitutes. In contact with ordinary concentrated nitric acid the crystals are at once liquified, and ultimately entirely dissolve. Addition of water to this solution precipitates a yellow crystalline dinitro-compound—

$$C_{20}\ H_{15}\ N_3\ O_5 = \left.\begin{matrix} C_6\ H_4\ (N\ O_2) \\ C_7\ H_6\ (N\ O_2) \\ C_7\ H_5\ \ O \end{matrix}\right\} N,$$

which is deposited from boiling alcohol in reddish-yellow needles. Perfectly similar treatment converts the diphenyl body into a mononitro substitute. Cold fuming nitric acid, which when acting upon the diphenyl body gives rise to the formation of a dinitro-substitute, transforms the benzoylated phenyltolylamine into a nitro-derivative containing, according to an approximate analysis, not less than 5 atoms of $N\ O_2$.

Dinitro-phenyltolylbenzoylamide dissolves in alcoholic soda with a feebly crimson colour. Ebullition of the solution eliminates the benzoyl atom in the form of benzoate, and on cooling small yellowish red crystals—

$$C_{13}\ H_{11}\ N_3\ O_4 = \left.\begin{matrix} C_6\ H_4\ (N\ O_2) \\ C_7\ H_6\ (N\ O_2) \\ H \end{matrix}\right\} N,$$

are deposited, which are easily purified by crystallisation from alcohol.

Lastly, when treated with reducing agents, the dinitronated phenyltolylbenzoyl compound is converted into fine white needles of a new base, to which I hope to return as soon as I shall have procured a somewhat larger supply of phenyltolylamine.

It scarcely requires to be mentioned that it is not necessary to prepare the pure toluidine-blue for the purpose of obtaining phenyltolylamine. It suffices to maintain for some hours a solution of ordinary but dried acetate of rosaniline, in its double weight of toluidine, in a flask provided with an upright condensing tube, at a boiling temperature, and to submit the violet-blue mass produced to destructive distillation over a naked burner. The distillate is treated with hydrochloric acid, and subsequently with water, when aniline and toluidine, together with several other basic substances accompanying the phenyltolylamine, remain as hydrochlorates in solution. The oil layer which separates generally solidifies, or may be purified by rectification. The resulting crystals are crystallised from alcohol.

The same method is also adapted for the preparation of diphenylamine, aniline being substituted for toluidine.

If I have bestowed upon diphenylamine and phenyltolylamine rather more attention than these substances at the first glance appear to claim, I have done so in the hope of gaining additional data for the investigation of the remarkable colouring matters from which these bases are derived. Both constitution and mode of formation of these colouring matters are still involved in darkness. Theory, as it often happens, has not kept pace with practice. The anticipation I expressed in a former note, that the study of the behaviour of the colouring matters under the influence of chemical agents might disclose their true nature, has only very partially been realised. Up to the present moment, chemists have not succeeded in giving a satisfactory account either of the atomic construction of these compounds, or of the mechanism of their formation; and it would therefore scarcely be worth while to return to this question before its definite solution, unless the publication of erroneous statements by M. Schiff had threatened to divert the researches of chemists from this subject.

According to M. Schiff,* the transformation of aniline into aniline-red by means of stannic chloride is represented by the equation

$$20\ C_6\ H_7\ N + 10\ Sn\ Cl_2 = 3\ (C_{20}\ H_{19}\ N_3,\ H\ Cl) + 6\ (C_6\ H_7\ N, H\ Cl) + H_4\ N\ Cl + 10\ S\,n\ Cl + 4\ C_6\ H_7\ N.$$

The formation by means of mercuric nitrate † by the equation

$$20\ C_6\ H_7\ N + 20\ Hg\ N\ O_3 = 3\ (C_{20}\ H_{19}\ N_3,\ H\ N\ O_3) + 6\ (C_6\ H_7\ N,\ H\ N\ O_3) + H_4\ N,\ N\ O_3 + 10\ Hg_2\ N\ O_3 + 4\ C_6\ H_7\ N.$$

The latter process is accomplished at as low a temperature as 80° C., and according to M. Schiff, is so elegant that he was enabled to make quantitative experiments. "Within a few hundredths," he says, "we have obtained the requisite quantities of the sought-for materials."

M. Schiff's equations are not conspicuous for elegance and simplicity, but they are absolutely inadmissible for other reasons. These equations utterly ignore the very essence of the process. I have pointed out, some time ago, that the formation of rosaniline involves the presence of *both aniline and toluidine.* Pure aniline furnishes no rosaniline, nor can this body be procured from pure toluidine. This fact I have since further established by many varied experiments, both on the small and on the large scale. The formation of rosaniline thus becomes the means of ascertaining rapidly the presence of toluidine. The amount of the latter in crude aniline * may become so minute that its presence can no longer be traced by distillation, or by conversion into oxalates. It may be recognised, however, with the utmost facility by submitting the mixture to the action of either corrosive sublimate or arsenic acid; on application of a gentle heat the crimson colour is immediately produced.

In the equations proposed by M. Schiff there figures, moreover, ammonia as an essential term. The existence of ammoniacal salts in the crude rosaniline was pointed out some time ago by Prof. Bolley. But this ammonia (which, as I have satisfied myself, is scarcely ever absent) is, according to my opinion, not an essential product of the reaction that gives rise to the formation of aniline-red. I have established by special and careful experiments that appropriate treatment of a mixture of aniline and toluidine with chloride of mercury at a moderate temperature is capable of producing very considerable quantities of rosaniline without elimination of more than a trace of ammonia. The ammonia generally observed belongs to a different phase of the reaction, being more especially due to the almost invariable production of a small quantity of aniline-blue.

If we wished, even now, to represent in formulæ the relation between rosaniline and the substances which give rise to its formation, the equation

$$C_6\ H_7\ N + 2\ C_7\ H_9\ N = C_{20}\ H_{19}\ N_3 + 6\ H$$

might be looked upon as an expression closely approaching truth. The hydrogen figuring in this equation is eliminated in the form of water, hydrochloric, hydrobromic, hydriodic acids, &c.

But even this equation gives no account of the mechanism of this remarkable process; indeed, we cannot hope for the solution of this chemical problem before we shall have succeeded in splitting up the molecule of rosaniline into the atomic groups which enter into its composition. It is true its transformation into aniline or toluidine-blue, as well as into the several violets which are generated by the substitution of alcohol radicals, prove even now that the rosaniline-molecule still contains three atoms of typical hydrogen, and hence that the complex atom $C_{20}\ H_{16}$ functions in this triamine with the value of six atoms of hydrogen; but this indeed is the limit of the experimental evidence as yet obtained.

With regard to the number and nature of the simpler radicals into which the carbon and hydrogen atoms of the complex atom $C_{20}\ H_{16}$ are grouped, we can only speculate. Derived from the radicals *phenyl*, $C_6\ H_5$, and *tolyl*, $C_7\ H_7$, under the influence of dehydrogenating agents, this complex atom may possibly contain the bivalent radicals *phenylene*, $C_6\ H_4$, and *tolylene*, $C_7\ H_6$,

$$(C_{20}\ H_{16})'' = \begin{matrix} (C_6\ H_4)'' \\ (C_7\ H_6), \\ (C_7\ H_6)'' \end{matrix}$$

when the molecular construction of the three colouring matters might be represented by the formulæ

Aniline-red.	Aniline-blue.	Aniline-violet.
$\left.\begin{matrix} (C_6\ H_4)'' \\ (C_7\ H_6)_2'' \\ H_3 \end{matrix}\right\} N_3,\ H_2\ O$	$\left.\begin{matrix} (C_6\ H_4)'' \\ (C_7\ H_6)_2'' \\ (C_6\ H_5)_3 \end{matrix}\right\} N_3,\ H_2\ O$	$\left.\begin{matrix} (C_6\ H_4)'' \\ (C_7\ H_6)_2'' \\ (C_2\ H_5)_3 \end{matrix}\right\} N_3,\ H_2\ O.$

We must not, however, forget that this is simply an hypothesis, and that the elements in the complex atom $C_{20}\ H_{16}$ may be associated in a great variety of other groups. An interesting observation quite recently made by Dr. Hugo Müller, and communicated to me by my friend while these pages are passing through the press, may possibly assist in further elucidating the nature of this class of bodies. Dr. Müller has found that rosaniline and its coloured derivatives are instantaneously decolourised by cyanide of potassium, a series of splendidly crystallised, perfectly colourless bases being produced. The composition of these bodies, which will probably be found analogous to a substance similarly obtained from harmaline by Fritzsche, remains to be established.

* Comp. Rend., vol. lvi., p. 271.
† Ibid., p. 545.

* Aniline obtained by distillation with potash from certain varieties of indigo, is apt, when treated with corrosive sublimate, to furnish traces of rosaniline. I infer from this result that aniline thus produced contains a small portion of toluidine. The formation of this substance from indigo would be as readily intelligible as the conversion under certain conditions of indigo into salicylic acid, a fact established by Cahour's observations.

Aniline prepared from crystallised isatin does not yield a trace of rosaniline.

Artesian Wells.—It has been observed that Artesian wells can only be successfully bored where porous strata are intercalated between impermeable ones. Where the intercalation is often repeated, several distinct sources of water may supply a single well. In that at Bruck, near Erlangen, there are three such sources; in that at Dieppe, seven; whilst the well at Dulmen, in Westphalia, is supplied by no less than thirteen strata, in a depth of 380ft. The great distance from which the water of an Artesian well may be derived was well shown by a boring near Tours, from which, when the borer was withdrawn, quantities of sand and small snail-shells were ejected, which must, without doubt, have found their way there from the mountains of Auvergne, thirty miles distant. A curious proof of the occasional direct communication of Artesian borings with superficial accumulations of water was given by wells of this description at Bochum, in Westphalia, and Elbœuf, in France, in the water from both of which eels and small fish have at times been found.

CHEMICAL SOCIETY.

ON THE ACTION OF SODIUM ON VALERIANATE OF ETHYL, VIZ., THE LIBERATION OF THE ACID-FORMING RADICLE VALERYL.

BY J. ALFRED WANKLYN.

More than twenty years ago an account of some experiments on the action of potassium upon acetic ether was published by Loewig and Weidmann.*

The result arrived at was that potassium reacts very energetically upon acetic ether, but that no gas is produced. The solid products were, moreover, found to consist partly of ethylate of potash, and partly of the potash-salt of a curious acid closely related to acetic acid, but which was only slightly examined.

This research does not appear to have attracted much attention. It was at the time unintelligible; and later, when the classical researches of Frankland and Kolbe, relating to the alcohol-radicles, came out, it seemed not to be in harmony with them. Inasmuch as metals eliminate ethyl from iodide of ethyl, it was not unnatural to suppose that they would also eliminate ethyl from acetate of ethyl and from other salts of ethyl.

In undertaking an investigation of the action of sodium upon the ethers of the fatty acids, the first point demanding attention was whether it is really a fact that the metal does not liberate the alcohol-radicle.

I have made very careful experiments on acetate of ethyl and on valerianate of ethyl, and get results corresponding in this particular with those of Lowig and Weidmann.

I sealed up a quantity of sodium with acetate of ethyl, which had been very carefully deprived of alcohol and of water, and weighed the tube containing these materials. I then heated the tube to 130° C. for some time, until the contents had changed from liquid to solid. After opening the tube and allowing any gas that might have formed to escape, I weighed it again. The loss amounted to 0·5 in 100 parts of acetic ether. Therefore no appreciable quantity of gas is evolved in the reaction of sodium upon acetate of ethyl, and therefore sodium does not react upon acetate of ethyl in the manner represented by this equation—

$$2.\ \left.\begin{matrix}C_2H_3O\\C_2H_5\end{matrix}\right\}O + Na_2 = 2.\ \left.\begin{matrix}C_2H_3O\\Na\end{matrix}\right\}O + \left.\begin{matrix}C_2H_5\\C_2H_5\end{matrix}\right\}$$

This results was confirmed in various ways. With sodium and valerianic ether, unquestionable results of a like character were also obtained.

If we consider what is really known about acetate of ethyl, we shall find that after all it is not so very clear that ethyl is the movable portion in it.

The reaction between acetate of ethyl and caustic potash, whereby alcohol is formed, is capable of two explanations, viz. :—

$$(1)\ldots\ldots\ \left.\begin{matrix}C_2H_3O\\\overline{C_2H_5}\end{matrix}\right\}O + \left.\begin{matrix}H\\\overline{K}\end{matrix}\right\}O = \left.\begin{matrix}C_2H_3O\\K\end{matrix}\right\}O + \left.\begin{matrix}H\\C_2H_5\end{matrix}\right\}O,\dagger$$

wherein ethyl and potassium change against one another.

$$(2)\ldots\ldots\ \left.\begin{matrix}\overline{C_2H_3O}\\C_2H_5\end{matrix}\right\}O + \left.\begin{matrix}\overline{H}\\K\end{matrix}\right\}O = \left.\begin{matrix}H\\C_2H_5\end{matrix}\right\}O + \left.\begin{matrix}C_2H_3O\\K\end{matrix}\right\}O,$$

wherein acetyl and hydrogen change against one another.

The remarkable fact discovered by Beilstein, that acetic ether does not give ether by reaction with ethylate of sodium, but forms with a double compound, which splits up, on the addition of water, into alcohol and acetate of soda, points to a fundamental want of resemblance between the ethers of the fatty acids and the haloid ethers, such as the iodides.

The well known reaction

$$\left.\begin{matrix}C_2H_5\\I\end{matrix}\right\} + \left.\begin{matrix}Na\\C_2H_5\end{matrix}\right\}O = \left.\begin{matrix}Na\\I\end{matrix}\right\} + \left.\begin{matrix}C_2H_5\\C_2H_5\end{matrix}\right\}O,$$

is thus seen to be without its counterpart when acetic ether is taken, the reaction

$$\left.\begin{matrix}C_2H_5\\C_2H_3O\end{matrix}\right\}O + \left.\begin{matrix}Na\\C_2H_5\end{matrix}\right\}O = \left.\begin{matrix}Na\\C_2H_5O\end{matrix}\right\}O + \left.\begin{matrix}C_2H_5\\C_2H_5\end{matrix}\right\}O$$

being found not to take place.

If we allow that in acetic ether it is the acetyl, and not the ethyl which is movable, then it is clear that acetic ether and ethylate of sodium cannot react so as to produce a change in the product:

$$\left.\begin{matrix}\overline{C_2H_3O}\\C_2H_5\end{matrix}\right\}O + \left.\begin{matrix}Na\\C_2H_5\end{matrix}\right\}O = \left.\begin{matrix}Na\\C_2H_5\end{matrix}\right\}O + \left.\begin{matrix}C_2H_3O\\C_2H_5\end{matrix}\right\}O,$$

giving ethylate of sodium and acetic ether, the very compounds which were taken at first.

Many other facts which are familiar to chemists tend in the same direction; the uniformity with which an acetate of a radicle gives the alcohol when it is treated with potash is one of them.

This is particularly striking in the β Hexyl series :—

Iodide of β hexyl gives hexylene with alcoholic potash. Acetate of β hexyl gives no trace of hexylene, but β hexylic alcohol instead:

$$\left.\begin{matrix}C_2H_3O\\\beta\,C_6H_{13}\end{matrix}\right\}O + \left.\begin{matrix}H\\K\end{matrix}\right\}O = \left.\begin{matrix}H\\\beta\,C_6H_{13}\end{matrix}\right\}O + \left.\begin{matrix}C_2H_3O\\K\end{matrix}\right\}O,$$

where the reaction is confined to an interchange between acetyl and hydrogen and where, the β hexyl being undisturbed, it has little opportunity for the display of its characteristic tendency to split up into hydrogen and hexylene.

Another remarkable reaction which favours the interpretation for which I am contending is that between ammonia—even aqueous solution of ammonia—and an ether of a fatty acid, *e.g.*:—

$$\left.\begin{matrix}C_2H_3O\\C_2H_5\end{matrix}\right\}O + \left.\begin{matrix}H\\NH_2\end{matrix}\right\} = \left.\begin{matrix}H\\C_2H_5\end{matrix}\right\}O + \left.\begin{matrix}C_2H_3O\\NH_2\end{matrix}\right\}$$

wherein acetic ether and ammonia give rise to alcohol and acetamide, acetyl changing against hydrogen, and not ethyl against ammonium.

After these examples of the mobility of acetyl, the following equations will not appear to be contrary to analogy:—

$$(1)\ldots\ldots\ 2.\ \left.\begin{matrix}C_2H_3O\\C_2H_5\end{matrix}\right\}O + Na_2 = 2.\ \left.\begin{matrix}Na\\C_2H_5\end{matrix}\right\}O + \left.\begin{matrix}C_2H_3O\\C_2H_3O\end{matrix}\right\}$$

$$(2)\ldots\ldots\ 2.\ \left.\begin{matrix}C_5H_9O\\C_2H_5\end{matrix}\right\}O + Na_2 = 2.\ \left.\begin{matrix}Na\\C_2H_5\end{matrix}\right\}O + \left.\begin{matrix}C_5H_9O\\C_5H_9O\end{matrix}\right\}$$

For obvious reasons it is easier to investigate the action of sodium upon valerianic ether than upon acetic ether. The advantage in dealing with a case when there is a difference in carbon-condensation between the acid-forming radicle and the alcohol-forming radicle, as in valerianic ether, over a case where, as in acetic ether, both radicles are alike in carbon-condensation, will be at once apparent.

On the present occasion, therefore, I shall give in detail an account of the examination of the action of sodium on valerianic ether, reserving the investigation of acetic ether and other ethers for a future opportunity.

The valerianic ether used in this research, after being washed and dried, boiled constantly between 132° and 135° C. A portion was digested in a sealed tube with aqueous solution of potash; it dissolved completely in the potash, leaving no oily layer.

On placing pieces of sodium in valerianic ether, the metal becomes very bright, and assumes a yellowish colour, like gold; heat is developed, but there is no evolution of gas. By-and-bye the liquid becomes very thick, a white solid being formed, and the reaction seems to come to a stand-still, on account of the extreme viscidity of the product.

In order to obtain anything like a complete reaction, it was necessary to employ some inert liquid to act as a diluent. Ether was chosen for this purpose, and before being used was washed with water, to remove any alcohol, and very completely dried, first with potash, and afterwards by distillation off fragments of metallic sodium.

The following are the details of an experiment:—

2 grms. of sodium,
6 grms. of valerianic ether,
7·5 grms. of ether,

were sealed up together and heated in the water bath. After the whole contents of the tube had become very thick—almost solid—the tube was opened, and the sodium unacted upon was cleaned and weighed. It weighed 0·7grm. The amount of sodium which had taken part in the reaction was, therefore, 1·3 grm.

The product from which the unattacked sodium had been separated was next treated with water, when it yielded an oil and an aqueous layer which was strongly alkaline. The amount of free alkali, estimated by means of a standard solution of acid, corresponded to 1·08 grm. of sodium.

The oil, which of course contained large quantities of ether, was washed, then heated in an open vessel in the water-bath to drive off the ether, then transferred to a little bottle and weighed. After this operation it weighed 2·2 grm.

It was dried and burnt with oxide of copper, a little chlorate of potash being used.

·2680 grm. gave ·7024 grm. CO_2 and ·2815 grm. H_2O.

Carbon	71·48
Hydrogen	11·67
Oxygen	16·85
	100·00

Therefore,

		Grms.
Valerianic ether taken	=	6·0
Sodium consumed	=	1·3
Sodium in caustic state	=	1·08
Oily product	=	2·2

The equation

$$2.\ \left.\begin{matrix}C_5H_9O\\C_2H_5\end{matrix}\right\}O + Na_2 = 2.\ \left.\begin{matrix}Na\\C_2H_5\end{matrix}\right\}O + \left.\begin{matrix}C_5H_9O\\C_5H_9O\end{matrix}\right\}$$

requires:—

		Grms.
Valerianic ether taken	=	6
Sodium consumed	=	1·06
Sodium in caustic state	=	1·06
Valeryl	=	3.92

It will be seen that the amount of sodium found in the caustic state is almost the theoretical quantity, and the remark may be made that the method by which this datum is arrived at is calculated to give a precise result. The sodium consumed is sufficiently near the theoretical quantity. The oil is of necessity below the mark: at least ·5 grm. would be lost by adhesion to the dish in which it was heated to drive off ether; there is a source of loss by evaporation and by solution in the water used to wash it.

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* Ann. Ch. Pharm. xxxvi. 297.

† The radicles which are supposed to replace one another have *a mark on the top.*

On comparing the composition of the oil with the composition of valerianic ether,

	Valerianic ether.	Valeryl.	Found.
C	64·62	70·59	71·48
H	10·77	10·59	11·67
O	24·61	18·82	16·85
	100·00	100·00	100·00

it is manifest that the oil cannot be unattacked valerianic ether; it is therefore certain that the sodium which had disappeared had used up the valerianic ether taken for the experiment.

The oil approximates in composition to valeryl, the slight excess of carbon and hydrogen being probably due to the presence of a little hydrocarbon—the product of a slight secondary action of sodium upon valeryl. The circumstance that the sodium consumed is slightly in excess over the sodium found caustic, is quite in accordance with there having been a slight degree of secondary action on the valeryl.

In another experiment an oil was obtained which gave on analysis—

Carbon	71·52
Hydrogen	11·04
Oxygen	17·44
	100·00

Freund* has shown that an amalgam of one part of sodium and two parts of mercury liberates a compound having the composition of butyryl from chloride of butyryl. It boils between 245° and 260° C., and appears to suffer decomposition on distillation.

Valeryl should be more readily decomposed than butyryl. I was therefore indisposed to attempt a purification of my product by means of distillation. It will be far easier so to modify the original reaction as to obtain it pure in the first instance. With this part of the investigation I am at present engaged. Meanwhile the fact that one molecule of valerianic ether is completely decomposed by one atom of sodium, and that the one atom of sodium appears in the caustic state, whilst the resulting oil has very nearly the composition of valeryl, is conclusive evidence that the reaction between sodium and valerianic ether is correctly represented by the equation

$$2\ .\ \left.\begin{matrix}C_5H_9O\\C_2H_5\end{matrix}\right\}O + Na_2 = 2\ .\ \left.\begin{matrix}Na\\C_2H_5\end{matrix}\right\}O + \left.\begin{matrix}C_5H_9O\\C_5H_9O\end{matrix}\right\}$$

With potassium the reaction is the same. One equivalent of potassium dissolves in one molecule of valerianic ether, and is subsequently found in the caustic state, whilst an oil separates just as before. In making the experiment with potassium the greatest caution is required: with care, the reaction may be effected with the greatest precision; without proper attention an explosion is the result.

From the great interest belonging to the acid-forming radicles it is my intention to prepare large quantities of valeryl, and to make a minute examination of its chemical character.

The principal other acid-forming radicles, including benzoyl, will be also sought by a similar procedure.

ON THE OCCURRENCE OF NICKEL IN LEAD, AND ITS CONCENTRATION BY PATTINSON'S PROCESS.

By Wm. Baker, Associate of the Royal School of Mines.

It is well known that, for certain manufactures, lead of a high degree of purity is required. The presence of a very small amount of copper is especially injurious for making white lead and glassmakers' red lead. Investigating the cause of a peculiar tint in glass, which was sometimes sufficiently marked to be called blue, and was readily accounted for by the presence of copper, I sought carefully for cobalt, but only found nickel. In all the samples of English lead which I have examined I have never detected a trace of cobalt. On the contrary, traces of nickel have frequently been found in various samples of Derbyshire lead, in Yorkshire lead, and lead from Snailbeach. Operating upon 2,000 grains, I have found the following quantities of nickel in the pig lead as delivered by the smelter:—

		oz.	dwts.	gr.	
Derbyshire lead, 1st sample	0·0023 °/₀ =	0	14	8	per ton.
Do. 2nd „	0·0031 „ =	0	19	14	„
Do. 3rd „	0·0023 „ =	0	14	8	„
Snailbeach lead	0·0007 „ =	0	5	10	„
Softened slag lead	0·0057 „ =	1	16	14	„

On submitting lead containing these quantities of nickel to Pattinson's process, I find a concentration of the nickel in the fluid portion. Crystals of lead were taken out in the proportion of $\frac{9}{10}$, leaving $\frac{1}{10}$ fluid lead of a 5-ton charge.

Samples of the fluid lead or "bottoms," upon analysis, contained nickel as follows:—

After 3 crystallations	0·0047 =	1	10	1	per ton.
After 1 „	0·0043 =	1	7	10	„
After 1 „	0·0062 =	2	0	12	„
After 2 „	0·0072 =	2	7	0	„

In all cases a weighable quantity could be obtained from 2,000 grains of lead.

Five tons of lead contained ·0068 °/₀ = 2 oz. 4 dwts. 10 gr. per ton. Four and a half tons were removed as crystals, and when melted contained only ·0047 °/₀ = 1 oz. 10 dwts. 1 gr. per ton. These figures show that nickel remains to a great extent with the fluid portion, much as copper does; and I have reason to suppose that when it reaches a certain amount, as is the case with copper, the separation is no longer effected, or only in a very small degree. In the case of copper this is easily understood, when it is seen that, at a low temperature, copper (in the absence of antimony and arsenic) will separate and be found in the dross on skimming, leaving the fluid lead, containing about 20 oz. per ton = 0·06 °/₀. To effect a separation of the copper by Pattinson's process, the amount at the commencement should not be more than 10 oz. per ton.

A sample of lead from 5 tons, when analysed, gave no indications of the presence of nickel; on crystallising $\frac{9}{10}$, the remainder gave distinct traces of the metal. In refined lead, I have only once succeeded in obtaining a weighable quantity, and only rarely found traces of nickel. That it is not removed by oxidation is proved by the larger quantity found in the fluid portion of the lead when crystallised, as well as by the fact that in the softened slag lead which is submitted to the powerful oxidising action of nitrate of soda, a considerable quantity of nickel is still found.

* Ann. Ch. Pharm., cxviii. 33.

INSTITUTION OF CIVIL ENGINEERS.

ON THE CHEY-AIR BRIDGE, MADRAS RAILWAY.

By Mr. E. Johnston, M. Inst. C.E.

The author remarked that the River Chey-Air presented the usual features met with in nearly all the large rivers of Southern India. The banks were generally low and ill defined, and the bed, for almost the entire width, and to an unknown depth, consisted of clean sharp sand. For nine months during the year the bed was perfectly dry, being subject only to heavy floods in the months of May, June, and November; but even during the driest seasons, the substratum was always charged with water to within 2ft. or 3ft. of the surface.

The bridge was situated on the North-west Line, at a distance of 143 miles from Madras; the extreme width of the river at the point of crossing was 3,360ft., the drainage area being about 2,272 square miles, and the fall of the stream at the rate of 11ft. per mile. At a distance of 20 chains above the bridge, the river separated into two distinct channels, that on the south being 1,600ft. in width, and that on the north 1,256ft. in width, and at the point of crossing the bank dividing the two was 464ft. in width. The highest point of this bank was 5·57ft. above the bed of the river, and 2·27ft. higher than the general level of the land for some distance on each side of the river. As it was ascertained that the highest known flood only covered the bank to a depth of 14in., it was determined to make this portion of the work a solid embankment, and to span the two arms of the river by distinct bridges; that on the south contained twenty-two openings, while that on the north had sixteen openings, each 70ft. span from centre to centre of the piers.

The piers were built of masonry, laid on timber platforms, placed within dams, at a depth of 15ft. below the bed of the river, the superstructure being composed of ordinary boiler plate girders. In commencing the operations, the sand over the site of the intended dam was first removed, until the water was reached. The dimensions of the dam, 52ft. by 22ft., being then set out, piles, 9in. square, were driven at intervals of 10ft., to a depth of 18ft., the heads being cut off level with the water. The piles were secured by waling pieces, and were strongly braced across. Close planking, 2½in. in thickness, was next let down behind the piles, and the space around the dam was backed up with clay and grass sods, to prevent the sand from slipping in. The Picottah pumps were afterwards fixed at intervals of 3ft. along three sides of the dams, being supported on sleepers, bedded on clay, one end of each sleeper resting on the waling pieces. Each dam was surrounded by a wooden trough, for receiving the water raised from the foundation pit, and this trough communicated with a channel, cut to a depth of about 5ft. at the commencement, and terminating on the surface at a distance of 50 chains down the river. This was rendered possible by the fall of the river, 11ft. per mile, and the lift was thus reduced from 15ft. to 10ft. The Picottah pump was much used in many parts of Southern India for irrigation purposes, and it had been found very efficient for emptying foundation pits. It consisted simply of a balance lever, one end of which was weighted, by a man walking up and down the lever, while to the other end a bucket was suspended by a long bamboo, another man standing on a staging in the dam guiding the bucket, and filling and emptying it. The bucket was made of thin sheet iron, and was capable of containing about 5 gallons. Two well-trained men would raise on an average about 35 gallons per minute, where the lift did not exceed 9ft. or 10ft. At the Chey-Air Bridge, it was found necessary to use at each dam thirty-six of these pumps, worked by a gang of seventy-two coolies, who were relieved every six hours, and who raised on an average 1,260 gallons per minute, the mean lift being from 7ft. to 8ft.

The timber platforms were of aucha and eloopay, both close, hard-grained woods; and being entirely protected from the alternate action of air and water, it was believed they would be very durable. These platforms were 42ft. in length by 13ft. in width; the main beams and transverse pieces were 12in. square, and over these there was a flooring of sleepers 10ft. long and 10in. by 6in. in section. On this flooring heavy courses of well bedded hard slaty magnesian limestone, the blocks varying in size from ½ to ¾ of a cubic yard, were built in hydraulic mortar, and well grouted, up to within 18in. of the bed of the river, and therefore about 18in. above the lowest level to which the water subsided in the sand. Above this point, the masonry consisted of a light-coloured magnesian limestone, obtained from a quarry situated 2½ miles from the work, and which was delivered at the bridge, by a native contractor, at the rate of 5*s.* 6*d.* per cubic yard, subject to a deduction of one-seventh for bad stacking. No appreciable settlement was noticed after the first course of masonry was laid. The piling and the timber around the dams had, in every instance, remained undisturbed; and the space between them and the masonry had been filled in with waste stone to a depth of 9ft. The works had withstood the mousoons during three years, without showing the slightest indication of any scour; in fact, after heavy floods, no alteration took place in the bed of the river.

The total cost of preparing a single dam, with timber platform complete, ready to receive the masonry, was

Pile driving	£24 3 6
Excavation	38 13 0
Pumping	50 2 0
Timber platform	37 9 0
	£150 7 6

The bridge contained 16,320 cubic yards of masonry, executed at a cost of £18,081. The works were commenced on the 13th August, 1860, and were completed ready to receive the girders on the 16th January, 1862.

Respecting the character of the work yet remaining to be done, it was stated that it would be merely a repetition of what had already been executed in the case of several large bridges on the same line of railway. In illustration, the superstructure of the bridge over the River Cavery was alluded to, the spans and all essential particulars being identical. The girders were continuous over two spans, and were thus 140ft. in length. They were ordinary boiler plate girders, so proportioned as to give a maximum strain of 5 tons per square inch on the extended parts, and of 4 tons per square inch on the compressed parts. Each length of 140ft. was composed of three portions; the central one was 30ft. in length, and had its centre over the middle pier, while the two ends were each 55ft. in length, and extended to the centres of the two adjacent piers. The position of the joints was determined by calculation, to be at about the points of contrary flexure, in various states of distribution of the load. The three pieces were joined together on a platform adjacent to the abutment; and when this was accomplished, the two girders were connected by cross bracing, and by a system of longitudinal bracing, formed of a "herring-bone" arrangement of half timbers, bolted to the under side of the cross bearers, by which the rails were carried. It was found, by experiment, that when the ordinary T iron cross bracing alone was fixed, the vibrations of a pair of girders could be increased to about 5in., by the application of a moderate lateral force isochronous with these vibrations; whilst on the addition of the herring-bone bracing, it became impossible to produce any appreciable vibration by such means. For the purpose of getting the girders into their places, at the top of each pier two frames were erected, each carrying two rollers in the lines of the centres of the girders. To the underside of the latter, rails were attached, with their running faces downwards. The girders were first lifted, by jacks, from the platforms, when several rollers were fixed on the platforms, and the girders were then allowed to rest on the rollers. The girders were next hauled forward by a powerful crab tackle placed on one of the piers in advance, and so were ultimately taken to the further end of the bridge; the remainder being successively hauled over in succession. Having thus always two bearing points, with the centre of gravity between them, there was no tendency to tilt, and no necessity for staging or scaffolding—a material advantage in the case of rivers subject to sudden floods of extreme violence.

GIFFARD'S INJECTOR.

By Mr. John England, M. Inst. C.E.

Before entering into a description of this instrument, the author alluded to what had been previously done, for raising or forcing water by means of a jet of steam, and apparatus without moving parts; including the plans of Solomon de Caus, of David Ramseye, of the Marquis of Worcester, of Savery, in 1698, and of the Marquis de Manoury d'Ectot, in 1818. It was observed that when Manoury, by the same means as Savery, had raised water to the height due to atmospheric pressure, instead of, like Savery, carrying it further by means of a steam-jet, he employed a water-jet, on the principle of Montgolfier's water ram, for raising it to the required height; so that Savery's method, though more than a century older than Manoury's, approached nearer to the apparatus under consideration.

In describing the mechanism of the Injector, the author divided the instrument into two distinct parts, by an imaginary plane at right angles to the axis, through the space between the two nozzles, through one of which the jet of mixed steam and water was forced, by the pressure from the boiler, while the other received this jet of mixed steam and water for transmission to the boiler. The instrument consisted of a cylinder, having fixed in it, below the level of the inlet of the feed-water, a conical piece, called the "lance." Sliding in the upper part of this cylinder was a perforated tube, with a tapering termination called the tuyère, and this tube was worked by a handle and screw, by which the area of the annular passage for the feed-water, formed by the conical piece in the cylinder and the tapering termination of the tube, could be varied at pleasure, according to the temperature of the feed-water and the pressure in the boiler, as the higher the pressure the greater the opening required. Within the tube there was a solid plug, called the needle, worked by another handle and screw, and likewise having a tapering end, by which the area of the steam passage could be increased or diminished, by the less or greater extent of the insertion of the needle in the tuyère. When adjusted for work, the action of the steam-jet from the tuyère was such, that a column of commingled water and steam, called the "sheaf," was projected in the direction of the axis of the instrument, through the terminus of the "lance." In the axis of the "lance," and at a short distance from its end, was fixed the second part of the apparatus, consisting simply of a divergent tube, whose properties had long been known, but of the application of which no one appeared to have thought, till the inventor of this instrument availed himself of it, with so much ingenuity and success. Leading directly to the boiler, this tube was furnished with a valve, which, when the work was stopped, closed with the back pressure.

Two modifications of the first part of the apparatus were then noticed. In one, which had been supplied for a stationary boiler, the tuyère, instead of sliding with the inner tube, was fixed to the cylinder, so that it became the terminus of the steam pipe from the boiler; and the inner tube, instead of carrying the needle, contained the "lance" and the divergent tube, and was now, when moved towards the fixed tuyère, the water adjustment, the packing between the water and the steam chambers, which with the moving tuyère was needed, being dispensed with. In the other, which was a modification of the latter, by M. Turck, the water chamber was isolated by the inner tube; and the inner tube, instead of carrying the "lance" and the divergent tube, moved independently of them, as well as of the needle; thus not only dispensing with the packing between the water and steam chambers, but getting rid of packing altogether.

The form of the "lance" had been determined, principally, by experiment. The minimum section of the divergent tube was the unit by which the other parts of the instrument were measured and proportioned, and determined its force of injection. Experiments had given 1·3 for the orifice of the "lance," or nearly that of the tuyère; but at very high pressures this must be reduced to unity, the tuyère then being 1·2.

Respecting the physical properties of the "sheaf," it was remarked that the indraught of the feed-water was accounted for, in the same manner as the working of water bellows, or the blast in locomotive chimneys, by the abstraction of *vis viva* due to an instantaneous change of velocity. The feed-water mixing with the motor steam, which it partially condensed, resulted in a sheaf made up of minute spheres, which, if received into a glass vessel, disappeared with the cessation of motion. Experiments proved that the velocity of the sheaf, so composed of spherical particles, was greatly in excess of that due to the quiescent force of the water in the boiler which it had to overcome. When leaving the boiler at a temperature due to its pressure, the steam escaped from the tuyère, and penetrated a liquid whose temperature was much less, a sudden change took place—an instantaneous conversion of heat into work. It was easy to express, algebraically, the useful effect resulting from this work; it was the force of projection with which the sheaf in each time-unit was moving; it was the dynamic quantity which would be turned into useful work. This quantity had for expression the incorporation of the mass with one-half the square of its velocity. With this force of projection, the sheaf, after leaving the "lance," and traversing the space in communication with the atmosphere, encountered the quiescent force of the water in the boiler, the moment it passed the minimum section of the divergent tube, the slight taper of which permitted, with minimum friction, the expansion of the sheaf around its axis. As this result of the back pressure from the boiler took place, the velocity of each element being converted into pressure, the sum of these effects represented the total energy of the sheaf. In other words, its pressure, in every successive cross section of the divergent tube, became greater, till at the end it attained the maximum, and entered the boiler. From the moment onward motion began and the work of injection took place, then, from the contraction of the sheaf in the "lance" to its expansion in the divergent tube, a simple phenomenon of liquid fluid, as in a conduit, was produced.

The author next alluded, in detail, to a table showing the conditions of working the Injector, for which he was indebted to M. Turck, of the Western Railway of France; and gave another table exhibiting the quantity of water injected per square millimètre of the minimum section of the divergent tube, in gallons per minute, by instruments of four companies, according to experiments made by the "Compagnie de l'Ouest."

The mode of working with the Injector on the Western Railway of France was, according to M. Turck, as follows:—Steam was maintained to the indicated pressure of 9½ atmospheres; going down inclines, the boiler was fixed to the maximum water level, and it was supplied during stoppages at stations, care being taken to arrive with low water. In those stations where the engine had to remain some hours before starting, the steam was at 2, or at most 3 atmospheres; and, as soon as the engine was shunted, the Injectors were set to work to fill the boiler, using up the steam—which would, with pumps and without a donkey engine, be wasted—to 0. There were engine-men who, when the steam was blown off, which seldom happened, were enabled to heat the water in the tender, and who, by feeding on the inclines and at stations, saved, as compared with the same boilers fed with pumps, but without a donkey engine, a kilogramme and a half of fuel per kilometre.

The test of the Injector appeared to be, its comparison with an apparatus, such as Mr. Beattie's, which, abstracting its first cost and that of maintenance, by utilising the heat of the exhaust steam, and by delivering the water at the boiling point, was asserted to effect a saving of fuel to the extent of 13½ per cent., as compared with any process, other than that of the Injector, delivering feed-water at the temperature of 50°. The apparatus was described, but it was contended that this method did not effect a saving of more than 9 per cent. To set against this there was the excess of first cost and of maintenance, the greater liability to accidents, and the increase of back pressure. Those were deemed to be so considerable, that most railway companies, both at home and abroad, now adopted the Injector for all new engines.

It was observed that the application of this instrument as an elevator opened a wide field for its employment; and in conclusion a list was given of all that had been published in France and in this country relative to the Injector, which, with the exception of the information furnished by M. Turck, had formed the data on which the paper had been prepared.

INSTITUTION OF ENGINEERS IN SCOTLAND.

ON A SELF-ACTING APPARATUS FOR STEERING SHIPS.

By Dr. J. P. Joule, F.R.S.

Some investigations in which I have been recently engaged have led me to the construction of magnetic needles having considerably greater directive power than those in common use. It has occurred to me that it might be possible to apply the power, thus increased, to the purpose of the automatical steering of ships. My idea is, to suspend a large compound system of needles or magnetic bars in the way first described by Professor Thomson, viz., by threads or fine wires attached above and below the system. By means of an electro-magnetic relay it would be possible to start a powerful machine in connection with the tiller whenever the ship deviates from a prescribed course.

Suppose a system to be composed of a thousand 4in. bar magnets, each ¼ of an inch in diameter, arranged in a vertical column, say 5 in breadth and 200 in height. According to a rough estimate I have made of the directive force of such a system, I find it to be equal, at one inch from the axis of revolution, to 300 grains, when at right angles to the magnetic meridian. This corresponds to 31 grains at 6° deflection, and 5 grains at 1°. Five grains would be amply sufficient to overcome any resistance to motion offered by a mercury commutator, and 30 grains would be more than sufficient with a properly constructed solid metallic commutator.

I would have a bent wire affixed to the lower end of the system of magnetic bars, one extremity of which should be immersed in a central cup of mercury, and the other should dip in one or the other of two concentric semi-circular troughs of mercury exterior to the central cup.

I would place the central cup in connection with one of the poles of a voltaic battery. The other pole must be in connection with a branched conductor leading to two electro-magnets. The free wires of these electro-magnets should be put in connection with the semi-circular troughs.

By this arrangement it is obvious that accordingly as the wire carried by the magnetic system is immersed in the one or the other of the semi-circular troughs, one or the other of the electro-magnets will be excited.

An armature should be placed between the two electro-magnets, so as to reciprocate between them whenever the wire passes from one semi-circular trough to the other.

In so doing, I would have the armature, suitably connected by levers, &c., to operate on easily-acting valves (throttle valves, for instance), placed in steam pipes proceeding from a steam boiler to opposite ends of a cylinder. A similar arrangement might be made for working the exit valves.

The piston of this cylinder should be connected with the tiller in such sort that whenever the ship turns to the right, the helm will be put to port, so as to bring her back to her course.

It is obvious that, if the dipping bent wire is in the direction of the magnetic axis of the compound system of magnets, and the division between the semicircular troughs is in the direction of the ship's length, the ship will be kept directed to the magnetic north. By turning the commutator in the direction of the hands of a clock, the ship will at once change to a course the same number of degrees west of north.

The use of such an apparatus as I have described would, of course, be limited to very extraordinary circumstances. In general practice it will be impossible advantageously to displace the intellectually-guided hand of the steersman, whose art consists in a great part in anticipating the motion of the ship, and, in heavy seas, in directing his ship so as to encounter them with safety.

In the discussion which followed,

Professor Wm. Thomson said that the general idea contained in the paper was similar to one he had heard described by a friend some time ago, regarding a self-recording compass. But the plan of carrying it out was very different. The plan upon which it acted was, that occasionally something should be moved up to meet the needle, whose position was thereby recorded. For instance, a circle carrying 32 stops, should be moved up occasionally by clock-work until one or other of those stops would be touched by the needle, and a relay moved accordingly, so as to produce a record of the position of the needle at that instant. The plan described by Dr. Joule was essentially different; and the reasoning in the paper bore out the practicability of the plan. No doubt there might be circumstances where the practicability of the plan might prove useful, although, as Dr. Joule had said, there might not be any very extensive use for it.

Professor Rankine said that from Dr. Joule's description of this contrivance it appeared to be practicable, and that it would work when executed. The shifting of the tiller by the action of steam applied to a piston was a practice already known. The new part of this invention was the self-acting method of operating upon the valve, which regulates the admission of the steam to the cylinder. Now, although Dr. Joule had said that it keeps the vessel in a particular course in calm weather, but would require the assistance of a helmsman in rough weather, yet he believed it would turn out to act just as a skilful steersman did. The steersman, in crossing a wave, allows the ship to fall off a little, and then brings her up again; and that was what he thought this contrivance would do—it would allow the bow of the ship to fall off a little at one time, and bring it up at another, and would always correct the deviation. He thought that in practice it would be found to do everything that a skilful helmsman does in crossing the swell of the Atlantic. The fact was, that he had a better opinion of its practicability than Dr. Joule himself seemed to have.

The President did not quite understand how these combined needles were to be worked. It would be most important if any means were devised whereby the course of a ship could be set and kept to by a self-acting steering apparatus. Steering by the aid of steam-power had been in use in America, but it required a man continually to attend it. He would like to know whether the magnets were difficult to keep in order.

Mr. D. Rowan said that, assuming the magnets were quite competent to close the valve, he thought there would be great difficulty in getting the piston to do its part, for in admitting the steam the piston would be apt to go the whole range. He thought there would be difficulty in regulating the steam.

Professor Rankine replied that, since steam could be regulated so that with the steam-hammer a nutshell might be cracked without breaking the kernel, there could not be any very serious difficulty in applying it to steering.

Mr. T. Davison asked whether the combination of magnets would prevent the usual oscillation in compasses aboard ship.

Dr. Joule remarked that a great improvement might be made in the compasses of ships. In coming from Liverpool that morning by steamer, he observed the mate "tapping" the compass to get it to work. Now, he had no confidence in a compass that required "tapping." He thought there was no plan equal to that Professor Thomson had introduced, having the instrument fixed at the top and bottom to a filament. With regard to the combined magnets, it was simply using a pile of bars or magnets, so as to increase the power. The bars might be circular, or flat, or otherwise; and as to the number, suppose there were five to begin with, four inches long, and half-an-inch asunder, they could be piled up so as to give a directive power many times as great as that of one magnet. The oscillation was nearly the same as when only using one, although the power was increased. The magnets could be continued up to any height desired. The oscillation would be at the same speed as a light bar; but there would be power to set in motion a relay, which, communicating with the valves, would let off and on the steam.

Professor Thompson said he felt much interested in the degree of separation of the bars. In his endeavours to control the pendulum of St. George's Church clock by an electric current from the Observatory, he adopted the plan of forming a magnet of a number of bars of watchmaker's rod steel, but he did not find the directive power increased in proportion to the number of the bars; for instance, he found that a magnet composed of 69 bars did not give more than about twelve times the power of a single bar. It would be supposed that 100 bars would have 100 times the directive force of a single bar, but he found that when placed close together they demagnetised each other temporarily to a large degree, and recovered their previous magnetic strengths when separated. It thus appeared that the power depended on the distance they were placed apart, so that if they were placed on the principle adopted by Dr. Joule the power might be increased five or six fold. The advantage of separating the bars, even a small distance, was great; and if circumstances permitted that they could be separated widely then the power was still further increased.

Mr. J. G. Lawrie asked how it would do to separate them 2in. or 4in.?

Dr. Joule said that depended on the length of the bars. His bars were 4in. long, and separated half-an-inch.

The President asked how, with the method of suspension described, the magnets could be kept in a vertical plane when the ship rolled?

Dr. Joule said that he had no doubt that difficulty might be got over.

Mr. Lawrie said that if the suspending filaments were long it would be impossible to keep them quite straight. There would be a *sag* upon them.

Note by Dr. J. P. Joule, received after the paper had been read:—I find on trial that a much smaller number of magnets than that I have given is able to work a mercurial commutator. Fifteen 4-inch bars would be amply sufficient to overcome the adhesiveness of the mercury to the wires dipping into it when the deflection is one degree. A similar observation applies to the metallic commutator. Professor Thomson, however, has shown me a far more delicate mode than either of the above. In this plan a single bar magnet is suspended by a fine platinum wire. To one arm of the magnet a platinum wire is attached vertically. Two horizontal parallel fixed wires are placed on either side of the suspended one. Whenever either of the fixed wires is, by the motion of the ship, brought into contact with the wire carried by the magnet, a current passes to it from the suspending wire. This current excites an electro-magnetic relay, by which another current is thrown upon an electro-magnet powerful enough to work the valves of the steam cylinder. Experiments conducted in the Physical Laboratory of the University are quite conclusive as to the practicability of this plan, and demonstrate the possibility of directing a ship by the agency of a needle much less powerful than that of an ordinary compass.

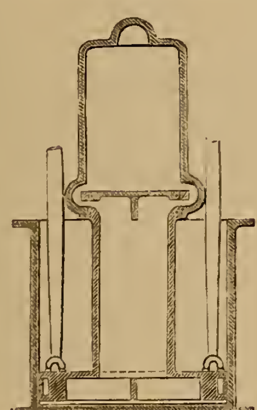
CORRESPONDENCE.

We cannot hold ourselves responsible for the opinions of our Correspondents.

LAKE'S DIFFERENTIAL STEAM ENGINE.

To the Editor of THE ARTIZAN.

SIR,—In the differential steam engine, of which the annexed diagram exhibits a vertical section, great simplicity of construction is achieved, in addition to increased economy in consumption of steam. The engine comprises two cylinders of different diameter, so arranged as to be axially in the same straight line; these cylinders are furnished with pistons, as shown in the sketch, that in the small cylinder being perforated round its periphery between the packing rings. The interior of the piston communicates with a trunk or chamber, which connects it to the large piston in the expansion cylinder, which is open at the bottom. When the small piston is at the bottom of the stroke, as illustrated



the holes in its periphery correspond to others in the curved lateral steam passages, of which the other ends open into the cylinder a little higher up, and through which steam from above the small piston flows, filling the trunk and space below the large or expansion piston.

Let us now examine the effect of the working of the engine, assuming the following dimensions: Diameter of small cylinder, 8in.; of large cylinder, 16in.; stroke, 1ft.; cubic contents of trunk equal those of the small cylinder; pressure of steam above the atmosphere, 60lbs. per square inch, or absolute pressure, 75lbs. per square inch.

The effective area of the small piston may be taken as 50 square inches; that of the large piston being four times as much, or 200 square inches. First we will consider the work done in the down stroke through which the steam acts on the small piston with its full force: we have 50 sq. in. × 75lbs. per sq. in. × 1ft. = 3,750ft. lbs.; the useless resistance is the atmospheric pressure, or 50 sq. in. × 15lbs. × 1ft. = 750ft. lbs., which, deducted from the gross work, leaves as effective work 3,000ft. lbs. done during the down stroke. In the up or expansion stroke, the steam supply is cut off as soon as the small piston has repassed the ends of the lateral steam passages, and then the steam in the trunk continues to expand during the remainder of the stroke; and because the large cylinder is four times the size of the trunk (of which the contents equal those of the small cylinder) it is evident the steam will expand five times, or down to a pressure of 15lbs. per sq. in. absolute; for that quantity of steam which at the commencement of the stroke filled only the trunk, will, at the end of the same stroke, fill the trunk, and in addition thereto the large cylinder. The mean pressure in the up-stroke will therefore be about 45lbs. per square inch; so the gross work done by the steam in the upstroke will be 200 sq. in. × 15lbs. × 1ft. = 9,000ft. lbs. From this must be deducted the prejudicial resistances: first, there is the whole pressure of steam on the small piston (for the small cylinder is always in communication with the boiler; this represents 3,750ft. lbs. work in the stroke. There is also the atmospheric pressure on the top of the annular part of the large piston, —150 sq. in. × 15lbs. × 1ft. = 2,250ft. lbs., making the total prejudicial resistances 6,000ft. lbs. in the up stroke, leaving for effective work 9,000 — 6,000 = 3,000ft. lbs., exactly the same as in the down stroke. Thus in one revolution of the engine 6,000ft. lbs. of work would be done. As soon as the steam in the large cylinder has expanded down to 15lbs. per square inch, a self-acting valve in the exhaust passage which has hitherto been kept closed by the pressure of steam against it, falls open of its own weight, or by pressure of a light spring; so the steam escapes from under the large piston, and another down stroke is made, at the end of which the closing of the exhaust-valve is produced by the pressure of the steam admitted to the large cylinder, or by a tappet. At the end of the up stroke the steam is not all discharged from the large cylinder, as the trunk will remain full at atmospheric pressure; so the steam actually used for each double stroke of the engine will be only four-fifths of a trunk full, or 0·28 cubic feet. If we suppose the engine to be running at 35 revolutions per minute, 588 cubic feet of steam per hour will be used, or 92 cubic feet per horse-power per hour (the power, in the instance cited, being 6·39 horses). This, at 75lbs. absolute pressure per square inch, is generated from 15lbs. of water per hour. with a consumption of 2lbs. of coal—hence the consumption of fuel will be but 2lbs. of coal per indicated horse-power per hour, corresponding to a duty of 110,000,000ft. lbs. per 112lbs. of coals consumed. Comparing this with the Cornish engines, we find the results favourable to the differential engine; for of the 34 engines reported in Cornwall for September, 1864, the average duty was but 49,800,000ft. lbs., and even the highest duty was only 70,800,000ft. lbs.; and the greatest economy yet attained by any Cornish engine over long periods of working was not more than 109,000,000ft. lbs. per 112lbs. of Newcastle coal consumed.

It may be further remarked that in the manufacture of the differential engine comparatively little labour would be required, as there is scarcely any fitting about it, and there is but one valve (that being self-acting), and no glands nor eccentrics. Yours, &c.,

FRANCIS CAMPIN, C.E.

REVIEWS AND NOTICES OF NEW BOOKS.

Vocabulary of Technical Terms in Eight Languages—Civil Engineering and Surveying. By HENRY HALL, Assistant-Surveyor, War Department. London: Edward Stanford, Charing Cross. 1865.

One of a series of technical vocabularies intended for the use of officers of the army, navy, and steam marine, architects, civil engineers, and others.

The words and sentences selected, and given in the present vocabulary, are the leading terms employed in civil and ecclesiastical architecture, military architecture and fortifications, civil engineering and surveying, building, construction, mechanical engineering, the manufacture of iron, &c.; mechanics statics and dynamics.

We have looked through Mr. Hall's book, and find it generally very correct; indeed, it is a very useful little work.

The Fibre Plants of India, Africa, and our Colonies. By JAMES H. DICKSON. London: Wm. Macintosh. 1865.

We know of no previously published work so well suited to give the general reader an accurate knowledge of the subjects treated of as Mr. Dickson's book.

The various fibre plants capable of being cheaply treated for the production of textile fabrics are receiving an amount of attention which only the American War and its effects upon the cotton industries of the world could have produced; and one of the great problems of the day—the cottonising of hemp and flax, and preparing it for spinning in the existing cotton machinery—is treated of very fully by the author. The work is altogether a very interesting one.

NOTICES TO CORRESPONDENTS.

A M. L.—The slide valves of the *Scotia* are, we are informed, common slide valves, with another valve forming, as it were, a shell bolted upon them, and open at the top and bottom. The steam enters through these top and bottom openings, and finds its way to the ports in the cylinder, through corresponding ports in the slide valve proper. The shell is fitted steam-tight to the steam chest-cover, so that the pressure of the steam thus neutralises itself.

R. S. (Turned and bored jointed pipes for gas and water).—The following recipe will be found useful in jointing the lengths of pipes. 1. Coat the pipe joints with a mixture composed of

1lb. red lead .... 1lb. white ditto................ 2lb. whiting	dry.	Use 2lb. 9oz. of raw linseed oil to 10lb. of dry material.

2. Messrs. Maclaren, of the Eglington Foundry, Port Eglington, Glasgow have, we believe, supplied considerable quantities of these pipes. We should recommend you to apply to them.

MECHANIC (Dublin).—We received your letter too late to reply in the present number. We will answer your question in our next, or by post, if you will send us your name and address.

PRICES CURRENT OF THE LONDON METAL MARKET.

	Feb. 4.			Feb. 11.			Feb. 18.			Feb. 25.		
COPPER.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
Best, selected, per ton	89	0	0	89	0	0	89	0	0	89	0	0
Tough cake, do.	87	0	0	87	0	0	87	0	0	87	0	0
Copper wire, per lb.	0	1	0	0	1	0	0	1	0	0	1	0
„ tubes, do.	0	1	1	0	1	1	0	1	1	0	1	1
Sheathing, per ton	95	0	0	94	0	0	93	0	0	94	0	0
Bottoms, do.	100	0	0	100	0	0	100	0	0	100	0	0
IRON.												
Bars, Welsh, in London, per ton	7	12	6	7	5	0	7	5	0	7	5	0
Nail rods, do.	8	10	0	8	10	0	8	10	0	8	10	0
„ Stafford in London, do.	9	2	6	8	15	0	8	15	0	8	15	0
Bars, do.	9	0	0	9	0	0	9	0	0	9	0	0
Hoops, do.	9	17	6	9	15	0	9	15	0	9	15	0
Sheets, single, do.	10	12	6	10	10	0	10	10	0	10	10	0
Pig, No. 1, in Wales, do.	4	10	0	4	10	0	4	10	0	4	10	0
„ in Clyde, do.	2	11	0	2	11	0	2	11	0	2	11	6
LEAD.												
English pig, ord. soft, per ton	20	10	0	20	7	6	20	7	6	20	7	6
„ sheet, do.	21	0	0	21	0	0	21	0	0	21	0	0
„ red lead, do.	22	0	0	22	0	0	22	0	0	22	0	0
„ white, do.	26	0	0	26	0	0	26	0	0	26	0	0
Spanish, do.	19	10	0	19	10	0	19	10	0	19	10	0
BRASS.												
Sheets, per lb.	0	0	9½	0	0	9½	0	0	9½	0	0	9½
Wire, do.	0	0	9	0	0	9	0	0	9	0	0	9
Tubes, do.	0	0	9¾	0	0	9¾	0	0	9¾	0	0	9¾
FOREIGN STEEL.												
Swedish, in kegs (rolled)	15	10	0	15	10	0	15	10	0	15	10	0
„ (hammered)	16	0	0	16	0	0	16	0	0	16	0	0
English, Spring	19	0	0	19	0	0	19	0	0	19	0	0
Bessemer's Engineers' Tool	44	0	0	44	0	0	44	0	0	44	0	0
TIN PLATES.												
IC Charcoal, 1st qua., per box	1	7	0	1	7	0	1	7	0	1	7	0
IX „ „ „	1	13	0	1	13	0	1	13	0	1	13	0
IC „ 2nd qua., „	1	5	0	1	5	0	1	5	0	1	5	0
IC Coke, per box	1	1	9	1	1	6	1	1	6	1	1	6
IX „ „	1	7	9	1	7	6	1	7	6	1	7	6

Fouling of the Bottoms of Ironclads.—At a recent meeting of the Franklin Institute of Pennsylvania, U.S., a letter was read from Rear-Admiral Dahlgren, accompanying a box of shells of some oysters removed from the bottoms of United States' ironclads. The Admiral stated that the oysters had a growth of about six months. The entire bottoms of the ironclads were covered with oysters and grass, to the great loss of speed, which is thus reduced to some three knots per hour, the rapid growth of the deposit rendering continued efforts necessary for its removal. The Admiral adds—"There is reason to believe that zinc paint will prevent the formation of the oyster, but not of grass or barnacle. Still, the removal of even these detaches the paint also more or less, and thus opens the way for the oyster. There is no obstacle so great as this to the use of iron vessels; and I transmit these specimens in the hope that the Institute may consider the subject worthy of its attention."

RECENT LEGAL DECISIONS

AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

Under this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least—less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

Lloyd *v.* the London, Chatham, and Dover Railway Company.—This was a motion for an injunction to restrain the company and its servants from erecting or causing or permitting to be erected or permitting to continue certain piers on the side of their line at the back of certain houses on the east side of Nelson-square, Gravel-lane, Christchurch, Surrey, to a greater height than 18ft. or nearer than 80ft. to the back of the plaintiff's premises, or in any manner at variance with a covenant contained in a contract entered into between the plaintiff and defendants, dated in June, 1863. It appeared that by the indenture in question the company purchased the plaintiff's interest in fee, and the covenant thereinafter contained for £10,711, such sum being for compensation for severance (except damage to party or division walls), and for all injury to the workshops, &c.; the premises purchased consisting of eight out of sixteen dwelling houses. The company formed their line, and the plaintiff's case was that on the 9th of January last he for the first time discovered that, in violation of the covenant, they were erecting the piers in question. The covenant in question was to the effect that the company would not at any time thereafter erect or permit to be erected on their hereditaments or any part thereof within 80ft. of the back of the premises on the west and north of the property of the plaintiff any building whatever of a greater height than 18ft. from the ground, or any chimney of less than 100ft. in height, or carry on any trade, or erect any window or skylight, &c. A good deal of evidence was read, by which it appeared that the piers in question formed part of an addition to the viaduct already existing for the purpose of constructing two additional lines of rails. It also appeared that the company were prosecuting an application to Parliament for extended powers, but this the company contended was contemplated previously, and they had power, under certain preliminary agreements, to make the four lines, to support which the piers previously commenced were necessary. On the other hand, the plaintiff insisted on the strict enforcement of the covenant. The Vice-Chancellor, without calling for a reply, said it was in fact not contended that what was being done was not in contravention of the covenant, but that it did not in fact express the intention of the parties, having regard to the surrounding circumstances. No doubt at the date of the agreement two lines of rail only were contemplated, although the parties were not therefore disabled from making four. The piers having been commenced, and so far complete, there must be an injunction to restrain the continuation of their erection to a greater height than 18ft., and within 80ft. of the plaintiff's property.

The Regent's Canal Company *v.* the Commissioners of Works and Public Buildings.—This was a special case stated for the opinion of this Court. It appeared that when the canal was formed, it was agreed between the company and the agents of the Crown that the company should make that part of the canal which passed through the Regent's Park, and which was formed through a deep cutting, by taking out the soil for the canal, and sloping the banks in the necessary manner, and that the towing path and the bed of the canal should be vested in the company, but that the banks and slopes should continue the property of the Crown, the company paying £180 per acre for the damage caused. A short time back a portion of the bank fell into the canal, whereupon the company brought an action of trespass against the defendants. It was argued for the company that the defendants, as the managers of the Crown property, were bound to have kept these banks in a state of repair when they had once been made by the company, and that they were liable for the damage arising from their neglect to do so. The Court, however, gave judgment for the Crown, being clearly of opinion that there was no cause of action.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

Metropolitan Board of Works.—The Main Drainage Committee reported in support of Mr. Bazalgette's proposition to refer the examination of Mr. Furness's claim for extras to an independent engineer. This view was not, however, taken by the Board. After a long discussion it was resolved, by a majority of twenty-three to five, that the matter should be left in Mr. Bazalgette's hands, and it was expressly understood that this was to be a vote of confidence in him.

New Boiler Regulations in France.—A ministerial decree has been issued in France relative to steam boilers. The following is a *résumé* of the chief instructions issued:—Every boiler, new or old, before it is delivered by the constructor, repairer, or seller, is to undergo a proof under the direction of Mining or Ponts et Chaussées engineers. This proof consists in submitting the boiler to a pressure, double of what it is not to exceed when it is working, for all boilers of a working pressure between half a kilogramme and 6 kilogrammes per square centimetre (7·1lb. and 85·3lb. per square inch(exclusively. The surcharge of proof for pressures under these limits is to be constant and equal to half a kilogramme per square centimetre; for pressures higher than the superior limit the surcharge is to be 6 kilogrammes per square centimetre. The proof is to be made by hydraulic pressure kept up as long as is necessary for the examination of all parts of the boiler. If the proof be satisfactory, a stamp indicating in kilogrammes per square centimetre the effective pressure that the steam should not exceed, is to be affixed to the boiler in such a manner as to be visible after it has been put in place. Two safety valves are to be provided for each boiler, to be weighted so as to allow the steam to escape before, or a least as soon as, the pressure arrives at the quantity marked on the stamp, placed in view of the fireman, showing the pressure of steam in the boiler. All boilers are to have apparatus of sufficient and effective power for supplying water to them. No steam boiler, to be employed in a building, is to be established without a declaration being made to the prefect of the department. Certain boilers are to be established only outside a house or workshop having an upper story where workmen are in regular employment. No boiler of the first class is to be placed at a less distance than 3 metres (9ft. 10⅛in.) from a neighbour's habitation. All furnaces of boilers, of whatsoever class they be, are to consume their own smoke. Six months' delay is accorded to manufacturers to whom no notice was given at the time of authorisation, to execute these last dispositions. The boilers of portable engines are to be submitted to the same proofs, and furnished with the same safety apparatus, as boilers established in a fixed place; so also are locomotive engines.

Welding Iron by Hydraulic Pressure.—Mr. B. Duportail, an engineer, has been trying experiments upon the application of hydraulic pressure to forging and boiler. His experiments were especially directed towards the welding of iron under the hydraulic press, by which a permanent and almost indefinite pressure is produced, by which the welding is effected throughout the mass of the iron, and not merely at a small depth, as under the forge hammer. In his last experiments Mr. Duportail welded, without previous preparation, two pieces of iron, 1½in. square, after heating them to a white heat.

The operation took place with the greatest ease; the iron was moulded like dough, and spread out at the sides whilst the pressure was in action. The pressure was stopped when the thickness at the joint was equal to that of the bars. After cooling, the piece was split in two for the purpose of examining the weld. The appearance was excellent, and one of the two pieces was put under a hammer of $1\frac{3}{4}$ ton, and struck three times, cold. The weld showed itself only under the second blow, and was not completely opened by the third.

A Lighthouse of sheet iron for lighting one of the most dangerous points on the coast of Africa has been commenced in one of the great ironworks of Paris. The same establishment has received orders to construct several large cases of sheet iron to be sent to Egypt for the preservation of corn.

Industrial Exhibitions in the Provinces.—An exhibition of works of art and industry has been opened in Lancaster by the mayor, in presence of a large assemblage of the inhabitants. The Assembly Rooms were chosen for the exhibition, but large temporary buildings had to be added. The title of the exhibition is comprehensive; it is "The Lancaster Exhibition of Works of Art and Industry, Floriculture, Manufactures, Specimens of Natural History, Dioramic and Panoramic Scenery, &c.," and is consequently of a most varied character. A public meeting has been held at Hanley to promote an industrial exhibition for North Staffordshire. Appropriate resolutions were unanimously agreed to.

The Lucknow Exhibition was opened on the 24th December last. All the capital for the Great Exhibition in Bombay has been subscribed, and all the shares have been taken up.

A Crystal Palace and Exhibition at Oporto.—An exhibition is to be held this year at Oporto. A building, mainly composed of glass, will be erected on the eminence of Torre de Marca, near the town; and it is proposed to open the exhibition on the 21st of August.

Bursting of a Tunnel.—A canal, which runs over a tunnel of the Great Western Railway, between the Soho and Hockley stations, near Birmingham, burst through the roof, and the water, escaping from the mouth of the tunnel nearest to Birmingham, flooded the railway station and the adjacent low grounds. An immense amount of damage has been done, and railway communication along the line was stopped for some days. No life was lost.

Gold Amalgamation.—A new amalgamating pan, claimed to be an improvement upon the Freiberg pan, has been invented by Mr. Kenyon, and introduced in the mines of Colorado. It is described as having a main arm resting on the head of a spindle, and driven by gearing beneath the pan. The arm reaches across the centre, and extends on each side half way from the centre to the circumference. At each end is an upright shaft, to which is attached a cluster of mullers, eight in each cluster. They are shaped like a flat-iron, 13in. wide at the head, and are made of French burr. To the top of the cone is attached a stationary cog-wheel, into which there work pinions attached to the upright shaft, thus giving the mullers a constant rotary motion, besides its motion around the pan. The advantages gained are a perfectly even wear all over the pan bottom, and the prevention of the centrifugal motion of the water which drives the ores before the mullers. The capacity of the Freiberg pan is one ton every twenty-four hours, while this pan will thoroughly digest four tons in the same time.

Opening of a Russian Tumulus.—An interesting discovery has just been made in a tumulus at Ekaterinoslaw, in Russia. It consists of a treasure which formerly belonged to a chief of the Huns. Among the different articles is a heavy gold diadem, in which is set a cameo of amethyst of ancient Roman workmanship; also a large collar, bracelets, and drinking cups, with handles formed by animals, the whole of which are in gold of remarkable workmanship.

Increased Value of Ironworks in America.—Mr. B. W. Morehead has recently disposed of the Pine Grove Ironworks, situate in Penn township, Pa., to the South Mountain Iron Company, for the very large price of 1,500,000 dollars. This is an extensive and valuable estate, well wooded and watered, and contains inexhaustible supplies of the purest iron ore. Within a year this estate was sold by Mr. William N. Watts to Jay, Cooke, and Co., of Philadelphia, for the sum of 250,000 dollars, which was then considered a very high price.

The North Haymarket Roof, Liverpool.—The Markets Committee presented to the Council several reports and resolutions on this subject, including reports of Mr. Alfred Waterhouse, architect, and Mr. Robson, with plans and estimates for a roof, combining iron and wood in its construction, with an estimate of cost; also tenders for the completion of the roof according to the original specification, and recommendation that the construction of the roof be proceeded with in accordance with the terms of that specification, and under the direction of the architect and surveyor; and that the tender of Messrs. Burroughs and Son, for the construction thereof, at the sum of £3,720, be accepted. The committee had passed a resolution exonerating Mr. Rollett from any blame or irregularity in the matter of the late accident. The confirmation of the proceedings was agreed to after disposal of an amendment disapproving of the recommendation of the Markets Committee.

Another Novelty in Cabs and other Carriages.—"A Patent Carriage Company, Limited," has been formed at Birmingham, for the purpose of bringing into use sundry novel improvements. The framework is of angle-iron, welded. By using this several inches of space are saved, and added to the accommodation. The panels, which in ordinary cabs are of wood, in these new ones are of papier mâché. The paper resembles leather, but is stiffer and very tough. Every part of a cab usually of wood, indeed, is in this instance made of paper. The springs are beneath the body, which brings the wheels 5in. nearer than in the ordinary vehicle, and yet also gives additional room in the width. The window runs along the roof on the inside, and draws down like a sash; and there is a sash door, which may be pushed down, and coils itself below the body of the vehicle. The ventilation is also improved. One style of Hansom has a top which slides down, and thus an open carriage is provided. The cost of vehicles is said to be considerably reduced by the new mode of construction.

Proposed City Loan.—The Corporation have issued privately a prospectus of a loan of £600,000, with a first issue of £200,000 on debenture bonds, for effecting the improvements authorised by the Holborn Valley Improvement Act, 1864. Mr. Benjamin Scott, the City Chamberlain, has been authorised to negociate its disposal. The bonds will be issued at par, under the common seal of the Corporation, for sums of £1,000, £500, or £100 each, for such fixed periods as may be arranged, not less than ten years or more than eighteen years, by means of coupons at the Bank of England, at the rate of £4 10s. per cent. per annum. The primary security, as provided by Parliament, is the net produce of the City's coal duty, which continues until 1882. The revenue in 1864 was £77,692. For the previous nine years the produce (less drawback) was as follows:—1855, £82,302; 1856, £64,130; 1857, £64,238; 1858, £65,825; 1859, £68,305; 1860, £74,824; 1861, £77,025; 1862, £70,230; 1863, £75,081; 1864, £77,692. There is a prior charge on the funds arising from the duty in the shape of bonds amounting to £376,000 for Cannon-street improvements, involving a present annual charge of £15,265 for interest, which is progressively diminishing as the capital is paid off. In order to make the security still more ample, the Corporation are authorised to secure payment of interest and principal out of their own proper revenue, in value at least £2,000,000 and practically unencumbered. These yield a present revenue of £120,000, without including the value of the Guildhall and other property.

What is an Inch of Rain?—By a recent return of the Registrar-General the following interesting information in respect to rainfall is given:—Rain fell in London to the amount of 0·43in., which is equivalent to 43 tons of rain per acre. The rainfall during a week varied from 30 tons per acre in Edinburgh to 215 tons per acre in Glasgow. An English acre consists of 6,272,640 square inches; and an inch deep of rain on an acre yields 6,272,640 cubic inches of water, which at 277·274 cubic inches to the gallon makes 22,622·5 gallons, and, as a gallon of distilled water weighs 10lb., the rainfall on an acre is 226,225lb. avoirdupois; but 2,240lb. are a ton, and consequently an inch deep of rain weighs 100·993 tons, or nearly 101 tons per acre. For every 100th of an inch a ton of water falls per acre. If any agriculturist were to try the experiment of distributing artificially that which nature so bountifully supplies, he would soon feel inclined to "rest and be thankful."

Dockyard Traction Engines.—In accordance with instructions from the Admiralty a formal report has been prepared by the officials of Chatham Dockyard of the result of the trials made at that establishment to test the working of Aveling and Porter's steam traction-engines, one of which has been in constant use in Chatham Dockyard for several weeks past for experimental purposes, during which it has been put to some of the most severe tests in all descriptions of labour. The results have been invariably most satisfactory. The reports made by several heads of departments all speak in the highest terms of the advantages resulting from the use of the steam traction-engine in such an extensive establishment as Chatham, as compared with the ordinary manual and horse labour. On the score of economy the comparison is still more favourable, the average cost at which one of the steam traction-engines can be supplied for use in the dockyard being 13s. 6d. per day, which is little more than the contract price paid by the Admiralty for a team of horses; while day after day, for some weeks past, the traction-engine has been engaged in transporting loads from one end of the dockyard to the other. This, in the ordinary way, would require as many as twenty horses. The plans are now before the Admiralty for laying down iron tramways through the principal parts of Chatham Dockyard, at an estimated cost of between £20,000 and £30,000. Experiments have, however, shown that three powerful traction-engines, the cost of which would be some £1,500, would, for all necessary purposes, entirely dispense with the proposed tramways, the engines answering all practical purposes, and at the same time doing away with the large outlay now required for the hire of the number of horses requisite to carry on the work at that establishment.

Railway and Canal Bills.—From a report of the Board of Trade it appears that the number of bills deposited this Session which relate to railways, canals, harbours, docks, and tidal waters in the United Kingdom is 439, of which 409 relate to railways. Of those railway bills, 348 authorise new works, which may be classed as follows:—By new companies in England, 162 bills are promoted for the construction of 1,980 miles of railway; in Scotland, 14 bills, for the construction of 392 miles of railway; and in Ireland, 15 bills, for the construction of 306 miles of railway, making together 191 bills promoted by new companies for the construction of 2,678 miles of railway. The number of bills promoted by existing companies is 116, for the construction of 1,262 miles of railway in England; 30 for the construction of 290 miles of railway in Scotland; and 11 bills for the construction of 40 miles of railway in Ireland, making together 157 bills promoted by existing companies for the construction of 1,592 miles of railway. The total length of new lines proposed to be constructed by new and existing companies is, therefore, 4,270 miles; and there are in addition 76 miles of deviation lines. There are included in the above 25 bills for the construction of 91 miles 5 chains of railway in the metropolitan and suburban districts promoted by the following companies:—In the eastern division, by the Blackwall, Greenwich, and Woolwich, 4 miles 26 chains in length; the East London (Thames Tunnel), 8 miles 47 chains; the Great Eastern and London and Blackwall (lease or amalgamation), the Great Eastern (additional powers), 7 miles 3 chains; the Hornsey and Kingsland Junction, 1 mile 57 chains; the King's Cross, Islington, and Limehouse, 5 miles 22 chains; the London and Blackwall and Millwall Extension, 5 miles 10 chains; the Metropolitan and South London, 9 miles 58 chains; the North London, Highgate, and Alexandra Park, 4 miles 38 chains; the North London (widening), 79 chains; the South-Eastern, 4 miles 46 chains; the Tottenham and Hampstead Junction (deviations), 1 mile 4 chains; and the Tottenham and Hampstead Junction (new lines), 8 miles 27 chains. In the western division the Balham and Brixton Junction, 3 miles 10 chains; the Barnet, Hendon, Hampstead, and London, 10 miles 10 chains; the Fulham, 4 miles 63 chains; the Hammersmith and City (alterations), 29 chains; the London, Brighton, and South Coast (additional powers), 1 mile 45 chains; the London, Chatham, and Dover, and the London and South-Western (running powers, &c.); the London, Chatham, and Dover (No. 1), 1 mile 20 chains, widening, 3 miles 10 chains; the Metropolitan (deviations), 23 chains; the Metropolitan and St. John's Wood (extension to Hampstead), 1 mile 3 chains; the Metropolitan District, 78 chains; the North Surrey, 2 miles 16 chains; and the Waterloo and Whitehall, 48 chains in length.

Locomotive Engines on Highways.—A deputation recently waited upon Sir G. Grey at the Home-office, with a view to request him to rescind the orders issued by him respecting the working of traction engines. The deputation was introduced by Lord Kinnaird, who read the following resolution:—"That a deputation be appointed by the meeting to wait upon Sir G. Grey, the Secretary of State for the Home Department, requesting him to rescind the orders which he had already made, restricting the passage of engines on the highways, excepting during the hours of night. Such orders being, in the opinion of this meeting, calculated to cause danger to life, which had not been found to be the case in their progress along the roads in daylight, and that he be requested to substitute regulations for their use during the day, which, if judiciously formed, would be much safer, and obviate all objections." Lord Kinnaird then said he had no doubt that Sir George Grey felt bound, under the Act of Parliament of 1861, to press certain restrictions contained in that Act, but he had found that by the use of the traction engines in the daytime no accident had ever occurred, and he hoped that the Act would be amended. Sir George Grey said that by the fifth clause of the Locomotive Act of 1861, if it was shown that there was wear and tear and breaking up of the roads, and inconvenience and danger by the use of locomotive engines, the magistrates of the county, on representation thereof, would cause him to put the Act in force, and if danger was apprehended he must restrict the hours of the use of the locomotives to the night. There had been a strong representation to him from Agbrigg, in the West Riding of the county of York, to the effect of the danger attending the daylight working, and the issue of the order was prompted by information he had received from some of the justices. If, however, they found it possible to take their engines on the roads without smoke or noise, the order would at once be revoked. Mr. Wells, who was employed on the new buildings, had said that he was employing engines without noise and smoke, and he hoped that such was the fact. He thought the question was one that should go before Parliament. Sir John Hay presented a memorial signed by eight magistrates and ninety-eight landholders. Sir George Grey said he had received a memorial from the Steam Ploughing Company, but he could do nothing until they could show that the Act required modification, which would then rest with Parliament. Sir John Hay said he had memorials in his hand representing 3,000 signatures, which had been got together within a fortnight, and others were still going on. The orders had been issued on the testimony of the magistrates, without the opposition being heard, and without the opportunity of knowing what had been said. Sir George Grey said he did not entirely depend upon the magistrates; their statements were confirmed by others. He heard more than one side of the question. One of the deputation said that, as a practical man and having the use of the steam traction engines, he had travelled from place to place, from 100 to 1,000 miles, but when they perceived a restive horse the engine was stopped and the steam shut off, and he knew of no instance in which an accident had occurred. There was one company which had been paying a dividend of $7\frac{1}{2}$ per cent., which, by the present restriction, had been compelled to dissolve. Mr. Howard said, that all danger might be avoided by having two men, the one to be 100 yards in advance while the engine was on the road, and on the approach of horses notice to be given to stop the engine and shut off the steam. Sir George Grey said, if they could advance any tangible and certain mode by which the frightening of horses could be prevented, and public safety insured, there was no doubt that a modification of the Act would be obtained through Parliament.

Mr. Edward Williams, who has been for upwards of twenty years connected with the great firm of Sir John Guest and Company, of the Dowlais Iron Works and Collieries, has, we understand, been appointed by the Directors of Bolckow, Vaughan and Co., Limited, their general manager, at a salary and commission, which will amount to about £2,500 per annum.

The Establishment of Messrs. James Taylor & Co., Britannia Works, Birkenhead, has been exceedingly active during the past year. Five hundred men are employed therein, and the following is the result of their labour for the year:—120 steam winches, 55 steam cranes, 10 steam travellers, and 35 donkey engines, representing an aggregate nominal power of about 1,800 horses, and a lifting power of 700 tons. These have all been made for our own and foreign Governments, the Mersey Board, and similar large concerns. The economy of using them is now found so great that there is little doubt a very large increase in that trade must take place.

NAVAL ENGINEERING.

The Turkish Frigate "Hodavendiker" was tried at the measured mile in Stokes' Bay on the 10th ult. Her engines are 600 nominal horse-power. She drew on trial 21ft. forward and 22ft. aft.; the indicated horse-power of the engines being 2,770; pressure of steam in boilers, 22lbs.; vacuum in condensers, 27in.; number of revolutions of engines maximum, 62·5; mean, 61·5; mean pressure in cylinders, 25·204lbs.; speed of vessel 11·501 knots; force of wind, 2 to 3, E.N.E.; quantity of coals on board, 325 tons; diameter of screw, 18ft.; pitch, 23ft. 6in. The engines were built by Messrs. Humphries, Tennant, and Co., of Deptford. The engines and boilers worked very satisfactorily.

Italian Ironclads.—At the close of the present year Italy will possess no fewer than fourteen ironclad frigates. Of these vessels, six have been built in France, two in America, one is now nearly finished and another is to be built in England, and four have been almost completed in Italy. The vessel building in England at the Millwall works, and now nearly finished, is the *Affondatore*, or the *Sinker*, and, as her name implies, she is a ram, though only in a very subdued degree, having a small and blunted submarine beak. Her length is 295ft. over all; her breadth, extreme, 40ft.; depth, 21ft.; and tonnage in builder's measurement, about 2,500. She is to have a single two-bladed screw, with engines of 700 horse-power nominal. With such power, and a small midships' section, in comparison with length, the speed of the *Sinker* is guaranteed at not less than 15 knots. The beak of the vessel projects 8ft. beyond the bows, and is of such weight in proportion to its displacement that it acts rather as a check upon her progress than otherwise. She is coated from end to end, and to a depth of 5ft. below the water line, with $4\frac{1}{2}$in. armour-plate resting on a 9in. teak backing and a $\frac{1}{2}$in. inner skin of iron. Longitudinal stringers of wrought-iron 2ft. apart are placed between the teak beams, with their edges abutting on the plates to keep them up to their work. Inside all these defences and within the inner skin come the framing ribs, which are of wrought iron 12in. deep and only 18in. apart. Like most of our ironclads, she has no outer keel, but bilge plates instead, and, unlike all other ironclads in the world, she has a ponderous upper deck, 2in. thick, which is being laid on in two distinct plates of 1in. each. This vessel is intended for two 600-pounders, placed in cupolas amidships—one forward and one aft. The cupolas are to be plain cylinders, grated at the top, and worked from the main deck below with the usual machinery. Their plating will be $5\frac{1}{2}$in. of iron, with 6in. of teak backing. This ship, though much inferior to the average of our English ironclads, is not a standard of what the new Italian navy is likely to be. One of the improved designs of the Italian Government, with models and specifications, by Captain Albini, of the Italian navy, is just now being forwarded to the Italian Government, and after their formal approval the vessel, it is stated, will be at once commenced in this country. The length of this ship between the perpendiculars is 280ft.; breadth, 43ft.; depth, 25ft., with a burden, according to builders' measurement, of about 2,500 tons. The external appearance of the ship is only that of a light steam corvette, with three small masts and one funnel, with a poop-deck and a high topgallant forecastle. Under water, however, she is fitted with a most formidable beak. It is made of enormous strength, and projects no less than 48ft. under water in advance of the apparent bow. Notwithstanding its strength the displacement of this submarine prow is so great that it acts like an air-tight caisson, and gives immense buoyancy to the fore part of the vessel, where it is most needed. This ship is to be coated from end to end, and to a depth of 5ft. below the water-line, with armour-plates of no less than 7in. thickness, backed with 9in. of teak, and lined with an iron skin half-an-inch thick, which abuts upon the massive wrought iron framing of the ribs. No vessel yet built either in Europe or America carries such a casing of solid iron as this. The armament is to be all on the upper deck, and will consist of one 600-pounder forward and three 600-pounders aft. The plan for fighting these guns is admirable. The high topgallant forecastle is simply a huge semicircular shield of iron 8ft. high, and of the same solidity as the sides of the vessel. This in its rear towards the foremast is closed in by a 6-inch screen of iron, loopholed for musketry, and with one small port through which a field-piece can fire and sweep the decks in case of an enemy boarding. This forecastle is roofed in with inch iron, and in it is placed exactly amidships one 600-pounder, which works on a pivot, so that without its weight being shifted from the centre of the vessel it can fire from three ports, either straight ahead or on either bow, as the exigencies of the chase may require. In the after poop, and just abaft the mizenmast, is the main battery, which, though at present only designed to carry two 600-pounders, will no doubt be increased to three guns of this great calibre. These guns, like that in the bows, are placed amidships, and will work on pivots, so as to fire, according as they may be wanted, out of the broadside ports on each side. To enable the muzzles of these guns to clear the port sills without shifting the ordnance from the centre of the vessel, the ports themselves are "recessed," or indented in the side of the ship, like the embrasures in the walls of a fortification. All parts of these embrasures are made of the same solidity as the rest of the broadside—viz., 7-inch iron with 9-inch teak, only the side of this battery looking on to the deck is of 6-inch iron, and this is crenelated for musketry, as in the case of the rear of the forecastle battery. All the hatches are closed with iron gratings, and in place of a centre tower for the captain and officers managing from the deck, there are two, one on each side of the ship, which, like massive iron sentry-boxes, project from the port and starboard bulwarks. This vessel is to be propelled with twin screws, each of four blades, placed far below the water-line and well under the counter. Each screw is worked by an independent set of engines, each of 350 horse-power nominal.

The Imperial Ottoman Frigate "Estogroul," 50 guns, recently fitted with her machinery in the Thames, under the inspection of officers of the English Admiralty, made her official trial on the 11th ult., at the measured mile in Stokes' Bay, near Portsmouth, which was attended with very successful results. The Admiralty Inspector of Machinery and officers of Portsmouth dockyard and steam factory conducted the trial in precisely the same manner as the trials of Her Majesty's ships are carried out on such occasions. The *Estogroul* drew 23ft. 9in. of water aft., and 22ft. 6in. forward, and was complete in stores and in all respects ready for sea. The wind varied from 4 to 5 in force during the time the ship was on the mile. Her mean speed with full boiler power was 12·037 knots, and at half-boiler power 9·641 knots. Her engines are of 600 horse-power nominal, supplied by Messrs. Ravenhill, Salkeld, and Co., of London. They worked exceedingly well throughout the trial.

The Imperial Ottoman Screw Line-of-Battle Ship "Kossova," 80 guns, made her official trials at the measured mile in Stokes' Bay, on the 13th ult. The ship has been recently fitted at Southampton by Messrs. Maudslay and Field, of Lambeth, with engines of the nominal power of 700 horses, under the inspection of the officers of the English Admiralty. The *Kossova's* engine cylinders have a diameter of 77in., with a length of stroke of 3ft. 9in. The boilers have about 21 sq. ft. of heating surface per nominal horse-power. The screw is two bladed, with a diameter of 19ft., and a set pitch on the trial of 20ft., but it can be varied from 20ft. to 24ft. pitch, being bolted together on Maudslay's principle. The screw's leading corners are cut, as is the custom now with all screw blades in use in Her Majesty's navy, on the Admiralty pattern. The screw is "lifting," and is hung in the usual banjo frame. On weighing her anchor at Spithead for her trial over the measured mile in Stokes' Bay the *Kossova's* draught of water was 23ft. forward and 25ft. aft, the upper edge of the screw being then immersed 2ft. 6in., the ship having 425 tons of coals in her bunkers, and being otherwise in all respects complete in stores, armament, and crew, and ready to proceed direct to sea from off the trial ground if required to do so. The wind was rather fresh from E.N.E., with a slight swell over the course. Six runs were first taken with full boiler power. This gave the ship a mean speed of 12·028 knots, the revolutions of the engines being—maximum, 70; and mean, 69·833. The mean pressure of steam in the cylinders was 24·04lb., and the vacuum in the condensers, 25in. The indicated horse-power was 3,606·63, or considerably upwards of five times the nominal power of the engines. With half her boiler power, which followed on her full power trials, the ship attained a mean speed of 10·655 knots, the revolutions of the engines being—maximum 69, mean 59·25, The mean pressure of steam in the cylinders was 16·4lb., and the indicated horse-power 2,117·8. In testing the ship in turning, when she had been taken off the measured mile on the finish of her full and half boiler power respectively, she was found to answer the helm very readily. At full power she made a half circle to starboard in 3 min. 40 sec., and she completed the circle in 7 min. 16 sec. To port she made the half circle in 3 min. 15 sec., and completed the circle in 6 min. 35 sec. With half boiler power, in turning to port, she made the half circle in 3 min. 32 sec., and completed the circle in 6 min. 57 sec. In turning to starboard her time was—half circle, 3 min. 20 sec.; full circle, 6 min. 35 sec. The last test to which the ship's machinery was subjected on her trial was the facility with which she could be managed in obedience to orders sent below from the upper deck bridge, and the result of this was as follows:—Engines stopped, 21 sec.; ditto started ahead, 27 sec.; ditto astern, 9 sec. The engines worked very satisfactorily, and the machinery was reported, in all respects, to be fit for service at sea.

Preserving Iron Ships.—The steam storeship *Buffalo* was, on the 14th ult., dry-docked at Deptford, for the purpose of examining Mr. Leetch's plan of preserving iron ships by means of a sheathing of coarse glass. The *Buffalo* has had more than twelve months afloat, and has stood the test of some severe weather. The surface of glass, as was anticipated, was totally free from animalculæ, seaweed, barnacles, or incrustations of any kind. On the removal of the plates, the side of the ship, bolts, &c., thus protected, were found exempt from corrosion, and appeared in as good a state of preservation as when the experimental sheathing was applied at Woolwich, in December, 1863. The plates, which were bolted on over a solution of gutta percha, were so firmly attached that after the removal of the bolts they required the hammer, chisel, and wedge to remove them. The invention is already widely known, and is about to be fitted, it is stated, to the new iron ship *Affondatore*, in course of construction at the Millwall Ironworks for the Italian Government.

Naval Appointments.—The following appointments have taken place since our last:—W. Gill, Chief Engineer to the *Indus*, for the *Lord Clyde*; T. O. Lewis, Chief Engineer to the *Fisgard*, for the *Spiteful*; T. Carter, G. F. Greaves, W. H. Moon, J. Lea, and Walter Crighton, promoted to the rank of First-class Assist.-Engineers; J. R. Hancock, First-class Assist.-Engineer (additional) to the *Cadmus*; C. J. Cock, Second-class Assist.-Engineer (additional) to the *Megæra*; W. Curtin, Chief Engineer to the *Niger*; E. Wimshurst, First-class Assist.-Engineer to the *Niger*; C. Lawrence, of the *Defence*, promoted to First-class Assist.-Engineer; E. Gossage, Assist.-Engineer to the *Enchantress*; T. L. Walker, Chief Engineer to the *Hector*; G. Aitcheson, Chief Engineer to the *Lion*; G. Metcalf of the *Magicienne*, L. J. Croome of the *Cumberland*, to be Engineers in the Fleet; A. Stewart (a), of the *Swallow*, to be Acting Engineer; C. Lund, of the *Pembroke*, W. H. Wivil, of the *Princess Alice*, J. Clift of the *Raven*, and Josh. Knight, of the *Bombay*, to be Engineers. The following Engineers and Assist.-Engineers belonging to the Sheerness Steam Reserve have received Second-class certificates of efficiency, as the result of the half-yearly examination, which was held in Sheerness dockyard on the 13th and 14th of December, 1864:—Mr. Frederick Bush, Engineer, Her Majesty's steamer *Torch*; Mr. W. Gibson, Engineer, *Tien-Sin*; Mr. George Scholes, Engineer, *Barracouta*; Mr. Edward G. Ashworth, Engineer, *Chasseur*; Mr. George A. Wells, Engineer, *Ruby*; Mr. H. J. Iles, First-class Assist.-Engineer, *Cadmus*; Mr. T. M'Farlane, First Assist.-Engineer, *Mors*; Mr. James Finlay, First Assist.-Engineer, *Icarus*; Mr. G. F. Sutton, First Assist.-Engineer, *Lizard*; Mr. James Wottoon, First Assist.-Engineer *Sponker*: Mr. C. M. Johnson, First Assist.-Engineer, *Wrangler*; Mr. George Thomson, First Assist.-Engineer, *Thrasher*; Mr. David Storrer, First Assist.-Engineer, *Challenger*; Mr. L. J. Croome, First Assist.-Engineer, *Hermes*; Mr. Robert Walters, First Assist.-Engineer, *Lizard*; Mr. William Bryan, First Assist.-Engineer, *Terror*; Mr. W. M. Taylor, First Assist.-Engineer, and Messrs. James Shore, Robert Burridge, Frederick J. Baron, John D. Chater, and George Tricker, Second Assist.-Engineers, *Cumberland*. The examinations consisted of questions prepared by the Rev. Dr. Woolley, LL.D., one of Her Majesty's Inspectors of Schools, in geography, English grammar, composition, French, arithmetic, algebra, geometry, trigonometry, statics, dynamics, hydrostatics, chymistry, and steam and the steam engine. W. Smiley, confirmed as Chief Engineer; J. P. Shearman, confirmed as Chief Engineer, and appointed to the *Asia* for the *Ringdove*; W. T. Beaton, Engineer, to the *Procris* for Gibraltar-yard; R. J. Hay, chief engineer, to the *Indus*, for the *Narcissus*; W. C. Beck, engineer, to the *Prince Consort*; W. H. Grove, engineer, to the *Cambridge*, for the *Redwing*; J. Elwess, assist.-engineer, to the *Indus*, for the *Narcissus*; W. F. Capps, confirmed as chief engineer; E. Parsons, of the *Griffin*, promoted to acting chief engineer; E. Tricker, acting second-class assist.-engineer, to the *Cumberland*, as supernumerary; J. M. Graham, assist.-engineer, to the *Fisgard*, as supernumerary; J. Knight, G. Pratt, and C. Thompson, as assist.-engineers, to the *Royal William*, as supernumeraries; J. Johnson and J. C. Sanders, supernumeraries in the *Indus*, promoted to the rank of engineers; R. Crosswater, engineer, to the *Asia*, as supernumerary; E. Lewis, engineer, to the *Liverpool*; W. Glanpole, Chief Engineer to the *Geyser*; W. Crosbie, Engineer, to the *Blenheim*, for the *Julia*; F. Bush, Engineer to the *Torch*; A. Forrester and E. Barratt, Assist.-Engineers to the *Torch*.

STEAM SHIPPING.

Trial Trip of the "Sir Herbert Maddock."—On the 13th ult. the Indus Flotilla Company's tug steamer, *Sir Herbert Maddock*, made her experimental trial trip on the river below Walker. As this vessel is exclusively adopted for towing, the barges accompanying her were lashed alongside, during the performance, loaded to their working draught. The steamer is 275ft. long, 28½ft. beam, draught of water 2ft. 10in. The barges, two in number, are each 200ft. long, 22ft. beam, 2ft. 2in. draught, and are lashed alongside the paddleboxes while being towed. The engines, 280 nominal horse-power, are diagonal, oscillating; diameter of cylinders, 65in.; stroke, 4ft. 6in. The boilers, four in number, the ordinary tubular marine. The average of the runs made at the measured mile was—Engines, 39½ revolutions per minute; steam, 23lbs. on boilers; indicated horse-power, 1,120; speed, 15 miles. The vessel and barges were built by Messrs. J. Wigham, Richardson and Co., Walker, and the steamer engined by Messrs. Robert Morrison and Co., Ouseburn. The trial gave the greatest satisfaction to all concerned, the contract speed being fourteen miles per hour.

Steam Shipbuilding on the Clyde.—The first of a fleet of steamers now being built for the postal and general service of Java and the other extensive Dutch possessions in the Eastern Archipelago has been launched from the yard of Messrs. Randolph, Elder, and Co. The vessels are to be built on the composite principle, in which the whole of the frame or skeleton is of iron and the interior of wood. The number of vessels required is nine, varying from 1,000 tons and 300 horse-power to 590 tons and 100 horse-power, with large freight and passenger-carrying capabilities. The construction of the four largest of these steamships has been entrusted to Messrs. Randolph, Elder, and Co., and they are being fitted with horizontal geared engines, likely to be attended with economy in respect to fuel. The vessel just launched is named the *Kœnig William III.* She is 225ft. long, 51ft. broad, and 22ft. deep, and her draught of water when loaded will be 12ft. The fine steamer *Europe*, one of the fleet of three built by Messrs. Scott and Co. for the French Compagnie Générale Transatlantique, has made a satisfactory trial of her engines in Victoria Harbour, Greenock. The burden of the *Europe* is 3,400 tons builders' measurement, and she is a sister ship to the *Washington* and *Lafayette*, at present plying between New York and Havre. The machinery of the *Europe*, like that of the sister ships, was made by the Greenock Foundry Company. The engines are side levers of 850 horse-power nominal, and the diameter of the cylinders is 94½in., with a stroke of 105in. The paddles are 37ft. 6in. in diameter. The boilers of the *Europe* are six in number. Four of them are for working the engines, the two others being donkey boilers. The four large boilers weigh, when empty, 60 tons each; they are 22ft. long, 14ft. high, and 12ft. broad. The four boilers have among them 1,131 brass tubes, each 7ft. long and 3in. in diameter, and they are fired by 24 furnaces, each 10ft. long.

Iron Shipbuilding on the Humber.—On the 14th ult. four steamers were launched at Hull; three of which were from the yard of the Humber Ironworks and Shipbuilding Company. The first ship launched from this yard was named the *Sun Gleam*. She has been built for Mr. J. Smurthwaite, of Sunderland, and is intended for the East India trade. Her dimensions are—Length between perpendiculars, 210ft.; beam, 36ft.; depth of hold, 23ft.; builders' measurement, 1,250 tons. A tug steamer, named the *Nile*, was next sent off the stocks. She is intended to ply on the river after which she is named, and has been built for Messrs. Ellison and Company, London. Her length is 102ft; breadth of beam, 17ft.; depth of hold, 8ft.; measurement, 107 tons; horse-power, 60. The next vessel launched was named the *St. Mungo*. She is the property of Messrs. Gilmour, Rankin and Co., London, and is intended for the East India trade. The *St. Mungo* is a massive structure, and there have been used over her construction about 1,000 tons of iron, her plates being about an inch in thickness. She is classed A 1 at Lloyd's for 12 years and at Liverpool for 21 years. She was launched on the "guillotine" system, the ceremony consisting in merely severing a riband. The dimensions of the *St. Mungo* are as follows:—Length between perpendiculars, 23ft.; breadth of beam, 36ft. 6in.; depth of hold, 23ft. 6in.; measurement, 1,370 tons. About the same time these launches took place, Messrs. C. and W. Earle and Co., whose yard is a little further down the river, sent off the stocks a magnificent steamer which has been built for Messrs. Wilson and Chambers, Liverpool, and is intended for the Mediterranean trade. She is provided with self-ballasting apparatus, and will be fitted with engines of 90 horse-power. Her length is 220ft.; breadth of beam, 26ft.; depth of hold, 16ft.; measurement, 700 tons.

Shipbuilding on the Thames.—On the 11th ult., two vessels were launched from the yards of the Thames Ironworks at Blackwall and that of the Millwall Ironworks at Poplar. The *Napoleon III.*, built at the Thames Ironworks, has been constructed for the Compagnie Générale Transatlantique. This is one of the largest and most powerful paddle steamers lately built, her burden, by builders' measurement, being nearly 4,000 tons, while her nominal steam power is to be 1,000, which is capable of being worked up to at least 6,000. Except the Cunard vessels no paddle steamer of such size and power has been built for some time past. Her length even between the perpendiculars is no less than 363ft., her breadth for tonnage 46ft., her depth 33½ft., and her tonnage 3,791 tons. Messrs. Ravenhill, Salkeld, and Co. are to be the makers of her engines. The *Rhone*, which was launched from the Millwall Works, has been built for the Royal Mail Steampacket Company. She, like the *Napoleon*, is a remarkably fine vessel, built for great speed and ample passenger accommodation. Her tonnage is in round numbers 2,500 tons. Her length over all is 310ft., with a breadth for tonnage of 40ft., and a depth amidships of 25ft. Her engines are to be 500 horse-power nominal, and capable of working to at least 3,000. Both launches were accomplished with perfect success.

Shipbuilding at Preston.—We noticed in our January number the shipbuilding works lately established at Preston, under the title of the Preston Iron Shipbuilding Company. We believe that it needs only a fair outlay of capital, with judicious and enlarged views, to make Preston a great port in every sense of the term. Even now there is length and depth enough of water in the Ribble to launch vessels of any size, and were wet and dry docks constructed, the immense strides the commerce of the port would take (with its consequent increase in the value of property) cannot be calculated. A centre of railway communication, with lines diverging to all parts of the kingdom, at the very door of all the consumers of the imports, with a large population of skilled artizans, it needs only such works as these, and establishments on a proper scale for the manufacture of marine engines (so that when the hulls of steamers are building, the engines may be fitting on board), to enable Preston to compete successfully with any port in the kingdom, for the construction of large ocean steamers.

LAUNCHES.

The Launch of the Paddlewheel Despatch-vessel "Helicon" has been successfully effected from No. 1 building slipway of Portsmouth Dockyard. The *Helicon* in all probability is the last wooden vessel that will be launched from Portsmouth Dockyard. For the duties of a vessel attached to a squadron of ironclads the *Helicon* will be admirably adapted, for, from her graceful lines and power of engines as compared to her tonnage, she will undoubtedly prove the fastest craft of her size in Her Majesty's navy. Her draught of water was found to be 6ft. aft and 4ft. 2in. forward. The following are the *Helicon's* principal dimensions:—Length between perpendiculars, 220ft.; length of keel for tonnage, 200ft. 1½in.; breadth, extreme, 28ft. 2in.; breadth for tonnage, 28ft.; breadth, moulded, 27ft. 2in.; depth in hold to top of floor, 14ft. 6in.; burden in tons, 834 4-94ths. She was launched as a mere shell, and her machinery has yet to be placed on board. This will consist of a pair of oscillating cylinder engines, driving feathering float paddlewheels of the collective power of 250 horse-power, nominal. Messrs. Ravenhill, Salkeld, and Co. are the makers. The *Helicon* was originally laid down from the same lines as the Admiralty paddle-yacht *Enchantress*, and the *Psyche* and the *Salamis* despatch-vessels.

TELEGRAPHIC ENGINEERING.

Atlantic Telegraph Company.—At the eighth ordinary general meeting of the Atlantic Telegraph Company, the directors, in their report, which was adopted, stated, that at present the new form of cable showed every probability of fully answering the expectations formed of it. The Hon. Mr. J. S. Wortley, the chairman of the company, observed that at present 1,120 miles of cable had been fully completed, and tested foot by foot—in fact, tested more than was necessary. It was proposed to lay the cable in the fine weather, between May and July, and by the end of that month it was hoped that the great enterprise would be successfully accomplished.

Electric and International Telegraph.—The report of the directors states that the net profit on the operations of the company for the half-year, after making every provision for the working charges, interest on debentures and loans, and the special vote of £1,000 to the late secretary, amounted to £54,076, against £50,568 in the corresponding period of 1863. The directors recommended a dividend of 4 per cent. for the half-year on the stock and shares of the company, leaving a balance of £14,831 to be added to the trust fund, which would then, with the accumulated interest, amount to £54,672. The directors had decided on extending their system through the north of Ireland, and connecting Belfast with Scotland by a cable across the Channel near Portpatrick. This extension would bring into communication with England and the Continent the active commercial districts of Ulster, and the company would also be secured by the possession of a double connection from such an interruption and consequent loss of traffic as had recently occurred by the temporary failure of their cable from Wexford to the Welsh coast. In repairing this cable the directors had used some miles of thick shore-end, specially constructed for the purpose, and the expense of this renewal would be charged against the fund for that purpose. The other extensions of the company's system during the half-year were 111 miles in length, principally for railway companies. The revenue account for the half-year showed that £141,590 had been received, and £87,513 expended, leaving a balance of £54,077.

Submarine Telegraph Company.—The half-yearly ordinary meeting of the shareholders of the company was held on the 21st ult. The secretary read the report for the half-year ending the 31st of December, which showed the receipts to be £26,823 3*s.* 5*d.*, against £25,184 1*s.* 2½*d.* in 1863. After adding £2,682 6*s.* 4*d.* to the reserve fund, there remained a sum of £11,791 15*s.* 11*d.*, which enabled the directors to recommend a dividend at the rate of 5 per cent. per annum, and to carry over to the next account the sum of £603 14*s.* 4*d.*

RAILWAYS.

Railway at Warsaw.—A projected line from Sandomir to Warsaw, which has long been in abeyance, will be carried out before long, especially in consequence of the great forges and ironworks in the neighbourhood of the route determined on, and the purchase of which is contemplated by a French company.

"Metropolitan District Railway."—This is the title of a new undertaking introduced by an influential board of direction. The object is to complete the "inner circle" of the metropolitan lines of railway lately authorised by Parliament, by means of the line to be formed between the City and the West-end of London *via* the Thames Embankment. Ultimately, the line will extend from Trinity-square, Tower-hill, to Kensington, thus completing the "inner circle." There will be eleven stations upon the line. The capital required is £3,600,000, of which the first issue will be £2,000,000, divided into provisional scrip certificates to bearer of £100 each, and interest at the rate of 6 per cent. per annum will be allowed on the fully paid-up capital during construction.

On the Propulsion of Trains on Lines with frequent Stations.—A paper "On the Best Mode of applying Power to Propel Trains on the Metropolitan Lines having frequent Stations and in Terminal Stations," was read on the 18th of January last, by Mr. P. W. Barlow, F.R.S., at the Society of Arts. Mr. Barlow recommends a modification of the rope traction system with stationary power to give temporary impulse in the place of locomotives. He says:—"When the duty to be performed is that of working a line in which the stations are very close together, and the stoppages frequent, it then results that all, or nearly all, the work of the engine is expended in acquiring the travelling speed; and that, in fact, it has not ceased to accelerate its speed when it becomes necessary to shut off the steam and apply the brakes, so as to stop at the next station. In fact, the same engine which in long stages would make an average speed of 35 or 40 miles per hour, is incapable, with frequent stations, of making an average speed of 13 or 14 miles, even with a greatly reduced load. In this condition of things, which is in fact the condition of metropolitan railways, a new set of circumstances has to be met, and the question arises whether, where these circumstances exist, stationary power, when applied in a manner strictly adapted to the case, is not more economical—capable of greater speed—and in all respects more suitable to the convenience and exigencies of the traffic and locomotive power?"

A Pneumatic Railway is projected at Scarborough to connect the north and south sands.

The Birkenhead Commissioners have petitioned Parliament in favour of the bill for connecting the Liverpool and Birkenhead Railways by a tunnel below the River Mersey.

A Tunnel at Newmarket has partially fallen in. The cause of the accident was an unusual flow of water from the Warren-hill, occasioned by sudden thaw, partially washing away the earth from the abutments, and so greatly affecting the condition of the brickwork that between 50ft. and 60ft. of the wall gave way.

The Goring Station of the Great Western Railway, between the Didcot and Reading Junctions, has been destroyed by fire.

The Bickley Tunnel, on the South-Eastern Railway, has been completed. The tunnel forms a portion of a new route to be opened up between London and Dover and the south coast, and which will shorten the present distance by the South-Eastern lines between London and Dover, St. Leonards, Hastings, Folkestone, and the Continent, by thirteen miles. The new line leaves the Lewisham Junction of the North Kent and Mid Kent Railways, and runs in an almost perfect straight line to the present Tunbridge Station of the South-Eastern, passing on its way through Bickley, Chiselhurst, and Sevenoaks. The tunnel at its greatest depth is about 40ft. below the surface, and in others it is not more than 4ft. or 5ft., and might, therefore, have been much more conveniently made in open cutting through Sundridge Park, to which, however, the owner, Mr. Samuel Scott, very naturally objected. The tunnel is egg-shaped, is built of unusual strength, and 964 yards long.

Midland Railway Tunnel.—The first brick of this tunnel, intended to pass under Hampstead, and to form a portion of the Midland extension line into London, has been laid. The tunnel will be 1,800 yards in length, and at its greatest depth will be 35 yards below the surface. The first brick was laid at a spot in Barham Park, near the Hampstead-road.

The Great Western and Vale of Neath lines are now virtually amalgamated. The bill has passed the standing orders, and the engineers of the Great Western Company now run through with coal trains from Aberdare to Swindon. The Great Western has thus two distinct lines communicating with the metropolis from places as far west as Swansea.

The Model of a new Electro-Magnetic Locomotive is now exhibiting at Versailles. Its inventors, MM. Bellet and Rouvre, assert that locomotives constructed on their principle could travel on ordinary railroads at the rate of 124 miles an hour! The power is obtained by magnetising and de-magnetising, by means of a current supplied by a fixed battery; and, it is said, only a small part of the force developed is thus utilised.

The Somerset and Dorset Railway Company have confirmed the agreement with the North Somerset Company, for a through communicatiou with Bristol by a narrow gauge line. Should this project be successful, the line will run from the Pylle Station, on the Somerset and Dorset line, to Shepton Mallet, and by the North Somerset line, through Radstock, to Bristol.

The London, Chatham, and Dover Railway Company from the present date propose to run trains once a day from Victoria to Ludgate Hill Stations, exclusively for the working classes, the fare for the douhle journey heing a shilling a week. The distance between the two stations is nearly three miles, so that the shilling will cover a mileage of about thirty-six miles! The line is said to have cost nearly £1,000,000 per mile.

The Proprietors of the Blackwall Line have agreed to lease their property for 999 years to the Great Eastern Company, at 4½ per cent. per annum.

The Divinend of the Lonnon and North-Western Railway is at the rate of 7 per cent. per annum; the Caledonian, 7¼ per cent. per annum; the Taff Vale, 10 per cent.; Bristol and Exeter, 5½ per cent.; and the South Eastern, 5¾ per cent. Each of the ahove are in excess of last year. Rumour speaks of 4 to 4½ per cent. as the next Great Western dividend.

The Largest Locomotive in the World.—A locomotive has recently been set to work on the Philadelphia Railroad, between Schuzlkil and Port Richmond. This locomotive, which is claimed to be the largest in the world, is to travel on a gradient of 7·100, on a length of about two miles. Its chief dimensions are as follows:—Diameter of cylinder, 20in.; stroke, 26¾in.; length of connecting rod, 11ft. 5⅝in.; number of wheels, 12; diameter of wheels, 3ft. 6in.; distance of axles from each other, 3ft. 11¼in.; diameter of boiler, 3ft. 3in.; diameter of boiler tubes, 2in.; length of tubes, 10ft. 2in.; numher of tubes, 174; length of firebox—internal, 9ft.; width, 3ft. 6in.; height, 2ft. 1iu.; area of fire-grate, 32¼ sq. ft.; aggregate heating surface, 1,421 sq. ft.; total length of engine, 35ft. 11in.; width, 8ft. 8¾in.; weight of engine, 45 tons; capacity of water tanks, 1,200 gallons; numher of Gifford's injectors, 2; Anthracite is used as fuel; two water tanks are provided on each side of the firebox underneath the heating platform; there is a third tank above the firebox. This locomotive is stated to have worked well ever since August, 1854, but to be liable to frequent damages.

DOCKS, HARBOURS, BRIDGES.

New Bridge across the Thames.—The foundation-stone of a new railway bridge across the Thames was laid on the 22nd ult. by Lord Harris, the vice-chairman of the London, Chatbam, and Dover Railway Company. It is an addition to, and closely adjoining, the bridge the Company have already constructed to lead into the Victoria Station, which has already been found to be fully occupied by traffic, and is expected to be altogether inadequate to meet the increased demand when the inner circle of metropolitan railway communication is completed.

MINES, METALLURGY, &c.

Coal-Cutting Machinery.—An engine has been designed by Mr. J. A. Reed, of New York, which, although originally intended for an entirely different purpose, would probably he applicable as an economic means of compressing air for coal-cutting machines and similar purposes. It is a combination of two oscillating cylinders, both placed in line, and acting on a crank shaft between them. One cylinder is for steam, 8in. bore, the other is for pumping air, 5½in. hore. They are without valves or valve gear, and may he run at high speed without the clanking and concussion usual in pumps; and this is claimed as a great advantage in an air-compressing engine, which must run fast in order to overcome the resistance of the compressed air near the end of the stroke, when the fly-wheel is not inconveniently heavy, and only one steam cylinder is used. The distribution of steam in this engine is effected hy the relative positions of the steam and exhaust ways in the framing and in the cylinder. The sides of the cylinders near the ends are planed, and have ports opening into the cylinders, the ways being as short as possihle, so that there may he the least room to he filled hy steam that does no work. The side frames are cast with steam and exhaust ways in them, and faces are planed on them to fit against the faces on the cylinders, and the openings are so situated that steam is admitted and exhausted properly. There is hut little lap, just euough to avoid blowing through; but this is deemed suitable for an engine that compresses air, and has its greatest resistance during the last half or third of the stroke. The same arrangement of ports and ways is suitable for the air-pumping cylinder, the clearing space being as small as possible. To lessen the clearance space a little crude petroleum should be admitted with the air, which will lubricate the piston and cylinder faces, and prevent leakage of air. There is a fly-wheel which carries a helt when it is required to use the engine for boring or other work, in which case the air-pumping piston-rod is disconnected from the crank pin. The hoiler is of the form most favourable to strength, and made strong enough to work with perfect safety at 150lbs. pressure. The air pressure will sometimes be 250lbs. Under such a pressure the common slide valve would work with much friction, and would prohahly wear fast; but in this engine the pressure tends to prevent wear, and produce leakage. The leakage is visihle outside, and can he stopped hy screwing up the nuts on the rods which hold the frame to the cylinder while the engine is running.

New Coal Theories.—At the Geological Society, Mr. Thos. Goodall, of Craigderran, read a paper entitled "Some Observations on Coal." He stated that he believed coal may yet he found at depths which at present we have no idea of, and that the use of coal would be entirely superseded 200 years after this; and that our descendants, although they may give us credit for doing well in so far as our knowledge extends, will still consider that our mode of producing heat has been very clumsy, and not at all suitable for them. He believed that coal was formed hy a process of what might be termed "simplification," and that the carboniferous period formed "the happy medium for the proper development of coal." The strata must have heen at first a heterogeneous and undeveloped mass, which was afterwards changed into coal by mechanical, chemical, and other means; and he believed the formation of coal to be in actual operation at the present day. An animated discussion followed.

Puddling Iron.—The Dowlais Iron Company have for some time past been makiug a series of important experiments how to convert pig into finished iron altogether by machinery. A few months ago they purchased the patent for a rotary furnace, obtained in 1853 by Mr. Bernard P. Walker, a cut-nail manufacturer of Wolverhamptou, and the manager of the company, Mr. Menelaus, has heen experimenting with it until, after making certain alterations in its shape and attendant apparatus, he has pronounced the method a success, and his company, equally convinced, have autborised the laying down of considerable works expressly for the making of iron hy this process. The discovery was to be hrought before the scientific world at the annual meeting of the Institute of Mechanieal Engineers in Birmingham, at which Mr. Menelaus had arranged to read a paper "On Machine Puddling." The entry of this subject on the notice paper calling the meeting drew together ironmasters from Scotland and Wales, and other somewhat remote districts, hut the time allowed for the reading of papers was consumed in the discussion on the first paper on the list, which related to metrical measurement. Mr. Menelaus, therefore, simply remarked that he had satisfied himself on the merits of the rotary furnace; and, as the best substitute for his paper, would there give an invitation to all the members of the Institute to be present a month from that day at the opening of the new works, when they might judge of its value by a personal inspection of its working. The manager of the Dowlais Company was present, with the engineer, to support this invitation, and introduced the inventor of the furnace to other members of the Institute. Ready to illustrate the paper, there were lying in the Institute room an immense "bloom" of iron, looking like a huge egg, and weighing 5 cwt., showing the state of the iron as delivered by the furnace, and specimens of iron in a finished state made from similar blooms. They were subjected to a close scrutiny by members of the Institute, and were pronounced to be of much superior workmanship to that usually produced by puddling hy manual labour. Eight furnaces capable of making 60 tons each per week are being erected in the new works, and by their operation iron will not only be puddled much better, but at considerably less cost than on the old principle. Too much importance cannot be attached to the discovery being made known on the eve of an aggregate meeting of all the ironmasters of England, called together to determine upon a universal lock-out of puddlers.

Gases in Coal Pits.—Mr. Samuel Plimsoll, who has for many years been connected with the London coal trade, has just drawn the attention of the colliery proprietors in South Yorkshire to a question of vital importance to them; and should the idea he bas suggested lead practical and scientific men to turn their attention to the subject, explosions in coal pits will in a great measure be avoided, and the loss of life proportionately diminished. Since the explosion at the Lund-hill colliery he has paid much attention to tbe subject of gas in coal-mines, and he has ascertained two things—first, that earburetted hydrogen gas is in pits distinct from the pure air; and, secondly, that it being only half the weight, an instrument might be invented which conld show to what extent the gas prevailed, and consequently to what extent danger was present. He proposed to attain this by placing a vertical glass tube, open at the ends, in a niche in a part of the pit where an impure atmosphere exists, and the column of air inside would resemble that outside of it. If a small balloon of gold-beater's skin was inflated with the lighter gas and put in at the bottom of this tube, it would rise to the top of the stratum of common air, because it would be lighter, and wherever this balloon rested it would indicate the dividing line between the pure and impure gas, the balloon resting upon tbe common air, and sinking a little way into it as the keel of a ship upon the water. He also pointed out another way by which, with a tape previously prepared chemically, tbe presence of impure gas would be clearly defined, and the miner would thus have placed before his eyes to what extent the foul gas existed. Mr. Plimsoll stated that he had been in communication with Dr. Allen, the ex-President of the Philosophical Society at Sheffield, and Mr. Peacock, the secretary of the Coalowners' Association, both of whom approved the plau, and thought that if the subject was taken up by practically scientific men much good would result. Mr. Plimsoll stated that bis only reason in moving this, as it appeared to him, vital matter, was the great loss of life that had heen occasioned in the South Yorkshire district, of which he enumerated the following:—1841, 15 men killed at Mount Osborne Colliery; 1846, 73 at the Oaks; 1847, 9 at Beeston Main; 1849, 75 at Darley Main; 1851, 50 at the Warren Vale; 1857, 189 at Lund-hill; 1860, 14 at Higham; and 1862, 52 at Edmund's Main. The subject of Mr. Plimsoll's communication has excited much interest throughout South Yorkshire, and from the attention that has already been directed to it, it is expected that some practical results will ensue.

ACCIDENTS TO MINES, MACHINERY, &c.

Colliery Accident at Salt Wells.—On the 9th ult., an accident happened at No. 10 pit, Salt Wells Colliery, by which six miners lost their lives. The colliery belongs to the Earl of Dudley, but is managed by Mr. Samuel Davies. At half past six o'clock in the morning the men went down to work, and the pit had been inspected, as is usual. Mr. Davies and the "doggy" left the workings, and almost immediately after a crash was heard, and it was ascertained that the men were huried heneath a mass of coal, weighing some 50 or 60 tons. Every endeavour was made to rescue the meu, hut when got out in each case life was extinct. The pit had beeu at work in the thick coal and ironstone for eight years, and this is the first accident that has yet occurred in it.

GAS SUPPLY.

Crystal Palace District Gasworks.—Testimonial to the Secretary and Manager.—On the 6th ult. a very pleasing gathering took place of the officers and employés of this company, who had assemhled for the purpose of presenting a very handsomely chased silver tea urn and salver, which had heen suhscrihed for and purchased hy those engaged on the works to Mr. Magnus Ohren, the esteemed secretary and mauager. A goodly company of visitors, iucluding, amongst others, Professor Glaisher and Mr. H. Coxwell, were present. The chair was taken by Mr. Arliss, who, after the company had partaken of the supper provided for the occasion, presented tbe testimonial to Mr. Ohren, accompanying the presentation with a few very appropriate and feeling remarks, and explaining that "it was the offspring of the spontaneous and heartfelt feeliugs of the workmen employed under him." Mr. Ohren, in returning thanks, drew a very pleasing picture of the zeal shown by all the officers and men in tbe employ of the company in the execution of their respective duties, and of the kindly feeling whicb existed between them.

An Explosion of Gas recently occurred in Greyfriars Church, Reading. It appears that the usual weekly service had heen held, and at its conclusion the incumbent and the memhers of the choir remained in the edifice to practise psalmody. During the time they were singing it hecame strongly evident that there was an escape of gas not far distant from tbe organ. One of the choir hegan to try to discover the place of escape, and incautiously placed a lighted candle near the gas staudard erected not far from where the choir were seated, and by means of an aperture in the ironwork the flame must have ignited the gas which had collected under the floor, and the consequence was that an explosion ensued. The incumhent was blown up from his seat, and fell on the floor, injuring his face, hut not severely. In addition to this, about ten or cleven pews were hlown up, the wood heing broken into splinters. Such was the force of the explosion that some large pieces of wood were carried to tbe extreme end of the building.

The Kent Gas Consumers' Company.—Steps are being taken to form a uew gas company, to he called the Kent Gas Consumers' Company, for the henefit, especially, of Lee, Blackheath, Lewisham, and the vicinity. The nominal capital is £100,000 in 10,000 shares of £10 each, the first issue heing £25,000. The company propose to supply fittings and maintain them in good repair, charging a rental of 7½ per cent. per annum on the amount so expended. Their maximum charge for gas will be 4s. 2d., and they propose to reserve power to pay a dividend of 1 per cent. over and above 10 per cent. for every reduction of 2d. per 1,000 cubic feet from 4s. 2d. they may make. At the Plymouth or Nottingham prices for gas they would therefore be entitled to share dividends of something like 17 or 18 per cent. per annum.

GAS REGULATORS.—These regulators, patented as a commnnication from Mons. Girond, of Paris, consist of movable valves or hollow plungers, worked by what is called the regulating gas—that is, the gas on its way to the burners from the regulating apparatus, the plunger being suspended from a weighted crank or beam, and being only worked when the supply is in excess of the combustion. There are also concentric chambers, in which the valves work, such chambers acting as water spaces and gas passages. The under part of the float or plunger is conical. The system may be adapted to pressure indicators, and to working clocks or time-keepers.

THE CORPORATION OF STOCKPORT have given notice of a reduction of 6*d.* per 1,000ft., after the 1st of July next. The price then will be 3*s.* 6*d.* per 1,000ft., both within and beyond the borough boundary, with discounts, by which their large consumers will be supplied at 3*s.* per 1,000ft. Their gas is manufactured entirely from the best Wigan cannel, and is of twenty-four candles' illuminating power.

THE SUTTON GAS COMPANY have made a reduction for the last quarter from 7*s.* to 6*s.* 6*d.*; and the Newcastle-under-Tyne Company announce a reduction from 4*s.* 6*d.* to 4*s.*; last year this company reduced their price from 5*s.* to 4*s.* 6*d.*; notwithstanding these successive reductions, they have just declared a dividend at the rate of 10 per cent. for the last half year.

THE PHŒNIX GASLIGHT AND COKE COMPANY, lighting a great part of the south and south-east of London, have also issued a notice to their consumers, that from and after the 31st of March next the price of their gas will be reduced to 4*s.* in the town, and 4*s.* 3*d.* in the country part of their district.

THE CITY, CHARTERED, AND GREAT CENTRAL GAS COMPANIES, which now supply the citizens of London with gas, have addressed communications to the City Commissioners of Sewers, stating that they will, at Christmas next, reduce their price to 4*s.* per 1,000 cubic feet.

THE DIRECTORS OF THE EQUITABLE GASLIGHT COMPANY, which supplies gas in the vicinity of Charing-cross and South Belgravia, have given notice that on the 1st of July next the price of their gas will be reduced from 4*s.* 6*d.* to 4*s.* per 1,000 feet.

THE COMMERCIAL GASLIGHT AND COKE COMPANY, Stepney, have also issued a notice to their consumers in the eastern part of the metropolis, that from and after the 31st of March next, the price of their gas will be reduced from 4*s.* 5*d.* to 4*s.* per 1,000 cubic feet.

THE CHELMSFORD GAS COMPANY have resolved to reduce the price of their gas to the consumers generally at Michaelmas next, from 5*s.* 5*d.* to 5*s.*, with a discount of 5*d.* for cash payments, making the net charge 4*s.* 7*d.*

THE WARWICK GAS COMPANY have resolved to reduce their gas 6*d.* per 1,000ft. for the current year. This has brought the price down to 5*s.*, and for speedy payments another 6*d.* per 1,000 is allowed.

THE CROWLE GAS AND COKE COMPANY have agreed to reduce the price of their gas. The chairman announced a dividend of 10 per cent., and the reserve fund exceeds that of former years.

THE CHESTER UNITED GAS COMPANY have declared their usual dividend of 10 per cent. on ordinary stock, and 7 per cent. on preference stock, with the arrears of dividend for 1861, amounting to 13*s.* 1*d.* per cent.

THE TONBRIDGE WELLS GAS COMPANY announces a reduction of price from 5*s.* 5*d.* to 5*s.*, and the Canterbury a reduction to 4*s.* 6*d.* The Whitstable Company have reduced their price from 6*s.* 8*d.* to 5*s.* 10*d.*, but the consumers are not satisfied.

THE PENRITH GAS COMPANY have agreed to charge 3*s.* 9*d.* to private consumers, and £2 per lamp per annum from the highways committee of the local board.

THE WORCESTER GAS COMPANY have declared a dividend at the rate of 10 per cent. per annum for the last half year.

THE LANGTON GAS COMPANY have announced a reduction in their price from 4*s.* to 3*s.* 8*d.*, with discount of 5 per cent. for prompt payment.

THE NOTTINGHAM GAS COMPANY have reduced the price of their gas from 3*s.* 2*d.* to 3*s.*, and further to large consumers in proportion.

THE CROFT AND HURWORTH GAS COMPANY (Darlington) have declared a dividend of 8 per cent., with a surplus for reserve fund.

THE IPSWICH GAS COMPANY have reduced the price of their gas from 4*s.* to 3*s.* 9*d.*

THE METROPOLITAN GAS COMPANIES are reducing their prices generally.

WATER SUPPLY.

THE WATER SUPPLY AND SEWERAGE OF BLAYDON.—Mr. Jos. Gordon, city surveyor, Carlisle, has, in compliance with a request from the local Board of Health of Blaydon, reported upon the water supply and sewerage of the Blaydon district. The result of Mr. Gordon's inspection and survey estimates the cost of the proposed additional water supply at £1,934, and the sewerage works at £3,510—making a total of £5,444. These figures include the cost of superintendence of construction, and all contingencies incidental to such undertakings; and Mr. Gordon has laid before the Board a detailed report of the whole works.

APPLIED CHEMISTRY.

ON ANILINE BLACK; BY M. LAUTH.—Aniline black is a new coloured derivative of aniline, which, so to say, completes the series of brilliant colours derived from this base. It differs, however, in many respects from the other coloured derivatives. The mode of production, the way of fixing it on fabrics, and the insensibility to physical and chemical agents which it presents are points on which it differs essentially from the red, blue, and violet of aniline. Mr. Lightfoot's process, which the author quotes, is well known to our readers, and we shall only quote from this paper the author's new process for aniline black, which, it will be seen, and, indeed, is admitted to be, but a simple modification of Mr. Lightfoot's. M. Lauth's process consists in printing with the mixture of hydrochlorate of aniline and chlorine of potassium an insoluble oxidisable salt, which will become soluble on the fabric—sulphide of copper, for example. By the oxidising action of the chloric acid (or the chlorine which is set free by the reaction of hydrochlorate of aniline on chlorate of potassium), the sulphide of copper is transformed into sulphate. In this same process some of the disadvantages of Mr. Lightfoot's process are avoided. It is more economical, the mixture does not act on the steel rollers, nor does it weaken the fabric—not more, at all events, than madder black. The colour is very permanent, and is fixed at from 20° to 40° C. Its composition allows of its being printed with all sorts of colours. Aniline black has a specially beautiful appearance; it has a very rich black velvety look. It is completely insoluble in water, alkaline, or acid, and is not affected by soap. Acids change the black to green, but the original colour is restored by an alkali. Bichromate of potash deepens the shade, but a very strong solution slightly reddens it. Strong chloride of lime bleaches it, but the colour returns after a time. M. Lauth promises another and further account of aniline black in a short time.

REMOVAL OF BISULPHIDE OF CARBON FROM GAS.—Mr. J. with Thompson has published a very simple process for purifying gas from bisulphide of carbon. It is based on the fact that the bisulphide and the vapour of water cannot exist together at a red heat, mutual decomposition taking place with the formation of sulphuretted hydrogen and carbonic acid.

$$CS_2 + 2\,HO = 2\,HS + CO_2.$$

The removal is carried out practically by mixing the gas as soon as it leaves the hydraulic main with a certain proportion of steam, and carrying the mixture through a tube heated to a fully cherry red. The length of this tube must be proportioned to the velocity of the current, so that there may be time for the whole of the mixture to become heated. The products of the reaction are, of course, removed by the ordinary methods of purification. Gas from ordinary coal so treated does not, according to Mr. Thompson, have its illuminating power diminished by the treatment.

ALCOHOL AS A TEST FOR CROTON OIL.—Mr. R. Warrington, F.R.S., has published in the *Pharmaceutical Journal* some experiments on the British Pharmacopœia test for croton oil, which have led him to conclude that the use of alcohol as a test for the purity of the oil is of no value. His own opinion, he states, is that freshly expressed oil, or rather oil expressed from fresh seeds, either abroad or in this country, does not dissolve in alcohol sp. gr. ·794—·796 to a greater extent than 20 per cent. at 50°; but that if croton oil has undergone a chemical change, such as resinifiation or oxidation by time and exposure to air, or has been expressed from seeds which have become changed in the same manner, then the oil is freely dissolved by the alcohol. It follows that "a test which is open to many weighty objections, both from the influence of small fluctuations of temperature, and for indicating the purity of a material liable to such marked differences from the effects of such natural, and in some cases inevitable, chemical changes is perfectly useless as a reliable indication of purity."

HOFFMANN'S TEST FOR PHOSPHORUS, AND THE FORMATION OF HYPOSULPHUROUS ACID.—By A. FROEBEL.—L. Hoffmann's method of detecting phosphorus in cases of poisoning is as follows:—"The process consists in distilling from the viscera, mixed with sufficient water and a small quantity of dilute sulphuric acid, about two drachms of fluid, mixing a few drops of sulphide of ammonium with the distillate, and evaporating the whole to dryness on a porcelain dish. If phosphorus were present in the viscera, even in the most minute quantity, a drop of the solution of perchloride of iron will produce a deep violet and brownish evanescent reaction." This reaction is now explained by Froebel as the consequence of the formation of some hyposulphite of ammonia on the evaporation of sulphide of ammonium to dryness.

CHEMISTRY OF COAL.—Dr. Frankland, in the course of a series of lectures on the Chemistry of Coal at the Royal Institution, explained the manner in which paraffin oil and paraffin candles are extracted from coal tar, and how the beautiful colours called magenta and mauve are produced from that disagreeable-looking and offensively-odorous substance. The accumulation of tar in gasworks was formerly a great nuisance, as there was no known available mode of making use of it, but it is now considered so valuable that coal is often distilled at a low heat for the purpose of producing it, the gas being thrown away. From coal tar chemists have separated no fewer than fifty compounds, of which three have been rendered principally useful for dyeing—benzole, phenylic alcohol, and aniline. For the production of colours benzole must be converted into aniline, which change is effected by heating it first with nitric acid, and then with acetic acid and scraps of iron. The colour mauve is produced by heating aniline with bichromate of potass and sulphuric acid; the magenta is obtained by heating aniline with arsenic acid; blue and violet are produced by heating magenta with aniline. Dr. Frankland produced a trayful of glasses, in which were placed small invisible particles of differently prepared substances from coal tar, and on pouring into the different glasses phenylic alcohol they were filled with fluids of various colours, all poured from the same bottle. The following was given as a brief statistical statement of the quantity of dye obtainable from coal:—30 cwt. of coal yield 360lbs. of tar, which furnish 18lbs. of naphtha, containing 6lbs. of benzole; and the latter yield 5lbs. of aniline, which produce 1lb. of magenta. One pound of magenta will dye 650lbs. of silk, or 900lbs. of wool, the latter quantity being the average produce of 160 sheep. Dr. Frankland showed the process of dyeing cotton, silk, and wool different colours, and he exhibited several other experiments to illustrate the remarkable properties of the substances extracted from what had, until recently, been considered waste products in the manufacture of gas.

A NEW METHOD OF HARDENING CAST IRON.—A patent has just been taken out in France for a method by which cast-iron may be made as hard as tempered steel. When the object in cast iron has been filed up and completely finished, it is to be heated to cherry-red, and plunged until it is cold again in a solution containing 70 oz. troy of sulphuric acid, and 4 oz. troy of nitric acid, to $2\frac{1}{2}$ gallons of water. The thickness of surface hardened is sufficient for ordinary wear, and the form of the object is not at all altered.

THE NEW BITUMINOUS SUBSTANCE FROM BRAZIL.—At the Royal Society of Scotland meeting, Professor Archer read a communication on a new bituminous substance imported at Liverpool from Brazil, under the name of coal. The Professor stated that the substance—a few specimens of which were presented to the meeting—had been submitted to chemical analysis, and had been found to yield a much larger percentage of oil than any of the bituminous coal which had been examined in Great Britain, not even excepting the Torbanehill mineral. It had little of the appearance of ordinary coal, but seemed to be indurated clay, and yielded a similar series of products to those afforded by other bituminous coal; it was very light, extremely buoyant in water, and was exceedingly inflammable, burning at a very low temperature.

THE LIQUID BITUMEN OF CUBA.—This bitumen is pasty, adheres strongly to the fingers, and has the aspect of coal-tar, becomes fluid upon boiling water, has a density of 1·33, and is entirely soluble in benzole. Liquified, and projected upon cold water, it floats. Distilled, it gives 67·18 liquids, 12·38 gases, and 20·44 coke. During the distillation, it first liquifies, then swells up, at which moment clear water passes over in small quantity. The mass then sinks down and boils tranquilly, a little more milky and very sulphurous water passing. Oil of an amber colour then distils over. Finally there passes over a thick ropy oil, of an orange-yellow colour (ruby-red by reflected light) which solidifies in the neck of the retort, and in the recipient. This thick portion contains paraffin, and 80 or 85 per cent. of the crude liquid consists of oil resembling oil of schist. The coke is very light and porous, and contains 91·56 of carbon and 8·44 of ashes, which latter are reddish, ferruginous, and similar to those before described. The author says that no bitumen of this species exists in France or Europe, and that it resembles the pasty bitumens of Asia and Canada. In other words, it is a variety of thick petroleum.

PREPARATION OF ALUMINIUM.—Mr. Corbelli has found a simpler and more economical process for procuring aluminium than that heretofore used. The metal is prepared from clay, first carefully purified from foreign matter, then dried and treated by an acid to remove iron. About six times its weight of sulphuric acid will answer the purpose. The clay is then allowed to settle, dried again, and mixed with about twice its weight of prussiate of potassa, the quantity of which is to be increased or diminished according to the contents of [illegible] in the clay. To this mixture one and a half times the weight of the clay is added of common salt, the mixture placed in a crucible, and heated to a white heat. After [illegible], the aluminium will be found at the bottom of the crucible.

LIST OF APPLICATIONS FOR LETTERS PATENT.

We have adopted a new arrangement of the Provisional Protections applied for by Inventors at the Great Seal Patent Office. If any difficulty should arise with reference to the names, addresses, or titles given in the list, the requisite information will be furnished, free of expense, from the office, by addressing a letter, prepaid, to the Editor of "The Artizan."

Dated January 27th, 1865.

235 J. E. F. Ludeke—Compasses for ascertaining the utmost correctness of the contents and square of any circle
236 C. D. Abel—Throstle spinning frames
237 J. Hind—Pumps for forcing liquids
238 R. Heltham—Removing dirt from the inside of the barrels of keys
239 J. Southall & H. Southall—Saddle trees and in the spring bars of saddle trees
240 C. De Bergue—Furnaces
241 J. Combe—Machine tools in which a variable speed is required
242 H. Moore—Applying power to the working of ships' windlasses
243 J. Twihill—Steam generators or steam boilers and furnaces
244 J. H. Johnson—Treatment of oils obtained from the distillation of tar
245 A. H. Brandon—Treatment of tar oils for employment as paint

Dated January 28th, 1865.

246 G. Haseltine—Manufacturing syrup and sugar from maize
247 S. Trulock, R. Trulock, & W. Trulock—Breech-loading fire-arms
248 B. Dobson & W. Slater—Cotton gins
249 V. Burg—Filtering apparatus
250 W. E. Newton—Rectifying alcohol, and in the apparatus employed therein
251 J. Petrie—Machinery for washing wool and other fibrous materials
252 J. Raines—Mortar mills, applicable also to grinding other substances
253 W. Clark—Breech-loading fire-arms, and in cartridges
254 E. Blakeslee—Cartridge boxes
255 E. T. Hughes—Drying wool, cotton, and other fibrous substances
256 A. S. Macrae—Lanterns for burning hydro-carbon fluids
257 W. Foster—Screw taps
258 W. H. Higgins—Machinery for shaping hat and bonnet blocks

Dated January 30th, 1865.

259 J. McInnes—Protecting the surfaces of metals from oxidation
260 G. Davies—Steam engines
261 W. Teall & A. Naylor—Extracting grease from the waste of fibrous substances
262 J. Gibson—Relieving wire ropes from strain when raising or lowering weights
263 F. A. Laurent & J. Casthelaz—Manufacture of beazoic acid
264 G. Carter—Construction of caps or pots for chimneys
265 C. H. Russell & J. Needham—Breech-loading guns
266 R. A. Brooman—Shades or globes for lamps and other lights

Dated January 31st, 1865.

267 M. Cartright—Apparatus for giving alarm in case of fire
268 J. W. Gill—Clothes fastener that may also be used as a letter clip
269 R. A. Brooman—Railways, and electric telegraph wires
270 W. H. Cox—Tanning hides, and in the apparatus employed therein
271 M. Henry—Effecting locomotion or propelling on land
272 T. Hall & S. Bonser—Mechanism for giving continuous revolving motion without the use of change wheels
273 J. Fletcher & D. Hamer—Increasing the expansion and power of steam
274 E. P. Colquhoun & J. P. Ferris—Lubricating apparatus
275 E. P. Colquhoun & J. P. Ferris—Permanent way of railways

Dated February 1st, 1865.

276 J. Meakin—Placing china, stone, and earthenware in ovens
277 J. Gray—Breaking flax and similar fibrous materials
278 A. Freeman—Folding fabrics on to cardboard for hot pressing
279 J. Sainty—Lever horse hoes and lever corn drills for hoeing and sowing of wheat
280 W. E. Gedge—Portable folding arm chair or seat
281 J. McNaught and W. McNaught—Washing and drying wool
282 G. J. Vertue—Manufacture of oil cake and food for animals
283 J. Roper—Corkscrews
284 J. Moysey—Coating the sides and bottoms of ships
285 G. H. Pierce—Socket for pipes and method of joining the same
286 J. Hughes—Armour-plated ships, forts, and other like structures
287 C. A. Wheeler—Protecting wall fruit trees

Dated February 2nd, 1865.

288 A. S. Stocker—Reflectors
289 J. W. Gray—Communication between passengers and guards of railway trains by night or day
290 E. Whittaker—Communication between passengers and guards
291 A. Murray—Boots and shoes
292 C. Langley—Armour-plated ships and works of defence
293 J. Maynes—Looms for weaving
294 J. Ball—Sheep shears
295 J. H. Johnson—Manufacture of ordnance and such like castings
296 J. S. Jeffreys—Armour-plated and other ships or vessels
297 T. Routledge—Treating levs resulting from the preparation of fibrous substances

Dated February 3rd, 1865.

298 W. Vale—Pencil cases
299 T. Joyce—Breech-loading fire arms
300 G. Horn & D. Horn—Driving bands or belts for machinery
301 B. L. Mosely—Tooth powder
302 W. Bartram—Self-adjusting lever powder and shot-charger for fire-arms
303 M. Blank—Working ships' pumps
304 W. Clark—Sewing machines
305 J. Westerby—Preventing the explosion of steam boilers

Dated February 4th, 1865.

306 J. R. Webb—Apparatus for obtaining the concentrated extract of hops
307 F. Row—Manufacture of citric and tartaric acids
308 J. Park—Clarinets
309 S. W. Wood—Revolving fire-arms
310 J. A. Phillips—Purifying lead used in the manufacture of white lead
311 F. C. Hills—Effecting the combustion of fuel in the furnaces of steam boilers
312 R. S. Baker—Vermin and other traps
313 E. Hottin—Rendering uninflammable cotton, silk, and other textile fabrics
314 W. Black—Combustion pump
315 R. A. Brooman—Preserving wood and protecting iron ships from oxidation
316 J. L. Hancock—Cushions for billiard and other like tables
317 A. H. Robinson—Air cushions, and other inflated articles
318 R. Richardson—Railway chairs, fastenings, and sleepers
319 R. M. Alloway—Treating or manufacturing pent for fuel
320 W. E. Newton—Preparation of superphosphate of lime

Dated February 6th, 1865.

321 C. R. Markham—Destroying the momentum of heavy bodies
322 J. Booth—Paper hangings
323 E. Williams & T. Williams—Spinning mules and throstles
324 W. H. Latham & E. C. W. Latham—Cutting the edges of books
325 R. A. Brooman—Hair pins
326 R. Shaw—Window safes for the protection of property
327 C. Duncan—Forming certain parts of metallic casks and drums
328 A. Steven—Hydraulic lifting or hoisting apparatus
329 W. Cockburn—Jacquard apparatus for weaving
330 A. A. Hulot—Typographic ink
331 J. I. Watts—Obtaining motive power
332 C. Beard—Ventilation of horticultural and other buildings
333 W. P. Wilkins—Mills for grinding wheat and other grain

Dated February 7th, 1865.

334 H. Masters—Sewing machines
335 C. Henderson—Construction of roadways and pavements
336 H. B. Barlow—Preparation of flax and other fibrous substances
337 R. Brassens & F. A. Le Mat—Ships
338 C. Langley—Steam engines
339 A. L. L. Gordon—Candlesticks
340 J. Cornes & W. Simpson—Cutting vegetable fibrous substances
341 C. Kilburn—Construction of life and swimming belts
342 R. De Bray—Gas-lighting
343 J. B. Walters—Machinery or apparatus for brushing the hair
344 W. Sim—Extraction of gases from mineral oils for illuminating purposes
345 J. Lake—Steam generators
346 R. Brandon—Cannon shot
347 A. A. Larmuth—Healds for looms
348 W. E. Newton—Improved apparatus for separating grain
349 G. Twigg—Fastenings for stay husks and other similar articles
350 S. E. Rosser—Ventilation of pressing irons heated by gas

Dated February 8th, 1865.

351 C. Field—New method for fastening and lacing ladies' stays
352 W. E. Wiley—Pencil holders
353 R. C. Thorp & P. Young—Miners' lamps
354 J. Desmoutils—Manufacture of grease for lubricating purposes
355 J. Singer—Garments
356 W. Anderson—Metal pipes
357 A. W. Banks—Signal applicable to railways and ships
358 E. Lindner—Breech-loading fire-arms
359 G. Elliot & H. Coxon—Discharging the cargo from a ship's hold
360 R. A. Brooman—Manufacture of wire and other netting
361 W. Staats—Manufacture of skirt borderings and linings

Dated February 9th, 1865.

362 W. A. Marsnall—Insulating material for telegraphic and other purposes
363 J. C. C. Halkett—Protecting wooden surfaces from fouling
364 J. Chubb—Iron safes
365 M. Bier—Propelling boats, or other floating objects
366 R. Winder—Ploughing and other like operations by steam power
367 M. Peck—Manufacture of patched balls for fire-arms
368 J. P. Lindsay—Locks for fire-arms
369 G. E. Meek & W. H. Howes—Fastenings for doors
370 A. V. Newton—Mechanism for operating the working parts of sewing machines
371 J. Dale—Substances to be used in place of the pigment usually termed satin white

Dated February 10th, 1865.

372 A. Krupp—Breech-loading ordnance
373 C. Lugard—Manufacture of scissors, shears, and edge tools
374 E. Leigh—Furnaces for smelting iron ores
375 J. Ramsbottom—Rolling and hammering iron and other metals
376 E. Lord—Preparing and spinning cotton and other fibrous materials
377 R. G. Hazard—Looms for weaving
378 A. C. Edwards—Communication between passengers and guard
379 H. W. Hart—Affixing postage and other gommed stamps and labels
390 W. E. Newton—Embankments and other similar constructions
381 G. Coles, J. A. Jaques, & J. A. Fanshawe—Manufacture of boots and shoes
382 H. Emanuel—Boxing, fencing, and cricket gloves

Dated February 11th, 1864.

383 J. Schneuhr—Apparatus for counting coins of money
384 D. H. Barber—Reaping machines
385 G. C. Haseler & J. B. Haseler—Manufacture of brooches
386 J. Porter & J. Porter—Better support and stay of the horizontal iron rail
387 C. Atherton & A. H. Renton—Buoys, beacons, floats, or pontoons
388 J. Hall—Production of oil for the use of machinery
389 T. A. Verkruzen & M. A. Verkruzen—Winding velvet ribbons
390 A. McLaren—Heating water, and in connecting hot water and other metal pipes
391 W. Cronkes—Separating gold and silver from their ores
392 C. West—Apparatus for giving alarms
393 E. H. Newby—Connecting partially into steel articles of malleable iron
394 E. J. Hill—Pen and pencil holders
395 J. J. Cass—Furnaces and boilers, and in generating steam
396 A. V. Newton—Construction of single thread sewing machines
397 H. H. Grierson & J. M. Rigby—Cupolas and blast furnaces
398 P. A. Le Comte de Fontainemoreau—Manufacture of caoutchouc

Dated February 13th, 1865.

399 D. Parr, W. H. Page, and C. J. Newey—Collars and other articles of dress
400 H. M. Kennard—Machinery for riveting
401 R. W. Thomson—Steam boilers
402 L. H. G. Ehrhardt—Gunpowder
403 J. A. Pastorelly—Extracting turpentine and tar from resinous woods
404 W. Adams—Bogie trucks used for supporting railway engines
405 J. G. Tongue—Applying paddle wheels for propelling boats
406 F. C. Vanuet—Penholders
407 E. B. Wilson—Fire-places
408 E. J. C. Welch—Supplying with a regular pressure air to burners
409 W. E. Newton—Sheet iron

Dated February 14th, 1865.

410 J. Gresham—Raising and forcing fluids and feeding steam boilers
411 H. J. Walduck & E. Barton—Furnaces for reducing ores
412 W. B. Newbery—Files
413 G. Harton—Waterproofing skins
414 W. C. Hine—Stoppering bottles, and measuring quantities therefrom
415 W. F. Batho—Expansion gear
416 R. J. Jones—Manufacture of clog soles by machinery
417 G. Whitton—Hydraulic presses
418 A. Eryer—Evaporation of liquids
419 E. H. Newby—Manufacture of cast and wrought iron
420 J. Trotman—Mooring anchors
421 J. von der Poppenberg—Breech-loading fire-arms
422 G. Homfray—Links of chains
423 R. P. Barrett—Combined garment
424 J. Purdey—Breech-loading fire-arms
425 B. Thompson—Fire arms
426 B. Thompson—Cartridges

Dated February 15th, 1865.

427 S. R. Freeman and A. Grundy—Blowing apparatus
428 W. A. Hackett—Fish hooks
429 W. C. Ridings—Protector for needles and cards used in jacquard machines
430 A. V. Newton—Sewing machines
431 W. H. Brown—Cast steel or other metal chains for cables
432 M. Lane—Working railway switches, points, and signals
433 C. Langley—Ventilating blinds or screens of ships and vessels
434 D. C. Pierce—Railway rails
435 F. J. Emery—Ornamenting china and earthenware
436 G. T. Humphris—Pumps, and in apparatus for working the same
437 G. H. Emerson—Invalid drinking cup
438 G. T. Bousfield—Construction of armour-plated ships
439 A. Clark—Burglar-proof and fire proof safes

Dated February 16th, 1865.

440 W. E. Gedge—Barege stuffs
441 W. Kirrage—Artificial stone for building and other purposes
442 R. A. Brooman—Boots, shoes, and other like coverings for the feet
443 E. B. Wilson—Furnaces
444 H. J. Picard—Sweeping and removing the refuse from the streets
445 H. C. Cleaver and J. Cleaver—Fog signal for the prevention of collisions
446 C. O. Staunton—Lifting and tilting casks containing liquids
447 W. E. Newton—Distilling petroleum and other volatile liquids
448 J. F. Hearsey—Apparatus for measuring the specific gravity of liquids
449 F. A. Laurent, J. Casthelaz, and N. Basset—Oxalic acid
450 J. Thompson—Safes
451 R. Smith—Treating sewage

Dated February 17th, 1865.

452 R. Hill & R. Tushingham—Treatment of clay for the manufacture of bricks
453 W. E. Gedge—Manufacture of various articles in pottery
454 C. Defries—Means of securing the safety of railway passengers
455 J. Brown—Armour plates for vessels of war
456 J. O. Christian, J. Charlton, and H. Charlton—Magnesium
457 W. Clark—Shifting wrenches
458 J. B. Brown—Mowing machines
459 J. Ferguson—Iron safes
460 C. F. Claas—Sulphates and carbonates of potash and soda

Dated February 20th, 1865.

461 T. P. Tregaskis—Use of magnets in overbalancing weights
462 P. E. Bidaux—Circular escapements
463 E. Carchion—Drying straw for the manufacture of straw hats
464 J. J. Chidley—Stopping bottles
465 C. Brakell, W. Hoehl, and W. Gunther—Substitute for leather
466 T. Ogden—Lubricating the cylinders of slashing machines
467 R. A. Brooman—Filters
468 J. G. Jones—Beam engines
469 J. Graham—Treating products obtained when coating iron with zinc
470 W. Robinson—Manufacture of iron and articles made thereof
471 C. D. Barge & A. Hermant—Waterproof coats and capes
472 L. W. G. Rowe & A. Baab—Protecting railway passengers
473 J. G. N. Alleyne—Furnaces, and in apparatus connected therewith

Dated February 20th, 1864.

474 G. H. H. Ware—Shifting points from an engine or train in motion
475 H. Percy—Sewing machines
476 A. Sharp—Bedsteads
477 W. E. Gedge—Chemical combustible substance and apparatus
478 J. Cliff—Utilisation of waste gases
479 J. D. Nichol—Folding envelopes

Dated February 21st, 1865.

480 C. W. Homer—Machinery for making bricks
481 R. Willison—Mashing machines
482 W. Hitchin—Sash fasteners
483 J. H. Johnson—Kneading dough
484 C. Baulch—Boots and shoes
485 J. R. Swann—Steam engines
486 W. E. Newton—Apparatus for extracting liquid from solid substances

Dated February 22nd, 1865.

487 E. Jesurum—Stopping railway trains
488 C. V. Walker & A. O. Walker—Railway signalling
489 J. Keighley & R. Shephard—Box looms
490 J. Mallison—Treating yarns or threads previous to dressing
491 I. Pariente—Scarfs
492 R. A. Brooman—Mercuro-hydraulic motor
493 J. Holley—Generating steam
494 J. Dodgeon, J. Gaukroger, & W. Shackelton—Looms for weaving
495 H. P. Ribton—Fasteners for envelopes
496 W. E. Newton—Slide valve
497 T. C. Webb—Ornamented articles of glass
498 J. Carter—Ventilating hats
499 G. N. Shore—Iron safes
500 J. Nicholas—Producing oil and coke from coal and slack
501 M. P. W. Boulton—Obtaining motive power from aeriform fluids
502 D. Barr—Machinery for dressing fruit

Dated February 23rd, 1865.

503 A. Barker—Looms for weaving
504 G. Sinclair—Signalling between passengers and guard in railway trains
505 W. Westbury & T. Wathen—Suspending fancy articles exposed for sale
506 W. H. Aubin—Breech-loading fire-arms
507 S. Whitfield—Fastenings for safes
508 W. S. Mappin—Safes or strong boxes
509 G. Haseltine—Naval ships
510 J. G. Hughes—Screw propeller
511 S. Saville—Separating wool from refuse
512 W. E. Newton—Artificial manures
513 W. Rowe—Buffers for railway carriages
514 H. K. Taylor—Protecting valuable property contained in safes from fire or thieves
515 A. Meyer & M. Meyer—Explosive compounds


LIVERPOOL BAY
SURVEYED BY COMMANDER H.M. DENHAM, R.N. F.R.S.
SCALE OF MILES
Med Wharf
Old Formby Channel
Formby Point
Crosby Point
Jordan Flat
Little Burbo
New Channel
Taylor Bank
Wash
Crosby Channel
BURBO FLATS
BURBO BANK
NORTH BANK
Brazil Bank
Wast Spit
Horse Channel
Rock Channel
RIVER MERSEY
LIVERPOOL
MOCKBEGGAR WHARF
Rock Light
Sand Hills
Leasowe
Wallasey
Seacombe
EAST HOYLE BANK
Helbre Island
Little Helbre
Helbre Point
LIME WHARF FLAT
WEST HOYLE BANK
RIVER DEE
MOSTYN BANK
Salisbury Bank
Salisbury Middle
Middle Patch
REFERENCE
*A Entrance 1839 now called Victoria Channel
*B Original bar of the New Channel
*C Remains of 1833 Entrance
*D Site of the Queens Channel
The Soundings are in Fathoms at low Water Spring Tides

NORMAND'S PATENT

CURVILINEAR SAWING MACHINE

FOR ROUGH-SQUARED OR ROUND TIMBER

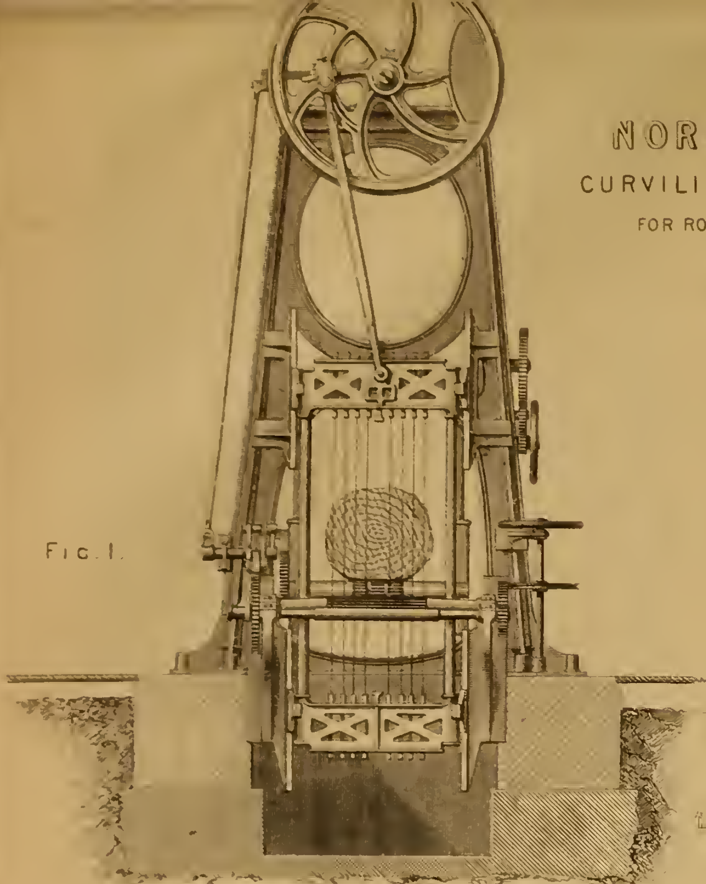


FIG. 1.

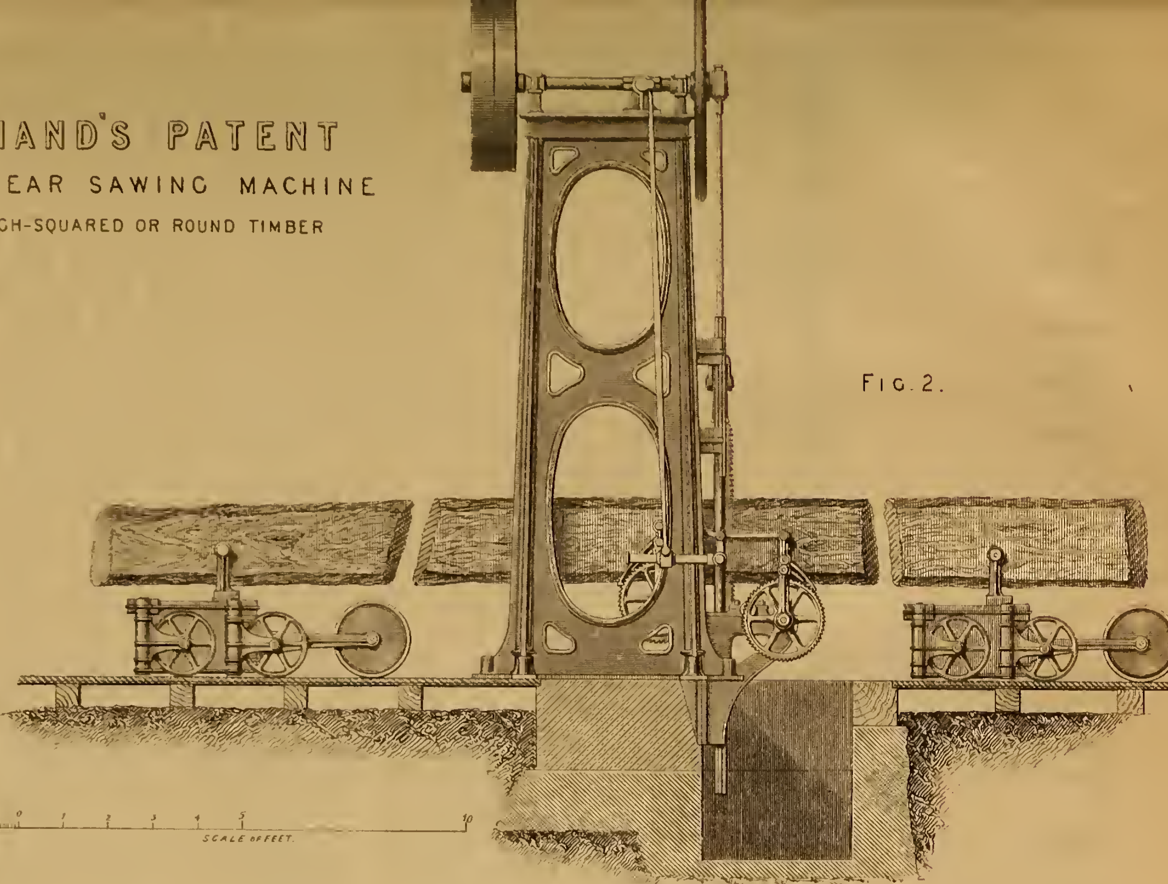


FIG. 2.

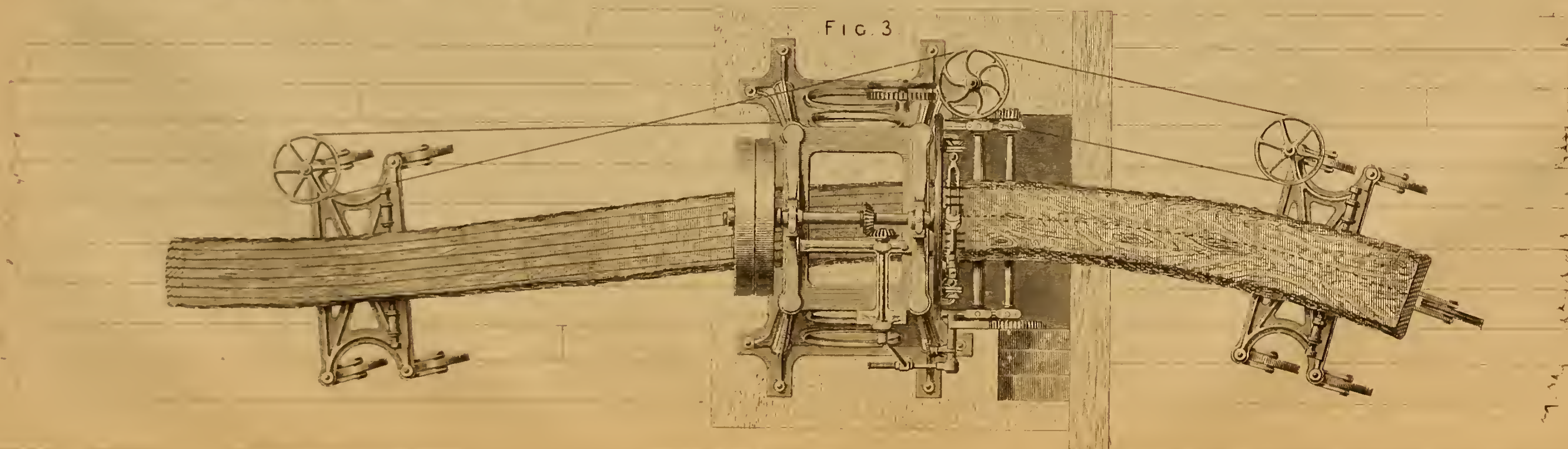


FIG. 3.

THE ARTIZAN.

No. 28.—Vol. 3.—Third Series.

APRIL 1st, 1865.

HISTORICAL AND DESCRIPTIVE SKETCH OF THE MERSEY DOCKS AND HARBOUR.

By J. J. Birckel.

(*Illustrated by Plate* 277.)

In fulfilment of our promise given in the paper of January last, we now produce upon the accompanying Plate (No. 277) Capt. Denham's survey of the Bay of Liverpool, made in 1836, and we shall supplement the same at a future date by that of Lieut. Murray T. Parkes, made in 1862, as also by that of Captain Thomas, made in 1813, if we should be able to find a copy of the latter; and having, since the publication of our paper on the bay, been favoured with the particulars of a scheme for the improvement of the sea channels of the estuary of the Mersey, as proposed to the Docks Board by Messrs. J. Murray and F. Giles, civil engineers, in 1861, or exactly ten years after Mr. Rennie had submitted his proposal to the same body, we have postponed proceeding with the description of the structural details of the dock-works in order to lay that scheme before our readers, together with the report accompanying it, believing the whole subject to be deserving of special notice, because the object which the gentlemen named have thought desirable to aim at shows that they had reasoned to nearly the same conclusions as those who had been consulted thereon independently of them, and at a different period. It does not appear, indeed, that Messrs. Murray and Giles were acquainted with the substance of Mr. Rennie's proposal, otherwise allusion must have been made to it by them, for the eastern portion of their scheme may be said to form a continuation of that portion of Mr. Rennie's, while on the western side they propose to construct a work almost similar to, though not quite so complete as, his breakwater, since they do not offer to carry their bank to any altitude exceeding that of the Burbo Bank itself. The principal object, however, which they aim at is the very one which we suggested as being the desirable one to realise, namely, to direct the whole of the scouring power of the ebb into one channel only. The following is an abstract of their report:—

The extensive series of docks at Liverpool and at Birkenhead communicate with the lower reach of the River Mersey, and thence with the Irish Sea, by channels running through great sandbanks deposited in the Liverpool Bay between Formby Point and Helbre Island. The sands are continued in deep water even beyond this limit, from St. Bees Head on the North to Lynas Point of the Island of Anglesea on the South. Through this vast mass of shoals the tidal and fresh waters of the Dee, the Mersey, the Ribble, and the rivers of Morecambe Bay force their way.

The observations of the late Rear-Admiral Beechey on the tides of the Irish Sea are valuable in showing that the northern and southern streams of flood encircling Ireland finally meet in Morecambe Bay, where the waters are heaped up and attain a height, at spring tides, of 30ft., augmented by a continuance of westerly and southerly winds.

It is, however, the eastern portion of the tidal stream coming round the south of Ireland, which, setting towards the Skerries, finally turns sharply round these rocks, and fills the estuaries of the Dee, the Mersey, and the Ribble. The more westerly, therefore, the mouths of these estuaries are, the greater will be the influx of the tidal water which exerts great force, and endeavours to penetrate the mass of sands that encumber them.

It appears from a chart made in 1813 by Capt. George Thomas, R.N., that only two passages then existed into the estuary of the Mersey, viz., the Formby or Crosby Channel, and the Horse or Rock Channel. The former was a continuation, nearly in a straight line, with the deep water channel of the river, between the Rock Fort and the shore of Bootle. The ebbing waters, therefore, had a direct course to sea between the Great Burbo Bank on the left hand, and the Formby and Jordan Banks on the right. The force of the ebb meeting the flood tide caused the formation of these last-named banks and turned the latter part of its course to the westward, creating thereby what was called the South Channel, with a depth of nearly two fathoms of water on the bar at low water of spring tides. The flood tide forced a passage, by what was called the North Channel, between Jordan Bank and Formby Point; its course onward lay between the Formby Bank and Crosby Point, but being obstructed by the high shore, passages were forced into the deep water channel at Crosby Point, and separated the Jordan from the Formby Bank, as well as the latter from the middle patch. These two passages of the flood and ebb were no doubt detrimental to navigation, and had means then been adopted *to keep the waters in one channel* over the bar, a greater depth would have resulted, and much intricacy and difficulty would have been obviated.

The Horse or Rock Channel was, in 1813, the other passage into the Mersey. As the ebbing waters from the estuary passed directly along the more direct channel just described, little or no scouring effect was produced in the other; its sea entrance at the gut was nearly at a right angle with the main stream, where also it was very narrow, and nearly dry at low water, while at its junction with the river there was great width, and a depth of not less than seven fathoms.

By referring to still older charts (see Greenville Collins's survey already published) it is found that the Horse Channel had an early existence, and at one period the flood penetrated the estuary of the Mersey at the Leasowes, covering with water all the low lands between it. This has been checked by an embankment at the Leasowes, and the flood now passes onward to the Rock Lighthouse, and so into the Mersey; but the hard bottom of the Rock gut has prevented this part of the channel from being scoured deeper, and the tendency of the sands to accumulate at this point of the Burbo Bank has likewise prevented the flood waters from scouring a passage to the northward. It is not improbable that when the Burbo Bank becomes surcharged with sand both in extent and in height (and since 1813 a very great accumulation has taken place) these sands, under the influence of strong north-westerly gales, may be driven southward, and form a lodgment on the Mock-beggar wharf, still further shoaling, and for a time, perhaps, closing the passage at the Rock gut.

We consider it important that every means should be adopted of assisting the flow of tidal water into the estuary, and, consequently, that the value of the Rock Channel should not be overlooked. We are aware of the impracticability of widening and deepening that part of it which may have a rocky bottom; but we think it well worthy of investigation, to obtain a series of borings across this gut in several directions, in order to trace the contour lines of the surface of the rock which may have a sudden escarpment to the northward, as in the bed of the river channel.

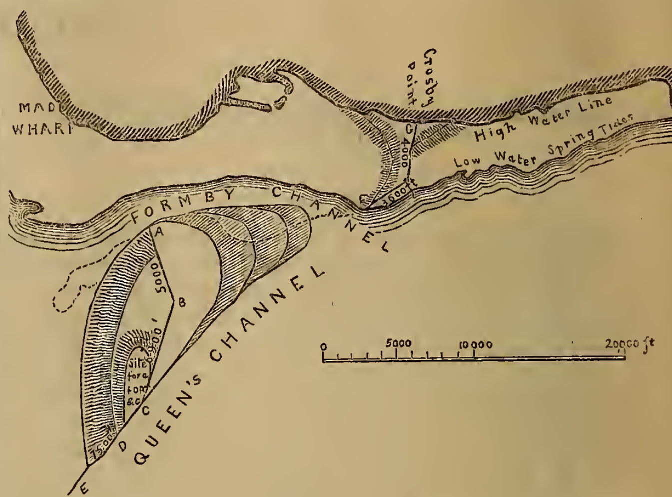
If this be so, then at a distance hereafter to be determined on, we are of opinion that a mass of rubble might be advantageously deposited along the south-eastern verge of the Burbo Bank, having its crest not higher than the present general level of the sands, and over which the last quarter of flood would have an uninterrupted course into the estuary; while standing above water to that period of the tide, the stream of early flood would, by the position of this barrier, wear and be directed into a permanent channel, and thus keep open, by means of the flood current, a sufficiently wide and deep passage into the main stream of the Mersey. As a consequence, the western part of the Rock Channel would be scoured to a greater depth than hitherto, for even now, with all its disadvantages, the seaward contour line of 3 fathoms depth at low water spring tides is only 4¾ statute miles from the Rock Lighthouse, while the same contour line of 3 fathoms by the main, or Queen's Channel, is 10 miles distant from the same point.

It appears from a study of the chart of 1813 that the sandbanks and deep water channels then indicated a great tendency for the ebbing waters of the Mersey to find for themselves an escape to sea southward of the Crosby Bank, and the flood tide appeared also to be making for itself the same passage. Nature effected this object, and the consequence was that near this spot a new channel was opened some time prior to 1833. A survey was commenced in that year under the direction of Captain Denham, R.N.* (see Plate), and in a paper communicated by him to the Dublin meeting of the British Association in August, 1835 (referred to by us in a previous paper) he states "that the scouring effects of the Mersey with its contracted mouth and attenuated throat produced and maintained a disgorging impetus of its expansive breakwater, so as to have recently forced a channel of half-a-mile wide and two miles long, of from 12ft. to 13ft. in depth under low water, through sands situated eight miles outside the coast line at a tangent to its regular course." But he continues to say that "notwithstanding the copious outlet, yet no sooner had the Mersey vented itself than it pertinaciously resumed its original northern set, merely appropriating its superabundance westward through the new channel."

In 1838 Capt. Denham submitted to the Dock Committee a chart of the new channel region (introduced in strong dotted lines into the survey, illustrated by accompanying plate), comprising the channels, banks, and shallows. The new or Victoria Channel, as shown by this chart, had then become the principal entrance into the Mersey, forming a noble curve for the passage of its ebbing waters. On the bar which was situated southward of the Little Burbo patches there was depth of about 11ft. at low water of spring tides, while the channel was bounded to the North by these and other numerous patches formed in the inner part of the Old Formby passage. It was bounded on the south by the Great Burbo Bank, which however had very much increased in height and extent, a portion of the bank having now only 6ft. of water on it at high tide, where formerly it was covered at low water of spring tides, showing an accumulation in height of at least 21ft.

Referring now to the survey by Lieut. Murray T. Parkes, in 1858 and 1859, we find three entrance channels into the Mersey, viz., the Rock Channel, which appears to be nearly in the same state as in 1838; the northern or flood channel of the Formby entrance which still exists, but whose waters have forced a passage between the Jordan and Formby Banks; and the main channel, which lies between the Great Burbo Bank on the south, and Jordan flats, now connected with Taylor's bank on the north. But here, again, as in 1813, we find the flood tide entering the main channel of the Mersey by one passage called the Queen's Channel, while the last of the ebb passes out by another called the Victoria Channel—the Little Burbo Bank, and another sand patch lying between them. In our opinion these patches of sand will gradually unite and establish two well defined channels, both admitting the flood waters, while one of them will more particularly direct the ebb in its escape into the bay. Whenever this occurs we may rest assured that the full effect of both ebb and flood is not realised, and *every effort ought to be made to throw these two currents into one channel,* in order to maintain the full scouring power of the ebb on the bar. Exposed as this bay is, with extensive sands constantly in agitation during every storm, it is possible that changes of a serious nature may at any time take place, and a continuance of gales may close one or both of these passages. We therefore are of opinion, after mature study of the changes which have occurred, that it behoves the conservators of the Mersey to fix and define the northern line of the channel, and thus secure a permanent deep water entrance to the port at all times of tide.

With that view we propose to form a barrier embankment on the sands, as delineated in the annexed woodcut, to prevent the ebbing waters from



making an escape to sea by the old Formby Channel, and to maintain the position of the new entrance in its most changeable part adjacent to the bar—that part of the barrier from A to B and from B to C to have its crest level with high water of neap tides, to admit the influx during springs into the estuary; and as there would exist a considerable in-run between its eastern termination and Formby Point it would assist in maintaining that passage. The western part of the barrier from C to D to have its solid crest level with high water of ordinary spring tides, but to heighten that portion with open timber work, to form a pier or gangway 20ft. in width at the level of 12ft. above such high water.

The entering waves would be encouraged to follow the direction of the seaward part of the barrier, and coming into collision with those falling over the landward part of it, and with the waves entering the Formby passage would thus *reduce the swell of the deep water channel,* and at the same time tend to cause the spit of sand to remain as at present on the southern side of the barrier between the points A and C.

The formation of a wave basin on the Crosby shore would be facilitated by the construction of a groyne, or jetty, marked F G, which would prevent the ebbing waters from making an escape to sea by the Formby passage, and direct their full scouring power on the bar of the main channel entrance.

We are also of opinion that a large deposit of sand and other detritus would remain as at present on the northern side of the barrier, and greatly protect it from the destructive effects of the waves. The higher part of this seaward tract of sand might hereafter be elevated with little difficulty above the high water mark, and be then made useful as the site for a fort, a receptacle for a lifeboat establishment, and other purposes, to aid in cases of wreck or damage to shipping; when fully silted up it would be accessible to the seaward part of the barrier by the gangway or pier, at the western extremity of which a lighthouse would be erected.

The following is the method we propose to adopt in the formation of this barrier:—The core or nucleus to be wholly composed of third class Rubble work deposited from craft on the sands and allowed to sink into them; on this foundation, when consolidated, to place carcases of timber, each 32ft. in length, to be constructed on the shores of the river, launched in skeleton with the exception of planking the bottom, sides, and ends for about 6ft. in height, pitched and caulked, then ballasted and floated at suitable periods of the tide into the situation required, *there to be scuttled*

* Now Rear-Admiral Denham.

and sunk; the planking of the sides to be afterwards put on from time to time and the space between filled with stones, protected from being washed out by an upper covering of large freestone blocks, lifted as the smaller pieces are thrown in, and this process to be continued until the carcases are fully charged. While this is going on, the rubble deposit on both sides of the carcases to be continued, partly from craft and from waggons running on railways laid on the carcases themselves when in place, so that the next coating on each side of them would be of second class rubble; this last to be again covered with first class rubble, and finally on the seaward side with artificial *beton* blocks, each weighing from 10 to 15 and 20 tons.

We estimate the cost of the works constructed in this manner, as follows:—

	Ft.	£	
The distance from A to B .... =	6,000		
" from B to C .... =	6,900		
Total	12,900		
or 4,300 yards at £60 =		258,000	
10 per cent. for contingencies =		25,800	283,800
The distance from C to E = 7,500ft. or 2,500 yards; if one half be executed in the first instance, say from C to D = 1,250 yards at £165 .... =		206,250	
15 per cent. for contingencies		30,938	237,188
The jetty or groyne on the Crosby shore:—			
1,333 yards at £8............... =		10,664	
1,200 yards at £20 .... =		24,000	
		34,664	
10 per cent. for contingencies ...		3,466	38,130
			559,118
Completion of the pier between the points D and E and lighthouse at its extremity, with 20 per cent. for contingencies...............			250,000
			809,118

The docks on each side of the river at Liverpool and at Birkenhead have been calculated to cost about twelve millions sterling; and great as the present dock accommodation is, it is daily found inadequate for the wants of the trade of the port, and large sums of money must be expended in their formation and extension. They are, however, up to this time without a fixed and deep water channel entrance from the sea, the first necessity and all important advantage of a commercial port. An outlay of the extent above mentioned and a large revenue derived therefrom make us feel sanguine that, in developing a project to improve the entrance of this fine river, navigated by shipping from all parts of the world, the estimated expense will not appear excessive for the advantages which would be thereby secured, and we submit the plan with confidence of its successful issue to the consideration of the Board of Trustees and Conservators of the Mersey.

(Signed),

JOHN MURREY, 11, Great Queen-street, Westminster.

FRANCIS GILES, 42, Blomfield-road, Maida Hill.

January 8th, 1861.

The foregoing considerations which, in their main particulars, coincide with the advice given by Rennie and others at a much earlier date, do not appear to have received the attention which they deserve at the hands of those members of the Mersey Docks and Harbour Board who are best able to judge of their importance, and it is yet to be feared that the months of the English Queen of rivers will be entirely filled up while the Birkenhead interest matures schemes of monopoly of the trade of the port.

(To be continued.)

NORMAND'S PATENT WOOD SAWING MACHINES.

(Illustrated by Plate 278.)

Referring to our notice in last month's issue we now present our readers with a second plate, illustrative of the wood sawing machines manufactured by Messrs. Normand, of Havre, the invention of Mons. C. B. Normand, being that which is adapted for sawing rough-squared, or round timber.

Plate 276, in our last issue, illustrated the Normand's Patent Straight Timber Saw Frame, convertible, by means of the apparatus therein shown, into a Deal Sawing Frame. In that machine the timber to be sawn rests upon a narrow longitudinal slide or carriage extending along the whole length of the timber, and passing through the saw frame between the saw blades; the slide, or carriage, travels upon a planed cast iron bed, and is provided with a rack by which the feed motion is received.

The timber, resting upon the slide or carriage being duly centred, is effectually held down and guided at its top part by means of a longitudinal guide-bar, passing also through the saw frame, and indenting the substance of timber to be cut. This top guide-bar does not travel along with the timber like the under carriage or slide, but remains stationary, the wood gliding along the sharp edges of its under surface. To adapt the guide-bar to the various depths of timber to be cut, it is connected by means of a series of iron rods with a lateral cast iron tube which runs parallel with the bar, and is suspended on standards, as shown in Fig. 1, Plate 276. It will be readily understood that, by working the vertical adjusting screw in front of the machine, the guide-bar may be raised and lowered at pleasure, so as to assume the required position, and press upon the timber under operation.

The arrangement of this machine allows of the setting and fixing the timber with great facility and safety; the sawing takes place with remarkable rapidity and precision, and does not necessitate any alterations in the attachment of the timber after the operation has commenced.

This machine is particularly adapted for sawing ship-frame timbers, deck beams, &c. In such kind of work it can cut from 300ft. to 400ft. run of timber per day of ten hours; added to this machine (illustrated in our last issue), is a moveable apparatus, there shown, by which the whole is turned into a very good deal frame; a great advantage is thus obtained through being able to perform these two different kinds of work with the same machine.

Mr. Normand's sawing machines are all furnished with strong cast iron frames, of the shape shown in the engravings, and carrying at the top the driving motion. By this means the expensive underground works required for machines driven from below, or the timber work required for those driven from above, are dispensed with.

The machine illustrated in the accompanying Plate is solely intended for shipbuilding purposes, to operate on trees in their irregular and unprepared state, and particularly adapted for sawing parallel cuts through long curved timber and converting it into planks, deck-beams, stringers, clamps, &c.

In this machine the directing movement takes place in the following manner:—The tree is supported close to the saws by fluted rollers, which transmit the feed motion, it rests at one or both extremities (according to the stage of the operation) on one of a pair of small carriages furnished with four pivoting wheels, which enable it to travel freely upon the floor in any direction. Each carriage is likewise furnished with a large and heavy central wheel, also pivoting, suitable mechanical means being provided for the purpose of keeping the movement of the carriages under the constant-control of the attendant who watches the advance of the timber.

It will be readily perceived that the advance of the timber will always take place in an arc of a circle, described from the point of intersection of the axis of the fixed roller, supporting the timber near the saws with that of the central (regulating) wheel of the carriage. Any modification required in the advance of the wood to cause it to be cut in the exact guide line previously marked on the timber, will be readily effected by means of the endless rope connecting the "steering apparatus," on the right hand side of the machine, to that of the carriages regulating the advance.

In effecting the sawing of the central portion of the tree, both of its extremities are supported on the carriages described, but one only regulates the advance, the other following freely the direction imparted to the tree. At this stage of the operation, the timber moving strictly parallel with the floor cannot, as hitherto, compensate the inequalities of its under surface by a sort of rocking action so as to remain in contact with the feed-rollers. In order to meet this difficulty, one of the latter, with the whole feed motion connected to it, is supported by parallel lifting screws, by which it can be raised or lowered, so that the pressure upon the lower side of the timber is constantly kept up while it is supported. Thus, the sawing of a piece of timber takes place under three distinct conditions—the first and last by the employment of one carriage only, the middle portion by the use of both carriages together; the required changes in the contrivances for supporting and guiding taking place without any stoppage in the action of the saws.

We have yet to present our readers with the engravings and description which we have prepared, of Messrs. Normand's patent machine for the curvilinear sawing of ship-frame timbers with bevils, twist, and taper. These we trust to be able to give in our next issue.

AN EXAMINATION OF THE ORDINARY RULE FOR CALCULATING THE HORSE-POWER OF THE STEAM ENGINE.

By the Rev. James Newlands Miller, Edinburgh, Member of the Liverpool Polytechnic Society.

That two equal forces acting on an object at the same point, and in opposite directions, would neutralise each other is an incontrovertible axiom in mechanics. No motion could be produced by the joint actions of such forces, but stable equilibrium would be their result. With such conditions the effect would thus be of a statical, but not of a dynamical, character. Who, in his reason, would expect that a weight of one pound, suspended by a cord over a pulley, could raise another weight of a pound attached to the same cord on the other side of the same pulley? The upward force exerted upon each by the other would be exactly counterbalanced by the equal downward force of its own gravity, and therefore each weight would remain in stable rest. If one of two weights so situated raised the other, the necessary inference would be either that the weight which descended was heavier than that which ascended, or that a downward impulse had been given to the former, in addition to its own gravity. In this latter case the aggregate force acting on the descending weight would be greater than the force acting on the ascending weight, as that aggregate force would consist of the impulse imparted to the weight, together with the force of its gravity; whereas, the force acting on the other would be merely that of its gravity.

If, again, the moments of two forces tending to move in opposite directions round a centre be equal, stable equilibrium is the result. No motion can ensue from such conditions. The wheel and axle afford an illustration of this: when, in that machine, the product of the power into its distance from the centre of motion is equal to the product of the weight into its distance from that centre, no motion ensues, but a state of rest obtains. If, however, the weight be raised by the power, the product of the power into its distance from the centre must exceed the product of the weight into its distance from it. These positions will not be disputed by any one conversant with the principles of mechanics.

It is also no less obvious that, if the piston of a steam engine were loaded so that the downward force or pressure upon it was precisely equal to the upward force or pressure upon it of the steam, then, as the two forces thus acting in opposite directions on the piston would be of equal intensity, so the piston would remain stationary, or in a state of rest. Thus, if the piston were so loaded that it weighed 1,000 lbs., and if the pressure of the steam upon it also amounted to precisely 1,000 lbs., the piston would remain motionless, as the two contending forces, that of the steam and that of the gravity of the piston and its load, would be equal. In order that a piston so loaded should be set in motion by the steam, it would be necessary that the steam should exert upon it a greater force than 1,000lbs.

There is, however, great confusion of thought displayed by even eminent men of science in calculating the practical dynamical result from the action of steam. They have confounded a statical with a dynamical result, having asserted that motion would be produced by steam in circumstances in which the force of the steam was opposed by an equal force acting in the contrary direction. In such a case no motion could ensue, but continuous rest would be realised. They have thus asserted that motion, in other words a dynamical result, would occur, when rest or a statical result was the only possible consequence. An instance of such confusion of thought occurs in pages 12 and 13 of Dr. Lardner's "Rudimentary Treatise on the Steam Engine." He there makes a statement to the effect that steam of 15lbs. pressure, acting in a tube of a square inch in section, on a piston fitting steam-tight into it, would raise that piston; and that 1in. of water, which is capable of becoming 1,700in. of steam of 15lbs. pressure, would, if converted into steam of that pressure, raise the piston 1,700in. high in the tube, if the tube were sufficiently long for that purpose. It is obvious, however, that the piston would not move at all, but would remain perfectly stationary, for the force of its own gravity would exactly counterbalance the force of the steam. There is as good reason for asserting that the piston would force down the steam, as for alleging that the steam would force up the piston. The piston could not be forced up by the steam unless the force or pressure exerted by the latter were greater than 15lbs., just as the steam could not be forced down by the piston unless the pressure of the steam were less than 15lbs. Dr. Lardner, therefore, laid down a false principle with respect to the effect of the pressure of the steam. He ascribed to it a dynamical effect under conditions in which it was capable of producing only a statical effect. As it requires a greater force to raise a weight than one equal to the force of gravity belonging to that weight, so he has ascribed to steam a greater dynamical effect than it is capable of accomplishing.

This error is, however, adopted unawares by various authors as a scientific truth, and is generally proceeded upon in calculating the horse-power of the steam engine. The ordinary rule for calculating that power is to this effect. Divide the product of the number of pounds of pressure from the steam upon the piston, and the number of feet which the piston travels, in a minute, by 33,000. Thus Davidson, in his "System of Practical Mathematics," lays down this rule for making that calculation:—"*The continual product of the area of the piston in square inches, the number of pounds weight of pressure of steam on every square inch of the piston, and the number of feet through which it moves in one minute, will show the number of pounds which the engine is capable of raising through the height of 1ft. in a minute, which divide by* 33,000, *and the quotient will show how many horses' power the engine can exert.*" This rule proceeds on the latent or tacit assumption that the pressure of the steam upon the piston could set the latter in motion, if it were loaded with a weight exerting a pressure upon it equal to that which the steam produces upon it. Nay, it assumes further that the piston would move with its usual rapidity under the action of the steam although it were loaded with such a weight—or, rather, that the piston is actually loaded with a weight of that amount while it is in motion. Thus according to this rule, which, with some slight allowances for friction, &c., is essentially the ordinary rule for calculating the horse-power of the steam engine, it is assumed that if, for instance, the pressure of the steam upon the piston were 10,000lbs., and the speed of the latter 200ft. per minute, a weight of 10,000lbs. on the piston could be raised by the steam at that velocity. That pressure, however, of the steam could only *balance* or *support* the weight on the piston; the former could not raise the latter 1in., or even in an infinitesimal degree. In order to raise that weight of 10,000lbs., the pressure of the steam upon the piston would require to exceed 10,000lbs.; and the greater the rapidity with which the weight was raised, the greater would that pressure of the steam require to be. The weight, therefore, which a continued pressure of 10,000lbs. could raise at the velocity of 200ft. per minute must be considerably less than 10,000lbs. As, then, the ordinary rule for calculating the horse-power of the steam engine virtually assumes that the pressure from the steam upon the piston could raise a weight exerting an equal pressure upon the piston, it follows, as an inevitable inference, that that rule overestimates the power of the steam engine, or that the power of the steam engine is not so great as that rule represents it to be.

That these remarks describe correctly what is involved as a latent assumption in the ordinary rule for calculating the horse-power of the steam engine, admits of corroboration from another aspect in which its work is sometimes considered. It is usually asserted, for instance, that an engine with a pressure of steam of 10,000lbs. on the piston and a speed of stroke of 200ft. per minute can raise on the shaft 200 times 10,000lbs., or 2,000,000lbs., 1ft., in a minute. But this is obviously equivalent to the work of raising 10,000lbs. on the shaft through 200ft. in a minute. Thus it is held that a pressure of 10,000lbs. on the piston could raise through the shaft a weight of 10,000lbs. at a speed of 200ft. per minute. In other words, a pressure of 10,000lbs. can raise a weight of 10,000lbs. 200ft. in a minute. It would be every whit as rational to assert that that weight of 10,000lbs. could force down the piston against the steam at the speed of 200ft. per minute. If all the power exerted by the steam upon the piston were transmitted unimpaired to the shaft, it could only balance or support that weight at the position relatively to the centre of the shaft, at which it is supposed that it could raise at that speed. It could not produce the dynamical effect of raising that weight through the minutest space.

The weight, then, which the ordinary rule for calculating the power of the steam engine represents it as capable of raising at a given velocity, could not be *raised* but could only be *balanced* by the power of the steam, at the position relatively to the centre of the shaft at which it is supposed it could be raised at that velocity. In other, words, the steam could produce on that weight, at that position only a statical effect, and not, as has been generally held, a dynamical effect. In that rule, a similar error is committed as would be done if it were held in the case of the wheel and axle, that when the product of the power into its distance from the centre is equal to the product of the weight into its distance from the centre, the power could raise the weight. With these conditions the power could no more raise the weight, than the weight could raise the power. They would mutually balance each other, and produce stable rest. And just as in that machine, the power could only raise a smaller weight than that referred to, so, in the steam engine, the resistance which the steam can overcome is smaller than is usually supposed. In other words, the ordinary rule for calculating the horse-power of the steam engine gives too high a result. A more correct method for calculating its power would be, after making due allowance for friction, &c., to multiply *the actual weight which the pressure of the steam upon the piston could raise at that speed* by the number of feet which the piston travels in a minute, and to divide the product by 33,000.

It may, however, be objected that the work of the steam in a given time is the product of its pressure by the space through which it travels in that time; that is, in other words, the work of the steam is the product of its pressure upon the piston by the space through which the latter travels in that time. But this representation of what its work is, does not specify any resistance whatever as overcome, or any useful effect produced. It merely states that the steam exerted a certain pressure upon the piston, and that the piston moved with a certain velocity. But neither that pressure on the piston, nor that velocity of the piston, nor yet both of these combined, constitutes the work got out of the engine. They are only intermediate conditions or means through which a certain amount of work may be got as an ultimate result from the engine. *Work is resistance overcome*, such as a weight raised through a certain space, or to a higher altitude. But the pressure of the steam is neither resistance overcome, nor yet a weight raised. It is a power which might overcome a certain resistance, or raise a certain weight through a certain space. But the resistance overcome, or weight raised, and not the power overcoming or raising that resistance or weight, is the main element of the work of the steam. The pressure of the steam is the worker, not the work; just as the weight raised by a man's strength to a certain height, and not the muscular force put forth by him in raising it, is the work performed by him. In short, the work of the steam engine, or of any other machine in given time, is the weight raised, or resistance overcome, by it in that time, multiplied into the space through which it is raised or overcome. That is the ultimate result of the engine in that time. But it is obviously absurd to assert that the pressure of the steam could raise the piston at a certain velocity, if the piston were so loaded as by its gravity to exert an equal pressure to that of the steam; for the two equal pressures acting in opposite directions on the piston would exactly counteract each other, and, therefore, the piston would be precisely as if there were no pressure at all upon it. But how could it move at all unless some force or pressure acted on it? In short, these two conflicting propositions would seem to be unconsciously held by those who maintain the opinion under discussion, namely—first, that the piston would remain in a state of motionless equilibrium, if the pressures exerted upon it in opposite directions by the steam on the one hand, and by the gravity of its own load on the other, were equal; and, secondly, that the piston would move at a certain velocity if it were acted upon by those two equal forces. In other words, those who advocate that view are chargeable with unconsciously maintaining that the piston would, under the action of those two equal forces, be both in rest and in motion at the same time.

In reference to this criticism Mr. Birckel, the Secretary, remarked that at a first glance it might appear that there is real ground for the charge brought against writers on mechanics, that they have confused the two distinct questions or conditions of statical and dynamical equilibrium, but upon careful study it will be found that such is not the case. Those writers on mechanics, both abstract and applied, who are entitled to our confidence, and among them Dr. Lardner, are fully aware that a preponderance of force is required in that direction in which motion, is to be produced; but when motion once has set in at the required velocity, no preponderance of force is required to preserve such motion since, the system (and whatever it be, it may always be reduced into that of a descending and ascending weight) will persevere in that particular state of motion by virtue of the inertia of matter, so long as there are no retarding causes at work to destroy the momentum which was at first communicated to the system, and gradually to bring about that particular state of motion which we call "rest."

It is of course not contended in the examination in question that writers on mechanics do not make due allowance for the constant presence of the retarding effects of friction, and it is not necessary therefore to take them into consideration in these remarks. The only question which now presents itself, and which remains to be answered, is the following:—What becomes of the mechanical work performed to communicate to the system in motion, the momentum corresponding to a given speed?

If it could be shown that this work is absolutely lost, then would writers on mechanics be really chargeable with the inaccuracy attributed to them in Mr. Miller's communication; but if that could be shown, then also would Newton's fundamental principle of mechanics be overthrown—*the principle that reaction is equal and opposed to action;* and since writers on mechanics have accepted and worked upon this axiom, the charge now brought against them would have to be made against Newton in the first instance. Axioms, however, are truths which are evident of themselves, which thrust themselves convincingly, and, as it were, without any effort of intelligence upon the observer's mind, in the daily occurrences of life. Thus when we say that the work performed upon a system (as instanced above) to create motion must be returned to us in some shape or manner before the original conditions of rest or motion can be brought about again, we cannot demonstrate the truth of that statement by any mode of reasoning, but we believe it to be true because we cannot conceive it to be otherwise—because if it were not so we should have discovered an embodiment of absolute annihilation, which is repugnant to human reason; experimentally, this natural and *à priori* belief may afterwards be easily demonstrated.

Applying now these considerations to the case of the steam engine, it follows that when the system is set in motion, the weight load or pressure working is really greater than the weight *then* being raised; but as soon as *uniform motion* has been attained, then must the working load be equal to the weight being raised, since there can be no preponderance of pressure without causing *acceleration of motion;* and since it has been shown that the work performed at the beginning, in order to produce motion at a certain velocity, must be returned to us, the proposition finally remains true that the work of the steam engine is equal to the product of the load on the piston by the space through which it has travelled.

The practical conclusion, however, to be drawn from Mr. Miller's examination is as follows:—Writers on mechanics cannot be too *precise*, but may be much too *concise*, in the exposition of the practical truths with which they deal. Too great conciseness, I have long been convinced, is the error committed by our scientific writers on mechanical subjects.

ROYAL SOCIETY.

ON A NEW GEOMETRY OF SPACE.

By Julius Plucker, For. Memb. R.S.

Infinite space may be considered either as consisting of points or transversed by planes. The points, in the first conception, are determined by their co-ordinates, by x, y, z for instance, taken in the ordinary signification; the planes in the second conception are determined in an analogous way by their co-ordinates, introduced by myself into analytical geometry, by t, u, v for instance. The equation,

$$t x + u y + v z = 1,$$

represents, in regarding x, y, z as variable, t, u, v as constant, a plane by means of its points. The three constants t, u, v are the co-ordinates of this plane. The same equation, in regarding t, u, v as variable, x, y, z as constant, represents a point by means of planes passing through it. The three constants x, y, z are the co-ordinates of this point.

The geometrical constitution of space, referred hitherto either to points or to planes, may as well be referred to right lines. According to the double definition of such lines, there occurs to us a double construction of space. In the first construction we imagine infinite space to be traversed by lines, themselves consisting of points; an infinite number of such lines in all directions pass through any given point; the point may describe each of the lines. This constitution of space is admitted when, in optics, we regard luminous points sending out in all directions rays of light, or, in mechanics, forces acting on points in any direction. In the second construction, infinite space is regarded likewise as traversed by right lines, but these lines are determined by planes passing through them. Every plane contains an infinite number of lines, having within it every position and direction, round each of which the plane may turn. We refer to this second construction when, in optics, we regard, instead of rays, the corresponding fronts of waves and their consecutive intersections, or when, in mechanics, according to Poinsot's ingenious philosophical views, we introduce into its fundamental principles "couples," as well entitled to occupy their place as ordinary forces. The instantaneous axes of rotation are right lines of the second description.

The position of a right line depends upon four constants, which may be determined in a different way. I adopted for this purpose the ordinary system of three axes of co-ordinates. A line of the first description, which we shall distinguish by the name of *ray*, may be determined by means of two projections; for instance, by those within X Z and Y Z, represented by

$$x = r z + \rho,$$
$$y = s z + \sigma,$$

or by

$$t x + v_x z = 1,$$
$$u y + v_y z = 1.$$

In admitting the first system of equations, a ray is determined in a linear way by means of the four constants r, s, ρ, σ, which may be called its four co-ordinates, two of them, r and s, indicating its direction, the remaining two, after its direction being determined, its position in space. In adopting the second pair of equations, t, u, v_x, v_y will be the co-ordinates of the ray.

A right line of the second description, which we shall distinguish by the name of *axis*, is determined by any two of its points. It is the common intersection of all planes passing through both points. We may select the intersection of the axis with the two planes, X Z and Y Z, as two such points, and represent them by

$$x t + z_t v = 1,$$
$$y u + z_u v = 1,$$

or by

$$t = p v + \pi,$$
$$u = q v + \kappa.$$

In making use of the first pair of equations, the four constants x, y, z^t, z^u, indicating the position of the two points within X Z and Y Z, are the co-ordinates of the axis. In adopting the second pair, the four co-ordinates of the axis are p, q, π, κ.

A complex of rays or axes is represented by means of a single equation between their four co-ordinates; a congruency, containing all congruent lines of two complexes, by means of two such equations; a configuration, containing the right lines common to three complexes, by three equations. In a complex every point is the vertex of a cone, every plane contains an enveloped curve. In a congruency there is a certain number of right lines passing as well through a given point as confined within a given plane. A configuration is generated by a moving right line.

In a linear complex the right lines passing through a given point constitute a plane; all right lines within a given plane pass through a fixed point. Two linear complexes intersect each other along a linear congruency. In such a linear congruency there is a single right line passing as well through a given point as confined within a given plane. Three linear complexes meet along a linear configuration.

Instances of linear complexes are obtained by means of linear equations between the four co-ordinates of any one of the four systems. A linear configuration of rays represented by three such equations between r, s, ρ, σ is a paraboloid, immediately obtained; between t, u, v_x, v_y a hyperboloid. A linear configuration of axes represented by three linear equations between p, q, π, κ is a hyperboloid, immediately obtained; between x, y, z^t, z^u a paraboloid. Instances of linear congruencies are exhibited by means of two linear equations, as well between t, u, v_x, v_y as between x, y, z_t, z_u, and their right lines easily constructed.

The general linear equation, however, between any four co-ordinates does not represent a linear complex of the most general description. Besides, there is a want of symmetry, the four co-ordinates depending upon the choice of both planes, X Z and Y Z. This double inconvenience, if not eliminated, would render it impossible to adapt in a proper way analysis to the new geometrical conception of space. But it may be eliminated in the most satisfactory way.

For that purpose I introduced (in confining myself to the case of the co-ordinates r, s, ρ, σ) a fifth co-ordinate $(s\rho - r\sigma)$, which is a function of the four primitive ones. Then the linear equation between the five co-ordinates,

$$A r + B s + C + D \sigma + E \rho + F (s\rho - r\sigma) = 0,$$

is the most general of a linear complex. After having been rendered homogeneous by a sixth variable introduced, it becomes of a complete symmetry with regard to the three axes O X, O Y, O Z. The introduction of the fifth co-ordinate $(s\rho - r\sigma)$ is the real basis of the new analytical geometry, the exploration of which is indicated in the ordinary way.

In the paper presented, a complete analytical discussion of a linear complex is given. We may for any point of space construct the corresponding plane containing all traversing rays, and *vice versâ*. Right lines of space associate themselves into couples of conjugated lines; to each line a conjugated one corresponds. Any right line intersecting any two conjugated is a ray of the complex. Each ray of it is to be regarded as two coincident conjugated lines. It is easily shown that each linear complex may be represented by means of any one of the following three equations, in which k indicates the same constant:—

$$s\rho - r\sigma = k, \quad \sigma = k r, \quad \rho = k s.$$

Accordingly a linear complex depends upon the position of a fixed line (depending itself upon four constants) and the constant k. Hence it likewise follows that such a complex of rays may, without being changed, as well turn round that fixed line, the axis of the complex, as move along it, parallel to itself. The same results may be confirmed by means of the transformation of ray co-ordinates, and thus analytically determined by the primitive constants A, B, C, D, E, F, the position of the axis of the complex and its constant k. In a peculiar case, wher k becomes zero, all rays of the complex meet its axis.

A linear congruency of rays, along which an infinite number of linear complexes meet, is represented by the equations of any two of these complexes. Through a given point of space passes only one ray, corresponding to it, as there is only one corresponding ray confined within a given plane. There is, with regard to each complex passing through the congruency, one right line conjugated to a given one. All these conjugated lines constitute one generation of a hyperboloid, while the right lines of its other generation are rays of the congruency, which therefore may be generated by a variable hyperboloid turning round one of its right lines.

The axes of all complexes intersecting each other along a linear congruency meet at right angles a fixed line, which is the axis of the congruency. Among the complexes there are especially two, the axes of which are met by their rays. These axes, meeting themselves the axis of the congruency, are its directrices. A linear congruency, depending upon eight constants, is fully determined by means of its two directrices. Each right line intersecting both directrices is one of the rays. The plane parallel to both directrices, and at equal distance from them, is the central plane of the congruency; the point where it meets, under right angles, the axis of the congruency, its centre. The two lines bisecting within the central plane the projections of the two directrices are its secondary axes. The directrices may be as well both real as both imaginary. In peculiar cases the two directrices are congruent, or one of them is at an infinite distance.

Each of two complexes being given by means of its axis and its constant k, both directrices of the congruency along which they intersect one another are analytically determined. A congruency being given by means of its directrices, the constants and axes of all complexes passing through it are determined.

A linear configuration of rays is the common intersection of any three linear complexes, and represented by their equations, $\Omega = 0, \Omega' = 0, \Omega'' = 0$. Each complex represented by an equation of the form of $\Omega + \mu\Omega' + \nu\Omega' = 0$, equally passes through the same configuration. So does any congruency along which two such complexes meet. A linear configuration is a hyperboloid; its rays constitute one of its generations, while the directrices of all traversing congruencies constitute the other. The central planes of all these congruencies meet in the same point—the centre of the hyperboloid. Its diameters meet both directrices of the different congruencies. The directrices are either real or imaginary; accordingly the diameters meet the hyperboloid, or meet it not. If the two directrices are congruent, the diameters become asymptotes. The hyperboloid passes into a paraboloid if there is one directrix infinitely distant.

A linear configuration is determined by means of three congruencies as it is by means of three complexes. That ray of it which meets one directrix of each congruency is parallel to the other. By drawing two planes through the two directrices of each of the three congruencies parallel to its central plane, we get a rhomboid circumscribed about the hyberboloid, the points of contact, within the six planes, being the points where the six directrices are intersected by the rays. A hyperboloid being given, we may revert to the congruencies and complexes constituting it. Finally, the equation of the hyperboloid in ordinary co-ordinates, x, y, z, is derived.

If we proceed to complexes of the second degree, the field of inquiry is immensely increased. Here any given point of infinite space is the vertex of a cone of the second order, and likewise within any given plane there is a curve of the second class enveloped by rays of the complex. The whole of the infinite number of cones, as well as of the infinite number of enveloped conics, is represented by a linear equation, between the five ray co-ordinates r, s, ρ, σ and $(s\rho - r\sigma)$. The general analytical theory of contact may immediately be applied to complexes of the second order, touched by linear complexes, &c.

In order to elucidate the geometrical conceptions explained, I thought it proper to present, in Section II., an application to optics, leading to a complex of a simple description. Rays of light, constituting in air a complex, will likewise do so after being submitted to any reflexions or refractions whatever. Let us, for instance, suppose that the complex in air is of the first order and its constant equal to zero, *i.e.*, that its rays start in every direction from all points of a luminous right line. Let these rays enter a biaxal crystal by any plane surface. Let the luminous line and this surface be perpendicular to each other. Then, within the crystal, the double-refracted rays constitute a new complex, which is represented, like the primitive one and independently of it, by means of an equation between ray co-ordinates.

For this purpose I return to a paper of mine of the year 1838, concerning double refraction, at the end of which, after having mentioned the application of Huygbens's principle to Fresnel's wave-surface and the construction of Sir William Hamilton, I proposed a new construction of the double-refracted rays in the most general case. Here I first made use of an auxiliary ellipsoid, with regard to which the polar plane of every point of the wave-surface is one of its tangent planes, and, reciprocally, the pole of every plane touching the surface one of its points. In representing Fresnel's ellipsoid by the equation

$$a^2 x^2 + b^2 y^2 + c^2 z^2 = 1,$$

the new auxiliary ellipsoid may be represented by

$$\frac{x^2}{b\,c} + \frac{y^2}{a\,c} + \frac{z^2}{a\,b} = 1,$$

or

$$a\,x^2 + b\,y^2 + c\,z^2 = a\,b\,c,$$

and replaced, for most purposes, by the similar one,

$$a\,x^2 + b\,y^2 + c\,z^2 = 1.$$

The construction, as far as we are concerned here, may be expressed thus:—Construct at the moment when Fresnel's wave-surface is formed the polar line of the trace along which the surface of the crystal is intersected by the elementary wave. The two refracted rays meet the wave-surface in the two points where it is intersected by the polar line constructed. In the paper of 1838 I promised a discussion of the construction given, but neglected it till the present time. This discussion immediately leads us to represent the complex of double-refracted rays by an equation, and at the same time we meet with several theorems worthy of notice.

If there is any incident ray, the plane of refraction, containing both double-refracted rays, is congruent with the diametral plane of the auxiliary ellipsoid, the conjugated diameter of which is perpendicular to the plane of incidence. All rays incident within the same plane. While the plane of incidence turns round the vertical, the corresponding plane of refraction turns round that diameter of the auxiliary ellipsoid, the conjugated diametral plane of which is the surface of the crystal. Whatever may be the plane or curved surface by which a crystal is bounded in a given point, all corresponding planes of refraction pass through a fixed right line.

A complex of rays starting in air in all directions from every point of a luminous right line, perpendicular to the surface of the crystal, is represented by the equation

$$r\,\sigma = s\,\rho,$$

the luminous right line being the axis O Z, while the two remaining axes, O X and O Y, are within the surface of the crystal any two right lines perpendicular to each other. This complex is transformed by double refraction into another, the equation of which assumes the most simple form,

$$r\,\sigma = k\,s\,\rho,$$

in especially admitting that the two axes O X and O Y are congruent with the axes of the ellipse along which the auxiliary ellipsoid is cut by the surface of the crystal, and that the third axis O Z is, within the crystal, the diameter of the auxiliary ellipsoid; the conjugated diametral plane is that surface. k is a constant indicating the ratio of the squares of the two axes of the ellipse.

The complex of double-refracted rays is of the second order; its equation may be easily submitted to analytical discussion. All its rays passing through any given point constitute a cone of the second order. This cone remains the same if the point describes a right line, passing through the origin. Likewise there is in any given plane a hyperbola, enveloped by rays of the complex. Peculiar cases are easily determined. The complex of double-refracted rays may be described in three different ways by a variable linear congruency. In the peculiar case in which the surface of the crystal is a principal section, O Z becomes perpendicular to it; if it is one of the circular sections of the auxiliary ellipsoid, the constant k becomes equal to unity, *i. e.*, all double-refracted rays meet the axis O Z. From the general case the case of uniaxial crystals is immediately derived.

NOTE ON THE ATOMICITY OF ALUMINIUM.

By Professor A. W. WILLIAMSON, President of the Chemical Society.

In the "Preliminary Note on some Aluminium Compounds," by Messrs. Buckton and Odling, some questions of considerable theoretical importance are raised in connection with the anomalous vapour densities of aluminium ethyle and aluminium methyle. The authors have discovered that the vapour of aluminium methide ($Al^2\,Me^6$) occupies rather more than two volumes (H = 1 vol.) at 163°, when examined by Gay-Lussac's process, under less than atmospheric pressure. The boiling-point of the compound under atmospheric pressure is given at 130°, and the compound accordingly boiled a good deal below 130° at the reduced pressure at which the determination was made. The vapour was, therefore, considerably superheated when found to occupy a little more than two volumes. When still further superheated up to 220° to 240°, it was found to possess a density equivalent to rather less than four volumes at the normal temperature and pressure.

The aluminium ethyle was found to have a density decidedly in excess of the formula $Al^2\,Et^6$ = 4 vols., but far too small for $Al^2\,Me^6$ = 2 vols. From their analogy to aluminic chloride, $Al^2\,Cl^6$ = 2 vols., the methide and ethide might be expected to have vapour-volumes corresponding to $Al^2\,Me^6$ = 2 vols., $Al^2\,Et^6$ = 2 vols. The authors seem, however, more inclined to doubt the truth of the general principles which lead us to consider these hexatomic formulæ the correct ones, than to doubt their own interpretation of the observations already made upon the new compounds.

Even if the vapour-volume of aluminic chloride had been unknown to us, there were ample grounds for assigning to aluminium methide a molecular formula $Al^2\,Me^6$, and a vapour-density corresponding to $Al^2\,Me^6$ = 2 vols.; for the close analogy of aluminic and ferric salts is perfectly notorious, and the constitution $Fe^2\,O^3$ for ferric oxide settles $Al^2\,O^3$ as the formula for alumina. With regard, however, to the chlorides of these metals, it might be supposed that the formula Fe Cl^3 and Al Cl^3 would be the most probable molecular formulæ; and Dr. Odling, in his useful "Tables of Formulæ," published in 1864, expressed an opinion in favour of these formulæ by classing as anomalous Deville's vapour-densities, which correspond to the higher formulæ $Al^2\,Cl^6$, $Fe^2\,Cl^6$. It is well known that Laurent and Gerhardt, whose penetrating minds raised so many vital questions of chemical philosophy, laid down a preliminary rule that every molecule must contain an even sum of the atoms of chlorine, hydrogen, nitrogen, and metals. According to this rule, the formulæ $Al^2\,Cl^6$, and $Fe^2\,Cl^6$ would have no greater probability than the formulæ Fe Cl^3, Al Cl^3; and judging by that rule, Dr. Odling naturally preferred the simpler formulæ.

Since Gerhardt's time chemists have, however, extended to the greater number of metals the arguments which proved oxygen to be biatomic; and we now know that the alkali metals, the nitrogen series, silver, gold, and boron, may count with the atoms of chlorine, hydrogen, &c., to make up an even number in each molecule, but that the greater number of metals must not be so counted; for that in each molecule in which they are contained the sum of the atoms of chlorine, hydrogen, nitrogen, potassium, &c., must be even, just as much as if the atom of the diatomic or tetratomic metal were not in the compound. In a paper "On the Classification of the Elements in relation to their Atomicities," I had occasion to point out that inasmuch as iron and aluminium belong, partly by their own properties, partly by their analogies, to the class of metals which do not join with chlorine, &c., in making up an even number of atoms, the number of those other atoms in each molecule must be even in itself, just as if iron or aluminium were not there; and that accordingly the formulæ $Fe^2\,Cl^6$, $Al^2\,Cl^6$ are really quite normal. In like manner I showed that the vapour-density of calomel, Hg Cl = 2 vols., is anomalous, as containing in a molecular volume a single atom of chlorine, although, in accordance with Gerhardt's rule, Dr. Odling had classed it as normal. I certainly understood that my able friend accepted my suggestion in this case at least, for he speedily brought forward theoretical and experimental facts in confirmation of it.

These examples serve to show that it was to be expected that the ethyle and methyle compounds of aluminium would contain an even number of atoms of ethyle and methyle in each molecule, and that their formulæ would accordingly be $Al^2\,Me^6$, $Al^2\,Et^6$.

It remains for us to consider how the deviation from our theoretical anticipations in the case of aluminium ethyle and the partial deviation in the case of aluminium methyle ought to be treated.

Fortunately we have the benefit of some experience to guide us in this matter, for a considerable number of other compounds have been found to occupy in the state of vapour nearly double the volume which corresponds to one molecule; but, with very few exceptions, all of them have already been proved to have undergone decomposition, so as to consist of two uncombined molecules. Thus sal-ammoniac is admitted to have the molecular formula $NH^4 Cl$; yet in the state of vapour this quantity occupies the volume of nearly two molecules, viz., four volumes. Has the anomaly led us to doubt the atomic weight of chlorine, nitrogen, or hydrogen, or to doubt any other of the results of our comparison of their compounds? or has it led chemists to diffusion experiments with its vapour, proving it to contain uncombined $H Cl$ and $N H^3$, each occupying its own natural volume? Has it not been proved that at the temperature at which sal-ammoniac vapour was measured, its constituents mix either without evolving heat (that invariable function of chemical action), or, according to another experimentalist, with evolution of far less heat than of the whole quantity of hydrochloric acid and ammonia combined, on coming together at that high temperature.

Again, $S O^4 H^2$ is known to represent the formula of one molecule of hydric sulphate, yet the vapour formed from it occupies nearly the bulk of two molecules. Has this fact cast any doubt on the atomic weights of the elements S, O, or H? Or has it led to the discovery of peculiarities in the constitution of the vapour which would probably have escaped notice had they not been anticipated by theory, peculiarities which go a long way towards bringing the apparent anomalies within the law?

Nitric peroxide, $N^2 O^4$, was considered, from our knowledge of other volatile componuds of nitrogen, to be anomalous in its vapour-volume being $N^2 O^4 = 4$ vols.; and we have been shown by the experiment of Messrs. Playfair and Wanklyn, that the anomaly almost disappears when the compound is evaporated by the aid of a permanent gas at a temperature considerably below its boiling-point, as its theoretical molecule $N^2 O^4$ is then found to occupy the two volumes which every undecomposed molecule occupies. This explanation seems to me to be the more entitled to grave consideration on the part of the discoverers of the new aluminium compounds, from the fact that the evidence in favour of it has been admitted to be conclusive by Dr. Odling, who classes nitric peroxide by the formula $N^2 O^4 = 2$ vols. among compounds with normal vapour-densities, in virtue of the fact that at low temperatures it can be obtained with that density, though having half that density at higher temperatures.

The arguments for admitting that the low vapour-densities of the aluminium compounds are anomalous are even stronger than those which are admitted in the case of nitric peroxide; for it did require very severe superheating to get the aluminium compounds to near four volumes, whereas it required very ingenious devices to get nitric peroxide out of the four-volume state.

Such guiding principles as we have acquired in chemistry are the noblest fruits of the accumulated labours of numberless patient experimentalists and thinkers; and when any new or old fact appears to be at variance with those principles, we either add to our knowledge by discovering new facts which remove the apparent inconsistency, or we put the case by for a while and frankly say that we do not understand it.

The decision of the atomic weight of aluminium has involved greater difficulty than was encountered in the case of most other metals, owing to the fact of our knowing only one oxide of the metal, and salts corresponding to it; but the analogies which connect aluminium with other metals are so close and so numerous, that there are probably few metals of which the position in our classification is more satisfactorily settled. We may safely trust that the able investigators who are examining these interesting compounds will bring them more fully than now within the laws which regulate the combining proportions of their constituent elements; for, as it now stands, the anomaly is far less than many others which have been satisfactorily explained by further investigations.

Meanwhile, aluminium is a metal singular for only appearing in that pseudo-triatomic character in which iron and chromium appear in their sesquisalts.

PRELIMINARY NOTICE ON THE PRODUCTS OF THE DESTRUCTIVE DISTILLATION OF THE SULPHOBENZOLATES.

By John Stenhouse, LL.D., F.R.S., &c.

The salt which I have hitherto chiefly employed is the sulphobenzolate of soda. $C_{12} H_5 Na 2 SO_3$, which was prepared according to Mitscherlich's* directions, by precipitating crude sulphobenzolate of lime by carbonate of soda, separating the carbonate of lime produced, and evaporating the clear solution to dryness. The finely powdered salt, which had previously been thoroughly dried, was introduced into a small copper retort and subjected to destructive distillation, when a considerable quantity of carbonic acid was evolved, and a brownish-coloured oily liquid, covered by a layer of water, collected in the receiver.

This oil was separated from the water and distilled in a retort furnished with a thermometer. The liquid began to boil at 10° C., and then rose slowly to 110° C., when only a small quantity of water, and an oil consisting chiefly of benzol, came over. The boiling-point then rapidly rose to 290° C., at which temperature the greater portion of the liquid distilled over, leaving a black residue in the retort.

The oil boiling at 290° C. is of a pale yellow colour, heavier than water, and has an aromatic and slightly alliaceous odour. It contains a considerable amount of sulphur.

When this oil is brought in contact with nitric acid, a very violent action ensues with evolutions of nitric fumes, and when the resulting solution is poured into water, a crystalline mass of a pale yellow colour is obtained. This, when dried and washed with ether to separate a small quantity of adhering oil, is dissolved in hot spirit, from which, on cooling, two colourless crystalline substances separate.

The first of these, which constitutes the bulk of the product, forms beautiful rhombic plates, which, when crystallised out of benzol, may be obtained of considerable size and great lustre, closely resembling chlorate of potassa in appearance. This body also contains sulphur. The second substance, the quantity of which is comparatively small, crystallises in long thin plates.

The oil, when treated with concentrated sulphuric acid, dissolves with a fine purple colour, and from this solution water precipitates a crystalline body, an organic acid remaining in solution, which forms a crystalline lime-salt.

I have likewise subjected to destructive distillation the sulphobenzolates of lime, ammonia, and copper. The two last yield very different products from the soda-salt.

I am at present engaged in examining these as well as the other bodies mentioned in this Notice, and hope soon to be able to communicate to the Society the results of my investigations.

* Pogg. Ann., vol. xxxi., pp. 283 & 634.

ROYAL INSTITUTION OF GREAT BRITAIN.

ON ALUMINIUM ETHIDE AND METHIDE.

By William Odling, M.B., F.R.S.

The symbols by which the atomic proportions of a few of the principal metallic elements are usually represented, together with the relative weights of these several proportions, are shown in the following table:—

Lithium	Li	7
Magnesium	Mg	24
Zinc	Zn	65
Arsenic	As	75
Silver	Ag	108
Tin	Sn	118
Mercury	Hg	200
Lead	Pb	207
Bismuth	Bi	210

It is observable that the atomic proportions of the metals range from 7 parts of lithium, through 108 parts of silver up to 210 parts of bismuth. Now it is found that all these different proportions have substantially the same specific heat, so that 7 parts of lithium, 108 parts of silver, and 210 parts of bismuth, for instance, absorb or evolve the same amount of heat in undergoing equal increments or decrements of temperature. Hence, taking silver as a convenient standard of comparison, the atomic proportion of any other metal may be defined to be, that quantity of the metal which has the same specific heat as 108 parts of silver.

Many of the metals unite with the halogen radicles chlorine and bromine, as also with the organic radicles ethyl and methyl, to form volatile compounds, which may be conveniently compared with the chloride and ethide of hydrogen. Now, it is found that the several proportions of metal or hydrogen contained in equal volumes of these gaseous chlorides or ethides are their respective atomic proportions; so that equal volumes of chloride or ethide of hydrogen, zinc, arsenic, tin, mercury, lead, and bismuth, for instance, contain 1, 65, 75, 118, 200, 207, and 210 parts of hydrogen or metal respectively. Hence, the molecule of chloride of hydrogen, H Cl, being conventionally regarded as constituting two volumes, the atomic proportion of a metal may be defined to be that quantity of the metal which is contained in two volumes of its gaseous chloride, or bromide, or ethide, or methide, &c.

These two definitions having reference respectively to the specific heats of the metals, and the molecular volumes of their gaseous compounds, lead in all cases to the same conclusion. Thus, 200 parts of mercury is the quantity of mercury which has the same specific heat as 108 parts of silver, and is also the quantity of mercury contained in two volumes of mercuric chloride, mercuric ethide, &c.

The atomic proportions of the different metals unite with 1, 2, 3, 4, &c., atoms of chlorine and ethyl, to form the two-volume molecules of their respective chlorides and ethides, as shown below:—

2 Vols.	2 Vols.	2 Vols.
$H Cl$	$H Et$	—
$HgCl_2$	$HgEt_2$	$Zn Et_2$
$Bi Cl_3$	$Bi Et_3$	$As Et_3$
$Sn Cl_4$	$Sn Et_4$	$Pb Et_4$

Or, two volumes of the gaseous chlorides of hydrogen, mercury, bismuth, and tin, for instance, are found to contain respectively 35·5 parts, twice 35·5 parts, three times 35·5 parts, and four times 35·5 parts of chlorine.

Aluminium, which is one of the three most abundant constituents of the earth's crust, and the most abundant of all its metallic constituents, enters into the composition of a large number of native minerals of great value in the fine and useful arts, and also forms extremely well-defined artificial compounds, possessing a high degree of chemical interest. Nevertheless, chemists are not at all agreed as to the atomic weight which should be accorded to the metal, or as to the molecular formulæ of its principal compounds.

The quantity of aluminium which has the same specific heat as 108 parts of silver is found to be 27·5 parts; and analysis shows that this quantity of aluminium combines with three times 35·5 parts of chlorine to form chloride of aluminium. Accordingly the atomic proportion of aluminium should be fixed at 27·5 parts; its chloride be formulated as a trichloride thus, $Al Cl_3$; and its other compounds be represented by corresponding expressions, as shown in th left-hand column of the following table, instead of by the heretefore used more complex expressions shown in the right-hand column:—

Al 27·5		Al 13·75
$Al\ Cl_3$	Chloride	$Al_2\ Cl_3$
$Na\ Al\ Cl_4$	Sodio-chloride	$Na\ Al_2\ Cl_4$
$Na_3Al\ F_6$	Cryolite	$Na_3\ Al_3\ F_6$
$Na_3Al\ O_3$	Aluminate	$Na_3\ Al_2\ O_3$
$H\ Al\ O_2$	Diaspore	$H\ Al_2\ O_2$
$K\ Al\ S_2\ O_8$	Alum	$K\ Al_2\ S_2\ O_8$
$K\ Al\ Si_3\ O_8$	Feldspar	$K\ Al_2\ Si_3\ O_8$
$P\ Al\ O_4$	Phosphate	$P\ Al_2\ O_4$

But the quantity of aluminium contained in two volumes of its gaseous chloride was found by Deville to be 55 parts, instead of 27·5 parts, while the quantity of chlorine was found to be six times 35·5 parts, instead of three times 35·5 parts. Hence, relying exclusively upon molecular volume, the atomic weight of aluminium would be 55, and the formula of chloride of aluminium $Al\ Cl_6$. This conclusion, however, is inadmissible for several reasons, and chiefly because it would make the atomic proportion of aluminium possess a specific heat twice as great as that belonging to the atomic proportion of any other metal.

To evade this difficulty some chemists have proposed to accord to the molecule of aluminic chloride the formula $Al_2\ Cl_6$, whereby an indivisible proportion of metal would be habitually represented by a divisible symbol; for it is agreed on all hands that the proportion of aluminium contained in the molecule of aluminic chloride is the smallest proportion of aluminium found in any aluminic compound whatsoever; that it is incapable of experimental division by any process whatsoever; and consequently that, so far as our present knowledge goes, it is an indivisible or atomic proportion.

Now there are undoubtedly certain bodies, elementary and compound, of which the ascertained vapour densities, and consequent volumes, no matter how accounted for, are, as a mere matter of experiment, discordant with the chemical analogies of the respective bodies: but in most instances these anomalous results are rendered unimportant by other determinations of vapour density, either of the same bodies raised to higher temperatures, or of associated bodies having a more decided volatility. Hence arises the question whether the ascertained volume of aluminic chloride, which is discordant with the specific heat of aluminium, may not be anomalous in a similar manner, and whether the anomaly may not be corrected by an examination of other more volatile aluminic compounds.

The methide and ethide of aluminium recently obtained by Mr. Buckton and the speaker are, so to speak, varieties of aluminic chloride, in which the chlorine has been replaced by methyl and ethyl, and are at the same time far more volatile and manageable than the typical chloride. Now, it has been found that two gaseous volumes of the methide and ethide of aluminium contain only 27·5 parts of aluminium, united with three atomic proportions of methyl and ethyl; and accordingly their molecules have to be expressed by the formulæ $Al\ Me_3$ and $Al\ Et_3$ respectively. In other words, the normal results obtained with the methide and ethide correct the anomalous result obtained with the chloride, and confirm the atomic weight and molecular formulæ deducible from the specific heat of aluminium.

That the ascertained vapour density of aluminic chloride is really anomalous receives a further corroboration in the behaviour of aluminic methide itself. At 220°, and all superior temperatures, the vapour density of this compound shows that two volumes of its vapour contain 27·5 parts of aluminium and *three* times 15 parts of methyl; but at 130° its vapour density, corrected for alteration of temperature, becomes very nearly doubled; or, in other words, two volumes of its vapour contain very nearly 55 parts of aluminium and *six* times 15 parts of methyl. According, however, to the well-known rule, based on the researches of Cahours and Deville, the molecular formula of a body must be calculated from its permanent or ultimate, and not from its variable or initial vapour density, whence the high vapour density of aluminium methide at 130° does not at all interfere with our attributing to its molecule the formula $Al\ Me_3$, deducible from its vapour density at 220° and upwards, and harmonising with the specific heat of metallic aluminium.

Aluminium ethide and methide occur as colourless liquids. The ethide boils at 194°, and does not freeze at − 18°. The methide boils at 130°, and solidifies at a little above 0° into a beautiful crystalline mass. Both liquids take fire on exposure to air, and explode violently by contact with water. They are produced from mercuric ethide and methide respectively, by heating these compounds for some hours in a water-bath, with excess of aluminium clippings. This process was obviously suggested by Frankland and Duppa's new reaction for making zinc ethide, methide, anylide, &c.

$$Al_2 + 3\ Hg\ Et_2 = Hg_3 + 2\ Al\ Et_3.$$

The National Lifeboat Institution.—At the annual meeting of this institution Earl Percy was chosen President, in place of the late Duke of Northumberland. The report stated that during the past year, gifts, in the shape of the entire cost, amounting to £8,077 11*s.* 10*d.*, of 25 new lifeboats, had been presented to the Institution, in addition to an anonymous donation from "A Friend" of no less than £5,000. The lifeboats of the Institution saved 432 lives and 17 vessels during the past year. For these services, and for the saving of 266 lives by shore boats and other means, the Institution had granted rewards amounting to £1,539. During the last two years about 12,000 persons had been afloat in the lifeboats of the institution, and only three of the lives of these had been lost during that period. The total receipts during 1864 were £31,917 9*s.* 8*d.*, and its expenditure, including its liabilities, was £29,034 9*s.* 5*d.* Legacies amounting to £3,365 had been received by the Institution during the past year.

CHEMICAL SOCIETY.

ON A NEW REACTION FOR THE PRODUCTION OF ANHYDRIDES AND ETHERS.

By John Broughton, B. Sc., Chemical Assistant, Royal Institution.

The reactions which are employed for the preparation of the anhydrides of the monobasic organic acids are those originally discovered by Gerhardt, where either the chloride of an electro-negative radicle is made to act on the corresponding alkaline salt, giving rise to the production of an alkaline chloride and the anhydride; or the same decomposition is indirectly superinduced by allowing the pentachloride or terchloride of phosphorus to act on the alkaline salt.

These methods, therefore, essentially consist rather in an almost synthetical formation of the anhydride by a process of double decomposition, analogous in its nature to those by which the compound and double ethers are produced, than in a direct elimination of the anhydride from the salt, of which the reactions for producing nitric and carbonic anhydrides afford familiar instances.

In addition to the above methods is that described by Gal (*Compt. rend.* lvi., 360), who, by acting on caustic lime and baryta with the chlorides of acetyl and benzoyl, obtained the corresponding anhydrides. As this method obviously necessitates the employment of the chloride of phosphorus, its principle rests mainly on the same decomposition as that discovered by Gerhardt.

It was therefore thought that a reaction by which the anhydrides of the organic acids could be more directly eliminated from salts, in the same manner as some inorganic anhydrides, would possess considerable interest, both in a practical and in a theoretical point of view.

For this purpose, several attempts were made to procure acetic and benzoic anhydrides by the action of boracic acid on the potassium salts of these acids; but this method, as might probably have been foreseen, failed to produce the desired substances.

It then occurred to me to try the effect of bisulphide of carbon. This substance was shown by Frémy, many years ago, to be readily decomposed by heated metallic oxides, into carbonic anhydride and a metallic sulphide, and also when heated with water to a high temperature, to form sulphuretted hydrogen and carbonic anhydride (Schlagdenhauffen, *J. Pharm.* [3], xxix. 491). It was therefore thought probable that, by acting on the dry metallic salts of the organic acids with bisulphide of carbon, the metal would be converted into sulphide, and the anhydride set free. With this view the following experiments were performed:—

Crystallised acetate of lead was dried for several hours, at about 120° C. and reduced to as fine a state of division as possible, and a small quantity was placed in a strong glass tube, which was then one-third filled with dry bisulphide of carbon, sealed, and heated in an oil-bath to about 150° C. After an hour's heating, the contents of the tube had become quite black, and after a few hours' exposure, the tube was removed from the bath, allowed to cool, and then opened, when a violent escape of gas took place, attended with a strong, pungent, acid smell. This gas, on being allowed to pass into baryta-water, was found to be carbonic anhydride. Several strong tubes of hard glass were then charged with 20 grammes each of dry acetate of lead, and as much bisulphide of carbon added as was necessary to make, on agitation with the acetate, a mixture of a creamy consistency. The tubes being then rather more than one third full were sealed and heated in the oil-bath, to a temperature of 165° C. The mixture quickly assumed a black colour, and after some hours' heating, one of the tubes, by exploding with great violence, gave warning that a large amount of gas had been liberated. After this it was found advisable to open the tubes once a day, in order to let the carbonic acid escape; and with this precaution the digestion was continued, till it was found that on opening the tubes, only a slight rush of gas took place. The reaction was then judged to have practically terminated.

The liquid contents of the tubes were then poured off as far as possible, and the remainder adhering to the solid sulphide of lead was separated by distillation at a moderately high temperature, and the whole fluid product thus obtained was submitted to distillation. The first product passing over was the excess of bisulphide used, after which the temperature of the boiling liquid gradually rose, when some acetic acid, with a trace of acetone, made its appearance, till the temperature gradually rose to 137° C., and remained constant till the whole had passed over.

The portions of distillate collected near the latter temperature had a pungent acid odour, attacking the eyes and nostrils; when mixed with water, it sank, and gradually dissolved with rise of temperature. On mixing it with alcohol, the odour of acetic ether was produced. To decide the matter, an analysis was made of the portions which boiled at 137°.

0·3010 grm. burnt with oxide of copper and oxygen, gave 0·5170 of $C\ O_2$, and 0·1636 of water.

		Calculated.	Found.
C_4	48	47·05	46·84
H_6	6	5·88	6·03
O_3	48	17·07	—
	102	100·00	

The liquid was therefore acetic anhydride, and its production can be expressed by the equation—

$$2\left[\begin{matrix} C_2\ H_3\ O \\ Pb'' \\ C_2\ H_3\ O \end{matrix}\begin{matrix} \}\,O \\ \\ \}\,O \end{matrix}\right] + C\ S_2 = 2\ Pb\ S + C\ O_2 + 2\left[\begin{matrix} C_2\ H_3\ O \\ C_2\ H_3\ O \end{matrix}\Big\}\,O\right]$$

Experiments with acetate of silver gave a similar result, with even greater readiness.

The above reaction of bisulphide of carbon, it will be perceived, is susceptible of at least three important applications for the formation of organic bodies, if it prove to be in any respect a general one.

1. The production of anhydrides as above from metallic salts.
2. The formation of compound ethers, by allowing the anhydrides in the nascent state to react on an alcohol.
3. In certain cases, for the isolation of anhydrides of electro-positive radicles, or ethers.

For the second application it was proposed to produce an ether of acetic acid which had not hitherto been successfully prepared, and for this purpose acetate of phenyl was chosen. This substance Scrugham (*Chem. Soc. Qu. J.* vii. 241) attempted to procure by acting on acetate of potash with an alcoholic solution of phosphate of phenyl, but did not succeed in obtaining it pure. Berthelot had found, during his experiments on etherification, that a small per centage of acetic acid entered into combination with phenylic alcohol when heated with the latter in sealed tubes.

In order to procure this ether, acetate of lead was at first sealed up with an equivalent quantity of phenylic alcohol and an excess of bisulphide of carbon; but after some experiments it was found better to operate with only half an equivalent of phenylic alcohol, as the presence of some of the latter in an uncombined state seriously affected the eventual separation of the acetate in a state of purity. The following was therefore the method adopted:—

20 grammes of well dried and finely divided acetate of lead were sealed up in strong tubes, with 3 grammes of phenylic alcohol, and a considerable excess of bisulphide, and heated in an oil-bath to about 170° C. The reaction soon commenced, and proceeded with more regularity than in the preparation of the anhydride, since the lead salt is soluble in the alcohol, so that the bisulphide is enabled to act with greater readiness. It was found necessary to open the tube daily, for it was shown by some explosions that the pressure of the liberated gas was very high. When the action had ceased, the liquid products were separated as above described, and redistilled. After the excess of bisulphide had distilled, acetic acid in considerable quantity passed into the receiver, then a small quantity of acetic anhydride, after which the temperature rose rapidly to 190° C., when a liquid of a pleasant empyreumatic odour made its appearance, and when the temperature had attained 210° C. the whole had passed over.

The portions distilling above 190° were rectified, and by repeated fractioning, the greater part was obtained of a constant boiling point of 200°. This was submitted to analysis as follows, by combustion with oxide of copper and oxygen:—

I. 0·2142 grammes gave ·5554 CO_2 and ·1133 H_2O.
II. 0·1964 grammes gave ·5098 CO_2 and ·1060 H_2O.

		Calculated.	I.	II.
C_8	96	70·59	70·71	70·78
H_8	8	5·88	5·87	5·99
O_2	32	23·53	—	—
	136	100·00		

The vapour-density of the liquid was taken as follows, by Gay Lussac's method, using a bath of spermaceti:—

Weight of liquid employed 0·2299 grm.
Observed volume of vapour 70·28 cc.
Temperature 218° C.
Height of barometer 744·5 mm.
Difference of heights of internal and external mercury 32 mm.
Height of column of spermaceti 230 mm. at 45°.

These data give sp. gr. of vapour 4·72. The calculated density of acetate of phenyl is 4·59.

The liquid, therefore, was acetate of phenyl.

Acetate of phenyl is a colourless liquid, boiling at 200° C., of a peculiar and fragrant odour, which is very persistent; its sp. gr. is 1·074, being somewhat heavier than phenylic alcohol, as acetic ether is heavier than ordinary alcohol. Though quite colourless when freshly distilled, it becomes somewhat yellow by keeping. It is slightly soluble in water, in which it sinks, and to which it imparts its peculiar odour. It is neutral to test-paper, and is not decomposed by boiling water; even when heated with water to 180° it acquires but a very slight acid reaction. Boiling solutions of the fixed alkalis gradually dissolve acetate of phenyl, with formation of an alkaline acetate and phenate. Its index of refraction is the same as that of German fusible glass, on which account tubes of the latter become invisible when immersed in this ether.

It will appear from the above experiments that this reaction of bisulphide of carbon will most probably be found of service in isolating anhydrous acids, in cases where the ordinary methods are not convenient, and will also, it is believed, receive many applications as a general mode of preparing compound ethers, since it has the advantage of being applicable to small quantities. Phenylic alcohol, which has hitherto been found so difficult of etherification, may probably, by the above process, yield its full complement of ethers in the manner of alcohols of other series.

Experiments have been commenced to illustrate the third application of this reaction, namely, that of eliminating phenylic ether from phenate of lead.

Whether the method be applicable as a means of procuring double ethers and anhydrides, further experiment must show.

In conclusion, the following desultory qualitative experiments have been tried:—

Chloride, bromide, iodide, and fluoride of lead are not attacked by bisulphide of carbon.

Nitrate of silver is most readily acted on by bisulphide of carbon, with production, in addition to sulphide of silver, of a green liquid and a white solid substance; but on attempting to open the tubes, they have burst with a most violent explosion.

Sulphate of lead is not affected by sulphide of carbon.

Benzoate, succinate, and ferrocyanide of lead are readily acted on by the bisulphide.

Formate of lead is entirely converted into sulphide by bisulphide of carbon, with much evolution of gas; traces of a strong acid are evolved, together with a sulphur compound of a powerful odour; all attempts to obtain formic anhydride have been unsuccessful, the latter being apparently entirely decomposed into gases.

Oxalate of lead is entirely unaffected by sulphide of carbon at a high temperature.

I take this opportunity of expressing my thanks to Professor Frankland for opportunity and leisure to make the above experiments.

LABORATORY MEMORANDA.

By ROBERT WARINGTON, Jun., Assistant to Professor of Chemistry, R. A. College, Cirencester.

I. *The Action of Ferricyanide of Potassium upon Ferric Salts.*—Most works on chemistry describe this reaction as producing a "dark brown," or "reddish-brown" fluid, and state that no precipitate is formed;* some manuals, however, tell us that a "greenish," or even a "dark-green" liquid is the result.† These statements are all incomplete, and may possibly mislead.

First, as to the colour. The dark-brown liquid is produced only when the ferricyanide of potassium is in *excess* of the ferric salt; the tint in this case is a dark sherry-brown. When the proportions are reversed, and a drop or two only of the ferricyanide mixed with an excess of ferric chloride, a brilliant emerald-green tint of a slightly bluish tinge is the result. If the proportion of ferricyanide of potassium is then gradually increased, the colour is first changed to sap-green, then olive-brown, and at last reaches the dark sherry tint before described. The whole series of colours is well seen if a single drop of ferricyanide of potassium is allowed to run down the side of a test-tube half filled with dilute ferric chloride; a brown ring forms at the surface, where the ferricyanide is in excess, from which streaks of colour slowly descend, their tint changing from brown to bright green, as they fall further towards the bottom.

It appears, then, that the colour produced on mixing an alkaline ferricyanide and a ferric salt is essentially dependent on the proportion of each which may be present.

Lastly, as to the statement that the liquid remains *clear*. This is true only when the solution is sufficiently acid; *basic* ferric salts afford an immediate pale brown precipitate with ferricyanide of potassium.

These results were all obtained with a freshly prepared solution of the ferricyanide.

II. *The Solubility of Magnesia in Alkaline Salts.*—That magnesia dissolves in salts of ammonium, with evolution of free ammonia, is a sufficiently familiar fact. That the presence of ammonium salts hinders or entirely prevents the precipitation of hydrated magnesia by an alkali is equally well known; but it is not, perhaps, so generally understood, that salts of potassium and sodium have an exactly similar effect, though in a far smaller degree. The action of ammonium salts, in preventing the precipitation of magnesia, is usually explained as owing to the formation of double salts of magnesium and ammonium. If this theory be correct, then the presence of *any* soluble base forming double compounds with magnesium, ought to have a similar effect, and, consequently, we should expect that salts of potassium and sodium would in this particular behave like salts of ammonium.

Magnesia dissolves to a small extent in a strong solution of a salt of potassium, and also in salts of sodium, the alkaline salt being in this case evidently decomposed, as the liquid strongly reddens turmeric paper.

The following experiments were made as to the faculty of alkaline salts to prevent the precipitation of hydrated magnesia. Two equal volumes of a solution of chloride of magnesium were taken; in one of these 200 grs. of chloride of potassium were dissolved; both were then treated with equal volumes of a solution of caustic potash, and, after standing some hours in a warm place, filtered, and the magnesium in the filtrate (that, therefore, which the potash had *failed* to precipitate) estimated by phosphate of sodium in the usual way. The experiment with chloride of potassium yielded 1·54 grs. of $Mg_4P_2O_7$, the other only 1·39 grs.; the potassium-salt had clearly, then, to a slight extent prevented the precipitation of magnesia. An experiment with chloride of sodium yielded a similar result. Trial was also made with sulphate of magnesium, the sulphates of potassium and sodium being added. The amounts of magnesium unprecipitated by the potash are shown by the following weights of pyrophosphate obtained:—

With sulphate of magnesium alone		·15 grs.
„ „	and sulphate of potassium	·50 „
„ „	and sulphate of sodium	·56 „

Another experiment, in which caustic soda was the precipitant, gave similar results:—

With sulphate of magnesium alone		·94 grs.
„ „	and sulphate of potassium	1·15 „
„ „	and sulphate of sodium	1·35 „

When these experiments were repeated with an increased quantity of caustic potash or soda, the effect here noted practically disappeared, a trace only of magnesium being found in any filtrate. This, indeed, took place when the amount of potash was increased by one-half, or even less. The excess of potash doubtless decomposed the double salt first formed, in the same way that a large excess of ammonia precipitates hydrated magnesia, even in the presence of sal-ammoniac.

* So Rose, Fresenius, and Gmelin.
† Thus Miller, and Northcote, and Church.

It appears, then, that salts of potassium and sodium do really hinder the precipitation of hydrate of magnesium,* though to not nearly the same extent as salts of ammonium; a result which well accords with theory, as the double compounds of magnesium with the former salts are well known to be far less stable than those with the latter.

Another fact in connection with the solubility of magnesia in alkaline salts, is the decomposition of this solution by water under certain conditions. For instance, if a strong solution of magnesium be mixed with sal-ammoniac and free ammonia, the proportion of the two latter being so adjusted as *just* to prevent precipitation on standing, the equilibrium of the mixture thus formed is destroyed by the addition of water, and magnesia is precipitated. In one experiment a mixed solution of the chlorides of magnesium and ammonium was treated with twice its volume of the strongest ammonia; at the end of twelve hours, the solution was still perfectly clear. An exactly similar mixture was prepared, and diluted with water to three times its bulk; at the end of twelve hours a considerable precipitate of magnesia had fallen. Salts of ammonium appear then to hinder the precipitation of magnesia in proportion to their concentration.

This fact serves to explain a phenomenon sometimes observed when making determinations of phosphoric acid. If the washings of the phosphate of magnesium and ammonium are allowed to mix with the main filtrate, an opaque ring is often formed at the junction of the two liquids, alarming the operator with the idea that his precipitate is washing through; the washings, however, if collected separately, are found to be perfectly clear. The cause of this appearance is probably the precipitation of the excess of magnesia on diffusion into the wash-water.

NOTE ON THE BOILING POINTS OF ISOMERIC ETHERS OF THE FORMULA Cn H2n O_2.

By J. ALFRED WANKLYN.

From Kopp's paper it would seem that those ethers of the fatty acids which are isomeric with one another, should have the same boiling point, or that all the ethers having the formula Cn H2n O_2, in which n has a constant value, have the same boiling point. This proposition and its consequences have found a place in the Handbooks.†

Having had occasion to prepare valerianate of ethyl and acetate of amyl, both of which have the same total formula, viz.,

$$C_7 H_{14} O_2,$$

I have observed that there is a considerable difference in their boiling points. Valerianate of ethyl boils at 133° C.; acetate of amyl at 140° C. The boiling point of acetate of amyl was found by Cahours to be 125° C., but it is probable that there was amylic alcohol present in the specimen examined by that chemist. A mixture of acetate of amyl with a good deal of amylic alcohol and a little moisture, would not be distinguishable from pure acetate of amyl by a combustion.

The acetate of amyl which was employed for the determination just given was prepared so as to be free from amylic alcohol. That it was tolerably pure was ascertained by an alkalimetrical analysis.

The natural conclusion from this and a number of facts of a like kind is that Kopp's laws respecting boiling points are not much to be depended on. From the glycols we have learnt that it is not *universally* true that homologous bodies rise in boiling point as they increase in complexity, and a careful examination of almost every homologous series discloses the fact that "the increment" is not uniform in all parts of the same series.

Thus, for instance, iodide of methyl boils at 43° C., iodide of ethyl at 73°, and iodide of amyl at 146° C.; giving an increment of 30° for the first addition of C H_2, and an increment of $\frac{73}{3}$°, or 24·3° for each C H_2, between ethyl and amyl.

Again, zinc-methyl boils at 46° C., zinc-ethyl at 119° C.: difference 73° for C H_2 equals $\frac{101}{3}$ or 33·7°

There is also the well-known example of methylic alcohol which boils at 65° C., instead of at 59° C. or 60° C., as Kopp's theory would require. Higher up in the alcoholic series we encounter Wurtz's isomeric amylic alcohols, having different boiling points, and then the isomeric hexylic alcohols. Although it will be objected that the hydrate of amelyne and the β-hexylic alcohol are not true homologues of ethylic alcohol, still the unexpected boiling points of these bodies show that mere inspection of the molecular formula of an alcohol is very little guide to the boiling point of that alcohol.

INSTITUTION OF ENGINEERS IN SCOTLAND.

ON A NEW WATER ENGINE.

BY MR. C. H. L. FITZWILLIAMS.

In places where a constant supply of water at a high pressure can be easily obtained, as is the case in most large towns, small water engines, for driving light machinery not constantly in use, can be more advantageously used than small steam engines, to perform the same work; for instance, for driving organ bellows, small turning lathes, hair brushing machines, &c. By the simple turning of a tap the engine is started, and the same tap serves also to regulate the speed and the power at which the engine works.

* According to Longchamp (Ann. Chim. Phys., [3] xii. 255), the precipitation of carbonate of magnesium is less complete in proportion to the amount of alkaline salts present.

† See Kekulé's "Lehrbuch der organischen Chemie," dritte Lieferung, page 601; also Limpricht's book, page 256, *et seq.*

The cylinder engine and the turbine are the only engines at present used for such purposes.

I have the honour to lay before you a drawing of a water engine on a new principle, which I hope you will think worthy of your attention.

In the drawings before you, the water enters the engine from the supply pipe

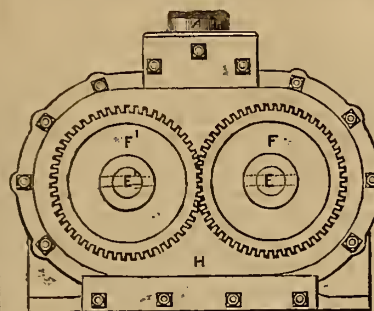


FIG. 1.

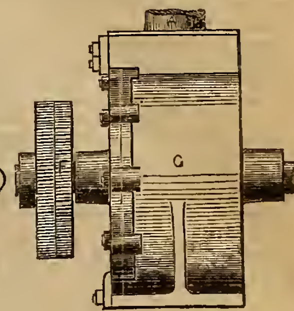


FIG. 3.

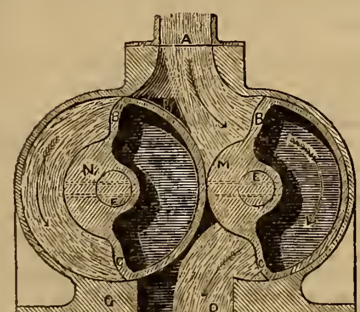


FIG. 2.

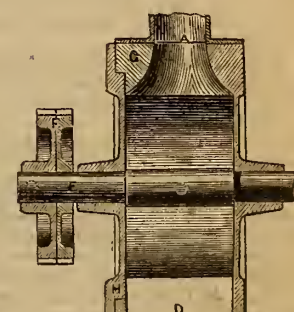


FIG. 4.

at A, presses on the piston at B, driving it round to C, making the drum M take the position of the drum N as shown in drawing; the shafts E and E' being geared together, N takes the position of M as shown in drawing, after the first half revolution; the water then acts on C' as before on B. The driving pressure being during one half of a revolution on the one shaft, and during the other half of the revolution on the other. The water, after it has done its work, is discharged at D. The teeth of the wheels F and F' are stepped, to make the movements of the two shafts more equal. G is the casing; H is the cover.

Three years ago Professor Weber, of Göttingen, in one of his lectures, mentioned that a new sort of air-pump had been invented by a man of the name of Repsold, in Hamburg, and used by him to discover leaks in the system of gas-piping laid down in that town. Weber made a rough sketch of the machine, and explained its theory, showing that the volume of the air passing through the pump during every part of a revolution was constant. Now, it struck me at the time, that this machine would make a good water engine; for if it was worked as an engine it would have no dead points, and also the pressure on the driving piston would be constant at all points of a revolution. When I considered the question more fully, I found that my supposition was quite correct.

In my design of an engine on this plan, which you have now before you, the piston surface is 3·75 square inches; the stroke, or its equivalent in this sort of engine, is 12·56in. Supposing the machine to work at 1,000 revolutions per minute, the piston must travel 1046·66ft. per minute; if the pressure is 40lbs. per square inch, the total work done by the water is

$$\frac{40 \times 3{\cdot}75 \times 1046{\cdot}66}{33{,}000} = 4{\cdot}75 \text{ H.P.}$$

What the co-efficient of efficiency of the engine is, I cannot say; it is not easy to calculate, and has never been determined practically. That of a well constructed turbine, according to Rankine and Delauny, is ·75; though Mr. Schiele says his turbine utilises ·89 of the power expended. Sir W. Armstrong gets by his cylinder engines from ·66 to ·77 per cent. The actual power of the engine would be, I should think, somewhat over 3·5 H.P. If the fall is not more than 30ft., it cannot matter much where the engine is placed with regard to it. It would be just as efficient if it were placed at the top of the fall as it would when placed at the bottom.

The water moves through the engine in one solid stream, during one half of a revolution down one side, and during the other half down the other. A comparatively small surface of the water comes in contact with the sides of the engine, so the friction cannot be great between either the water and the engine itself, or between the different molecules of the water. The drums ought to fit as well as possible, without touching each other or the casing.

If the engine has work to do of an irregular nature, the stored force in the column of water in the supply pipe comes into play, and acts in the same way as that stored in a fly wheel. In the cylinder engine this same latent force is a source of great trouble and waste. Sir W. Armstrong in his hydraulic engine has recourse to relief valves, in the valve casing, allowing water to escape into the exhaust when the pressure, at the turn of the stroke, gets higher than the engine can bear with safety. His engine when this happens is said to "overrun" itself.

A small rotary water-pressure engine on this plan works well as a water-meter, as the same quantity of water must be used for each revolution, so that knowing the number of revolutions made, the quantity of water passed through the machine is also known. I have tried this model as a meter, and found that although the drums do not fit at all well, it allows a very little water to run through it unaccounted for. When running at 2,208 revolutions per minute the slip was 1·21 per cent. The pressure on the water was about 6lbs. or 7lbs. per square inch. I could not try it at any higher speed, as the cock from which I got the water was very small, and could not supply enough to drive the model any quicker. When running at slower speeds, I found the slip to be relatively greater, though the pressure was much less. At first sight one would be led to suppose that the higher the speed, and consequently the pressure, the greater would be the slip; but this is not the case. When running at a very high speed the escape between the drums is much diminished. Directly any water manages to get between them, it is thrown back again, as the surfaces of the drums, between which it tries to pass, are moving quickly in the opposite direction. The engine can be worked as a pump when driven by a pulley off some other engine. A pump made on this plan would possess the advantage over the common centrifugal pump, that it can work at quick or slow speeds with equal efficiency.

This principle might also, I think, be adopted to advantage in the construction of an exhauster in a gas work, to facilitate the transportation of gas from the retorts into the gas-holder, as it can run at a very high speed without fear of its getting out of order and breaking down. I believe a good machine of this sort is very much wanted.

I think I have now stated the principal uses to which engines made on this principle may be applied, and hope that before long I may have the pleasure to see an engine constructed after my design put to some practical use.

Mr. Fitzwilliams, in answer to a question, said that the machine would work with steam; but he did not intend it to be so used, as it could not be worked expansively, and also the leakage between the discs would be considerable. Water was the best motive power to apply to it.

Professor Rankine said this was a very ingenious mode of using water, and it would be well if further experiments were made with it. It seemed to be a very valuable machine, especially where economy of space and great simplicity were required. He admired the manner in which the two discs were made to move in opposite directions, in order to prevent the water slipping, and to resist leakage.

Mr. J. M. Gale thought that if the machine were used in driving anything, the slip would be greatly increased. Whenever it had to meet any resistance there would be a pressure against the projecting parts of the discs, and the water would then have a tendency to leak. There must be a considerable leakage unless the instrument was very accurately made. He believed that as a water meter it would do very well. There was one advantage in it over other meters, that while with a common cylinder meter there was the concussion of the engine every time the valves were charged, and the turbine had to be worked at a maximum velocity to have a maximum effect, this machine could be worked efficiently at any velocity.

Mr. Downie remarked that, as an exhauster, a similar machine had been in use in gas works for about twenty-five years, and worked very well. There would certainly be great difficulty in keeping what they might call the piston tight under high pressure; for if it were made tight at the periphery its power would be absorbed, and if it were made to run freely there would be considerable waste. The opposite action of the discs was a very beautiful arrangement, but he agreed with Mr. Gale that a considerable quantity of water would escape round the periphery if the machine was made to do work.

Mr. J. Elder said it seemed to him that with over 2,000 revolutions per minute they must expect very little slip, with water at 6lbs. pressure. The drums would be travelling nearly at the velocity due to the fall. He thought that if used as a motive power engine the slip would be considerable, and that it would not be an economical engine, travelling slow with a great head of water.

Mr. Fitzwilliams said that as a water meter he thought the machine could be used most advantageously. If there were 100lbs. pressure in the supply pipe, the meter would run at 7,000 to 10,000 revolutions per minute, at which speed there could be little or no slip between the discs.

Mr. Yule remarked that in working the engine under a high pressure, friction would be very great. There was a lateral pressure on the discs creating friction upon the axles equal to the sectional area of the discs, and, as the friction increased in proportion to the pressure, he was of opinion that the efficiency would be very low when working at a high speed, under great pressure, and that the friction would soon destroy the bearings.

Dr. Joule, in answer to a question by Professor Rankine, said that he had constructed an air pump on the principle mentioned by Dr. Rankine, the pistons of which were 10in. in length and 2in. in diameter, and which were lubricated by oil. They fitted quite loosely in the cylinders. He could, when working at a low velocity, obtain a pressure of 15 atmospheres; and therefore he was of opinion that, considering the space through which the water would have to go, there might be comparatively little leakage.

Professor Rankine stated that the result of Dr. Joule's experiments led him to believe that the leakage around the outside of the revolving discs would not be very great.

Mr. Day said that some years ago he had made experiments with reference to the leakage of water or gas where pistons did not fit tightly, and found that a piston 2in. long, barely $\frac{5}{8}$in. in diameter, with nearly $\frac{1}{64}$in. clearance between it and the cylinder, moving at a velocity of, he thought, 2ft. in $1\frac{1}{2}$ seconds, lubricated with oil, there was no appreciable leakage at all. He tried with a piston $\frac{1}{2}$in. in diameter, fitting pretty close to a gun-metal ring, and he found that as much air was compressed with the piston working in oil and fitting loosely, as in the one which fitted tightly.

INSTITUTION OF CIVIL ENGINEERS.

ON THE METROPOLITAN SYSTEM OF DRAINAGE AND THE INTERCEPTION OF THE SEWAGE FROM THE RIVER THAMES.

By Mr. J. W. Bazalgette, M. Inst. C.E.

Before proceeding to describe the modern works for the drainage of London, which, even prior to the introduction of the improved system, was probably the best drained city of the present age, the author glanced at the early history of its sewerage. The minutes of the ancient Westminster Commissions of Sewers contained records of peculiar interest—showing, amongst other things, that improvements for drainage were effected under the advice and instructions of Sir Christopher Wren, nearly two hundred years ago, and that the Commissioners of Sewers, in the reign of Charles II., and subsequently, interfered to regulate the proceedings for the drainage of the Royal Palace in St. James's Park. Sketches attached to the paper represented the condition and appearance of some of the main valley lines—as the Fleet Sewer, the Tye Bourne, and the Bayswater Brook (now called the Ranelagh Sewer), and the King's Scholar's Pond Sewer—taken from actual surveys in 1809. Up to about the year 1815, it was penal to discharge sewage or other offensive matters into the sewers; cesspools were regarded as the proper receptacles for house drainage, and sewers as the legitimate channels for carrying off the surface waters only. As the population of London increased, its subsoil became thickly studded with cesspools, improved household appliances were introduced, and, it having become permissive, overflow drains from the cesspools to the sewers were constructed; thus the sewers became polluted, and covered brick channels were necessarily substituted for existing open streams. These works, prior to the year 1847, when the first Act was obtained, making it compulsory to drain houses into sewers, being under the direction of eight distinct Commissions, each appointing its own officers, were not constructed upon a uniform system; and the sizes, shapes, and levels of the sewers at the boundaries of the different districts were often very variable. Larger sewers were made to discharge into smaller ones, sewers with upright sides and circular crowns and inverts were connected with egg-shaped sewers, or the latter with the narrow part uppermost were connected with similar sewers having the smaller part downwards. In the year 1847, these eight commissions were superseded by "The Metropolitan Commission of Sewers," whose members were nominated by the Government. That Commission directed its energies mainly to the introduction of pipe sewers of small dimensions in lieu of the large brick sewers previously in vogue, to the abolition of cesspools, and to the diversion of all house drainage, by direct communications into the sewers, making the adoption of the new system of drainage compulsory; so that, within a period of about six years, thirty thousand cesspools were abolished, and all house and street refuse was turned into the river. Similar systems were, about the same period, to a large extent adopted in the provincial towns, by which means their drainage had been much improved, but the rivers and streams of this country had been seriously polluted. Within nine years, "The Metropolitan Commission of Sewers" was followed by six new and differently constituted Commissions, whose labours were duly recorded; but they were unable, during the limited period of their existence, to mature and carry out works of any magnitude. However, the subject of the purification of the Thames, then becoming full of sewage, received much consideration; and the late Mr. R. Stephenson, Mr. Rendel, and Sir W. Cubitt, who were members of the third Commission, reported upon one hundred and sixteen competing plans, having that object in view, arriving at the conclusion, that none were such as could be recommended for execution. In 1850, the late Mr. Frank Forster was appointed Chief Engineer of the Commission, and, under his direction, Messrs. Grant and Cresy commenced the preparation of a plan for the interception of the sewage of the area south of the river, and Mr. Haywood, Engineer to the City Commissioners of Sewers, assisted Mr. Forster in making a similar plan for the districts on the north side. In 1852, the fifth Commission was issued, and the author became the Chief Engineer on the death of Mr. Forster. Two years later, the author was directed to prepare a scheme of intercepting sewers, intended to effect the improved Main Drainage of London, and Mr. Haywood was associated with him for the northern portion. The plan so prepared subsequently received the approval of the late Mr. R. Stephenson and Sir W. Cubitt, and was recommended for adoption.

In the year 1856, the present Metropolitan Board of Works was formed—being the first application, in the metropolis, of the system of local self-government. The author, having been appointed engineer to the Board, was instructed to prepare a plan for the main drainage, in which it was essential that ample means should be provided for the discharge of the large and increasing water supply consequent on the universal adoption of closets, and of the ordinary rainfall and surface drainage at all times, except during extraordinary floods; and that it should afford to the low-lying districts a sufficiently deep outfall to allow of every house being effectually relieved of its fluid refuse. The objects sought to be attained by these works, now practically complete and in operation, were the interception, as far as practicable by gravitation, of the sewage, together with so much of the rainfall mixed with it as could be reasonably dealt with, so as to divert it from the river near London; the substitution of a constant instead of an intermittent flow in the sewers; the abolition of stagnant and tide-locked sewers with their consequent accumulations of deposit; and the provision of deep and improved outfalls, for the extension of sewerage into districts previously, for want of such outfalls, imperfectly drained. Prior to these works being undertaken, the London main sewers fell into the valley of the Thames, and the sewage was discharged into the river at the time of low water. In the system now adopted, it had been sought to remove the evils thus created, by the construction of new lines of sewers, at right angles to the existing sewers, and a little below their levels, so as to intercept their contents and convey them to an outfall 14 miles below London Bridge. As large a proportion of the sewage as practicable was thus carried away by gravitation, and for the remainder a constant discharge was effected by pumping. At the outlets the sewage was delivered into reservoirs on the banks of the Thames, placed at such a level as would enable them to discharge into the river at or about the time of high water. By this arrangement, the sewage was not only at once diluted by the large volume of water at high tide, but it was also carried by the ebb to a point of 26 miles below London Bridge, and its return by the following flood tide within the metropolitan area was effectually prevented.

The points which required solution at the threshold of the inquiry, then successively noticed, were :—

1st. At what state of the tide could the sewage be discharged into the river so as not to return within the more densely inhabited portions of the metropolis.

2nd. What was the minimum fall which should be given to the intercepting sewers.

3rd. What was the quantity of sewage to be intercepted, and did it pass off in a uniform flow at all hours of the day and night, or in what manner.

4th. Was the rainfall to be mixed with the sewage, in what manner and quantities did it flow into the sewers, and was it also to be carried off in the intercepting sewers, or how was it to be provided for.

5th. Having regard to all these points, how were the sizes of the intercepting and main drainage sewers to be determined.

6th. What description of pumping engines and pumps was best suited for lifting the sewage of London at the pumping stations.

As regarded the position of the outfalls and the time of discharge, an extract was given from the report of the late Mr. Robert Stephenson and Sir William Cubitt, dated the 11th of December, 1854, referring to a series of experiments made with a float, by the late Mr. Frank Forster, and subsequently repeated by Captain Burstal, R.N., and the author, which proved that it was essential to go as far as Barking Creek, and that the discharge should take place at or near to high water. These experiments also demonstrated that "the delivery of the sewage at high water into the river at any point is equivalent to its discharge at low water at a point 12 miles lower down the river; therefore the construction of 12 miles of sewer is saved by discharging the sewage at high instead of at low water."

With respect to the velocity of flow and the minimum fall, it was difficult to lay down any general rule, because the condition of sewers, as to the quantity of deposit and the volume of sewage, varied considerably; but the results arrived at by Mr. Wicksteed, Mr. Beardmore, Mr. John Phillips, and Professor Robison were quoted, in confirmation of the author's own observations and experience, which led him to regard a mean velocity of $1\frac{1}{2}$ mile per hour, in a properly protected main sewer, when running half-full, as sufficient, especially when the contents had previously passed through a pumping station. Having thus determined the minimum velocity, it became necessary to ascertain the quantity of sewage to be carried off, before the fall requisite to produce that velocity could be estimated. That quantity varied but little from the water supply; and as it was contemplated that $31\frac{1}{4}$ gallons per head per diem might be supplied to a district, of average density of population, containing 30,000 people to the square mile, except in outlying districts, where the number of inhabitants was reckoned at 20,000 per square mile; and as actual measurements showed that provision for one-half of the sewage to flow off within six hours of the day would be ample, the maximum quantity of sewage likely hereafter to enter the sewers at various parts of the metropolis had been arrived at.

It had been advocated, by theorists, that the rainfall should not be allowed to flow off with the sewage, but be dealt with by a separate system of sewers. This would have involved a double set of drains to every house, and the construction and maintenance of a second series of sewers in every street, at an expenditure of from ten to twelve millions sterling, at the least, besides the inconvenience. Observations of the quantity of rain falling on the metropolis within short periods showed that, on an average of several years, while there were about one hundred and fifty-five days per annum on which rain fell, there were only about twenty-five days upon which the quantity amounted to $\frac{1}{4}$in. in depth in twenty-four hours, or the 1-100th part of an inch per hour if spread over an entire day. Of such rainfalls a large proportion was evaporated or absorbed, and either did not pass through the sewers, or did not reach them until long after the rain had ceased; for it was shown, in the report of Mr. Bidder, Mr. Hawksley, and the author, in 1858, that although the variations of atmospheric phenomena were too great to allow any philosophical proportions to be established between the rainfall and the sewer flow, yet, as a rule of averages, $\frac{1}{4}$in. of rainfall would not contribute more than $\frac{1}{8}$thin. to the sewers, nor a fall of $\frac{4}{10}$in. more than $\frac{1}{4}$in. There were, however, in almost every year, exceptional cases of heavy and violent rain-storms, which had measured 1in., and sometimes even 2in. in an hour. But it had been considered probable that if the sewers were made capable of carrying off, during the six hours of the maximum flow of the sewage, a rainfall not exceeding $\frac{1}{4}$in. in twenty-four hours on more than twenty-five days in a year, there would not be more than twelve days in a year on which the sewers would be overcharged, and then only for short periods during such days. The rare and excessive thunderstorms had been provided for, by the construction of overflow weirs at the junctions of the intercepting sewers with the main valley lines, which would act as safety valves in times of storm, when the surplus waters would be largely diluted, and, after the intercepting sewers were filled, would flow over the weirs, and by their original channels into the Thames.

Having thus ascertained the quantities of sewage and of rainfall to be carried off, and the rate of declivity of the sewer as limited only by considerations of the necessary velocity of flow, the sizes of the intercepting sewers were readily determined by the formulæ of Prony, Eytelwein, and Du Buat, and the drainage sewers by the useful formula of Mr. Hawksley, which it was said, in the report of the late Mr. R. Stephenson and Sir W. Cubitt, already referred to, were "applicable to almost every variety of condition which the complete drainage of large towns involves."

In regard to the sixth and last head of the inquiry, in 1859, numerous competing designs, involving the comparative advantages of Cornish or rotative engines, and the respective merits of centrifugal and screw pumps, chain pumps, lifting bucket wheels, flash wheels, and every variety of suction or plunger pump, and pump valve for raising the metropolitan sewage, were reported upon by Messrs. Stephenson, Field, Penn, Hawksley, Bidder, and the author. Based upon the recommendations contained in that report, condensing double-acting rotative beam engines, and plunger or ram pumps, had been adopted; the sewage being discharged from the pumps through a series of hanging valves. The contractors for the engines at Crossness and at Abbey Mills, had guaranteed that they should, when working, raise 80,000,000 lbs. one foot high, with 1 cwt. of Welsh coal.

It had already been stated, that a primary object sought to be attained by these works, was the removal of as much of the sewage as possible by gravitation, so as to reduce the amount of pumping to a minimum. To effect this, three lines of sewers had been constructed on each side of the river, termed respectively the High Level, the Middle Level, and the Low Level. The High and the Middle Level Sewers on both sides discharged by gravitation, but for the two Low Level Sewers the aid of pumping was necessary. The three lines of sewers north of the Thames converged to, and were united at, Abbey Mills, east of London, where the contents of the Low Level Sewer would be pumped into the Upper Level Sewer; the aggregate stream would thence flow through the Northern Outfall Sewer, which was carried in a concrete embankment across the marshes to Barking Creek, where the sewage was discharged into the river by gravitation. On the south side, the three intercepting lines united at Deptford Creek, and the contents of the Low Level Sewer were there pumped to the Upper Level, whence the three streams would flow in one channel through Woolwich to Crossness Point in Erith Marshes. Here the whole mass of the sewage could flow into the Thames at low water, but would ordinarily be raised by pumping into the reservoir.

As the intercepting sewers carried off only 1-100th part of an inch of rain in an hour, and the volume of sewage passing through them was at all times considerable, the flow through these sewers was more uniform than in drainage sewers constructed to carry off heavy rain storms. The form, therefore, generally adopted for the intercepting sewers was circular, as combining the greatest strength and capacity with the smallest amount of brickwork and the least cost. In the minor branches, for district drainage, the egg-shaped sewer, with the narrow part downwards, was preferable; because the dry weather flow of the sewage being very small, the greatest hydraulic mean depth, consequently the greatest velocity of flow and scouring power, was obtained by that section in the bottom of the sewer, at the period when it was most required; and the broader section at the upper part allowed room for the passage of the storm waters, as also of the workmen engaged in repairing and cleansing these smaller sewers.

A more detailed description was then given of the several works, and of some of the peculiarities or difficulties met with during their construction.

On the north side of the Thames, the High Level Sewer varied in size from 4ft. in diameter to 9ft. 6in. by 12ft. Its fall was rapid, ranging at the upper end from 1 in 71 to 1 in 376, and at the lower end from 4ft. to 5ft. per mile. In its construction, much house property was successfully tunnelled under at Hackney. Adjoining the railway station, a house was underpinned and placed upon iron girders, and the sewer, being there 9ft. 3in. in diameter, was carried through the cellar. This sewer also passed close under Sir George Duckett's canal; the distance between the soffit of the arch of the sewer and the water in the canal being only 24in. The bottom of the canal and the top of the sewer were here formed of iron girders and plates with a thin coating of puddle, and no leakage had taken place. The Penstock and Weir Chamber, at the junction of the High and Middle Level Sewers at Old Ford, Bow, placed three-fourths of the northern sewage completely under command. It was built in brickwork, was 150ft. in length by 40ft. in breadth, and was, in places, 30ft. in height. The principal difficulties in the prosecution of these works arose from combinations and strikes amongst the workmen, and from a long-continued wet season, preventing the manufacture of bricks, as well as from the great increase in the prices of building materials and of labour.

The Middle Level Sewer was carried as near to the Thames as the contour of the ground would permit, so as to limit the low level area, which was dependent upon pumping, to a minimum. The district intercepted by this sewer was 17½ square miles in extent, and was densely inhabited. The length of the main line was about 9½ miles, and of the Piccadilly branch 2 miles. The fall of the main line varied from 17½ft. per mile at the upper end to 2ft. per mile at the lower end. The sizes of this sewer ranged from 4ft. 6in. by 3ft., to 10ft. 6in. in diameter, and lastly to 9ft. 6in. by 12ft. at the outlet. About 4 miles of the main line and the whole of the Piccadilly branch were constructed by tunnelling under the streets, at depths varying from 20ft. to 60ft. This sewer was formed mostly in the London clay, but to the east of Shoreditch the ground was gravel. During the execution of the works under the Regent's Canal the water burst in; but by enclosing one-half of the width of the tunnel at a time within a coffer-dam, and then by open cutting, the sewer was subsequently completed. The Middle Level Sewer was carried over the Metropolitan Railway, by a wrought iron aqueduct 150ft. span, weighing 240 tons. The depth between the under side of the aqueduct and the inverts of the double line of sewers was only 2½in.; and as the traffic of the railway could not be stopped during the construction of the aqueduct, which was designed to be only a few inches above the engine chimneys, the structure was built upon a stage at a height of 5ft. above its intended level, and was afterwards lowered into its place by hydraulic rams. The sewers were here formed of wrought iron plates riveted together. The Middle Level Sewer was provided with weirs, or storm overflows, at its various junctions with all the main valley lines.

The length of the main line of the Low Level Sewer was 8¼ miles, and its branches were about 4 miles in length. Its size varied from 6ft. 9in. to 10ft. 3in. in diameter, and its inclination ranged from 2ft. to 3ft. per mile: it was provided with storm overflows into the river. As well as being the intercepting sewer for the low level area, which contained 11 square miles, it was the main outlet for the drainage of the western suburb of London, a district of about 14½ square miles, which was so low that its sewage had to be lifted at Chelsea a height of 17½ft., into the upper end of the Low Level Sewer. It was originally intended to deodorise or utilise the sewage of the western division in its own neighbourhood, rather than to incur the heavy cost of conveying it to Barking, and lifting it twice on its route to that place. But strong objections having been raised to this, the latter and more costly plan had been adopted. The works of this division were executed mainly through gravel, charged with such large volumes of water, that it was necessary to lay stoneware pipes under the inverts of the sewers, to lower the water in the ground, and to convey it to numerous steam pumps before the sewers could be built.

The Northern Outfall Sewer was a work of peculiar construction; for, unlike ordinary sewers, it was raised above the level of the surrounding neighbourhood in an embankment, which was of sufficient strength to carry a roadway, or a railway, on the top, should it ever be required to do so, as was not improbable. Rivers, railways, streets, and roads, on the line of this sewer, were crossed by aqueducts. The North Woolwich and the Barking Railways were lowered to enable the sewer to pass over them; for the sewer, being reduced to a minimum uniform fall of 2ft. per mile, could not be raised or depressed like a railway, to accommodate its levels to those of previously existing works. This constituted one of the chief difficulties in laying out the Outfall Sewer, for the district was already closely intersected by public works.

The Barking Reservoir had an average depth of 16⅔ft., and was divided by partition walls into four compartments, covering together an effective area of about 9½ acres. The ground over which it was built, being unfit to sustain the structure, the foundations of the piers and walls were carried down in concrete to a depth of nearly 20ft. The external and partition walls were of brickwork, and the entire area was covered by brick arches supported upon brick piers, the floor being paved throughout with York stone.

The Abbey Mills Pumping Station—the largest of the kind on the Main Drainage Works—was furnished with engines of 1,140 collective horse-power, for the purpose of lifting a maximum quantity of sewage and rainfall of 15,000 cubic feet per minute a height of 36ft. This station alone would consume about 9,700 tons of coal per annum; but the cost of pumping was not entirely in excess of former expenditure upon the drainage; for the removal of the deposit from the tide-locked and stagnant sewers in London previously led to an annual outlay of about £30,000. The substitution of a constant flow through the sewers, now rendered possible, must necessarily largely reduce the deposit, and consequently the expense of cleansing.

On the south side of the Thames, the High Level Sewer and its southern branch, corresponding with the High and Middle Level Sewers on the north side of the river, together drained an area of about 20 square miles. Both lines were of sufficient capacity to carry off the flood waters, so that they might be entirely intercepted from the low and thickly-inhabited district, which was tide-locked and subject to floods. The Main Line varied in size from 4ft. 6in. by 3ft. at the upper end, to a form 10ft. 6in. by 10ft. 6in. at the lower end, the latter having a circular crown and segmental sides and invert; its fall ranged from 53, 26, and 9ft. per mile to the Effra, and thence to the outlet it was 2⅓ft. per mile. The Branch Line was 4½ miles in length; its size varied from 7ft. in diameter to 10ft. 6in. by 10ft. 6in., of the same form as the Main Line, by the side of which it was constructed. It had a fall of 30ft. per mile at the upper end, and of 2⅓ft. per mile at the lower end.

The Low Level Sewer drained a district of 20 square miles. The surface of this area was mostly below the level of high water, and was, in many places, 5ft. or 6ft. below it, having at one time been completely covered by the Thames. The sewers throughout the district had but little fall, and, excepting at the period of low water, were tide-locked and stagnant; consequently, after long-continued rain, they became overcharged, and were unable to empty themselves during the short period of low water. The want of flow also caused large accumulations of deposit in the sewers, the removal of which was difficult and costly. These defects, added to the malaria arising from the stagnant sewage, contributed to render the district unhealthy; and it was with reference to its condition, that the late Mr. R. Stephenson and Sir W. Cubitt so forcibly described the effect of artificial drainage by pumping, as equivalent to raising the surface a height of 20ft. The Low Level Sewer had rendered this district as dry and as healthy as any portion of the metropolis. Its length was about 10 miles, and its size varied from a single sewer 4ft. in diameter at the upper end, to two culverts each 7ft. by 7ft. at the lower end, their fall ranging from 4ft. to 2ft. per mile. The lift at the outlet of the sewer was 18ft. Much difficulty was experienced in executing a portion of this work, close to and below the foundations of the arches of the Greenwich Railway and under Deptford Creek, owing to the immense volume of water there met with. This was, however, at last surmounted, by sinking two iron cylinders, each 10ft. in diameter, through the sand to a depth of about 45ft., the water being kept down by pumping at the rate of from 5,000 to 7,000 gallons per minute. The sewer was carried under Deptford Creek, and the navigation was kept open, by constructing a coffer-dam in the middle of the creek, and executing one-half of the work at a time.

The Deptford Pumping Station, where the sewage was lifted from the Low Level Sewer into the Outfall Sewer, was provided with four condensing, rotative beam engines, each of 125 horse-power, and capable together of raising 10,000 cubic feet of sewage per minute a height of 18ft.

The Southern Outfall Sewer conveyed the sewage which flowed into it from the High Level Sewer by gravitation, through four iron culverts laid under Deptford Creek, and that which was pumped into it from the Low Level Sewer, from Deptford through Greenwich and Woolwich to Crossness Point in the Erith Marshes. It was entirely underground for its whole length, 7¾ miles, was 11ft. 6in. in diameter, and had a fall of 2ft. per mile.

The Crossness Reservoir, which was 6½ acres in extent, was covered by brick arches supported on brick piers, and was furnished with overflow weirs and with a flushing culvert. Its height, level, and general construction were similar to that at Barking Creek. The ground upon which these works were constructed consisted of peat and sand, or soft silty clay, and afforded no sufficient foundation within 25ft. of the surface. The outlet of the Southern Outfall Sewer was ordinarily closed by a penstock, and its contents were raised by pumping into the reservoir which stored the sewage, except for the two hours of discharge after high water. The sewage was thus diverted from its direct course to the river into a side channel leading to the pump well, which formed part of the foundation for the engine-house. From this well it was lifted hy four high-pressure condensing rotative heam engines, each of 125 horse-power, actuating, direct from the beam, two compound pumps, each having four plnngers.

The tunnelling, and the formation of the sewers through quicksands charged with large volumes of water, under various portions of the metropolis, more particularly in the low-lying districts on the south side of the Thames, were rendered practicable and safe hy a mode of pumping the water out of the ground, without withdrawing the sand, which was adopted and perfected during the progress of the works. The method was to sink, in some convenient position near to the intended works, a hrick well to a depth of 5ft. or 6ft. below the lowest part of the excavation. In some cases, where the depth was great, an iron cylinder was sunk below the brickwork, and the bottom and sides of the well were lined with shingle, which filtered the water passing into it, and exposed a large surface of this filtering medium. Earthenware pipes were carried from this well and laid below the invert of the intended sewer, small pits heing formed at the mouths of these pipes, to protect them from the deposit. By these means, the water had been successfully withdrawn from the worst quicksands, and they had been rendered firm and dry for huilding on. The effectual backing of the invert and haunches with concrete formed (in such treacherous ground), it was asserted, the cheapest and the best foundation. Numerous instances were mentioned of tunnels completed during the progress of the Main Drainage works, in peat and sandy soils charged with water, in the manner which had heen described.

The bricks used in the works had been mostly picked stocks, frequently faced with gault clay hricks, and the inverts were occasionally faced with Staffordshire blue bricks. The brickwork was as a rule laid in hlue lias lime mortar, mixed in the proportions of two of sand to one of lime for two-thirds of the upper circumference of the sewers, and the lower third had heen laid in Portland cement, mixed with an equal proportion of sand. A considerable length of sewer had heen laid entirely in cement. A double test of the quality of the cement had heen employed, which had tended greatly to improve the manufacture of that material. The specifications provided that "the whole of the cement shall be Portland cement of the very best quality, ground extremely fine, weighing not less than 110lbs. to the bushel, and capable of maintaining a hreaking weight of 500lbs. on $1\frac{1}{2}$ square inch, seven days after heing made in an iron mould, of the form and dimensions shown on a drawing, and immersed in water during the interval of seven days."

There were about 1,300 miles of sewers in London, and 82 miles of Main Intercepting Sewers. The total pumping power employed was 2,380 nominal horse-power, with an average estimated consumption of 20,000 tons of coal per annum. The sewage on the north side of the Thames at present amounted to 10 million cubic feet per day, and on the south side to 4 million cubic feet per day; but provision was made for an anticipated increase up to $11\frac{1}{2}$ and $5\frac{3}{4}$ million cubic feet per day respectively, in addition to a rainfall of $28\frac{1}{2}$ and $17\frac{1}{4}$ million cuhic feet per day respectively, or a total of 63 million cubic feet per day.

The total cost of the Main Drainage works would he ahont £4,100,000. The works had been executed under the immediate superintendence of the Assistant Engineers, Messrs. Lovick, Grant, and Cooper. The principal contractors had been Messrs. Brassey, Ogilvie, and Harrison, Mr. Webster, Mr. Furness, Messrs. Aird and Sons, Mr. Moxon, Messrs. James Watt and Co., Messrs. Slaughter, and Messrs. Rothwell and Co. The works were now completed, with the exception of the Low Level Sewer on the north side of the river, which was being formed in connection with the Thames Embankment and the new street to the Mansion Honse, and would therefore, prohably, not come into operation for a couple of years. The proportion of the area drained by that sewer was one-seventh of the whole. Some sections of the works had been in operation for from two to four years, and the largest portion for more than one year; so that the principles upon which they were based had already been fairly tested.

The communication was accompanied by numerous appendices, and was illustrated by a map of London, and by models and enlarged diagrams of some of the principal works. The author presented to the Institution, a complete set of the specifications and of the contract drawings relative to the works.

AN ACCOUNT OF THE DRAINAGE OF PARIS.

By Mr. H. B. Hederstedt, Assoc. Inst. C.E.

Before describing the modern system, allusion was made to the manner in which the drainage of the city was effected up to the year 1808, when the subject first received thorough investigation, and after which numerous works were undertaken, so that by the commencement of 1832, there was a total length of drains of different kinds of 40,302 metres. The year 1832 marked an important epoch; for then the dreadful ravages of the cholera showed the absolute necessity for cleansing and draining the streets upon a better system than had previously prevailed. An accurate survey of the city, both above and below ground, having been made, levels were taken, and the principal features of each existing drain, or series, were recorded in a tabular form.

As Paris was situated wholly in the valley of the Seine, it was assumed that the drains should empty themselves into that river as far as possible, following the undulations of the streets in a more or less direct course. On the left, or southern, bank, where the city occupied an even and almost unbroken slope, the drains discharged directly into the river, independent of each other, and without consideration of their ultimate connection, by a tranverse sewer parallel with the river, as in, the system now in use. The islands of St. Louis and Notre Dame dipped on each side of a longitudinal ridge coinciding with the centre line of the river, and their surface water at once entered the river, by drains on each slope. On the right, or northern, bank, there was one slope bordering on the river, down which the drainage passed into the Seine, and beyond this there was a dip in a northerly direction, towards the hrook of Menilmontant, or the track of the "great drain," as it was called, which received the drainage of all the streets on this northern slope, and which finally fell into the river at Chaillot, some distance off on the west. The ridge of this slope was within the present fortifications, and from it descended another slope in a southern direction now lying beyond the fortifications, but the drainage of which could, if deemed desirable, be placed in connection with the river on the north of and beyond Paris. There were thus five principal divisions—the left bank, the Isles of St. Louis and Notre Dame, the right bank southernmost slope, the right hank northern slope, and the extramural slope.

The Seine was subject to heavy floods, hut these were fortunately rare, as during the past two hundred and sixteen years there were only nine on record. In 1658, the surface of the river rose $28\frac{1}{2}$ft. above its ordinary level. In 1802, when the last flood occurred, the river only rose $6\frac{1}{2}$ft. above the level of the discharging mouth of the modern drain at Asnières. These floods were all more or less disastrous, sometimes lasting fourteen days, and submerging large areas of the city. To check their recurrence, the low portions of the streets along the banks of the river were raised and walled in, to a point above the influence of floods so severe as that of 1658. There were, however, some parts of the city still exposed to floods, hut their effects would be less disastrous, from the efficiency of the new drains, which carried off flood water almost as soon as the river level itself could suhside, instead of leaving it to he absorbed or evaporated.

The progress of the drainage works might be gathered from this, that from the year 1832 to January, 1837, the length of drains was increased from 40,302 to 76,565 metres, while the new works in preparation and projected amounted to an additional 20,000 metres.

The position, cost, and object of the several drains, with the difficulties encountered in their construction, were then noticed. During 1833, thirty-three works were completed, of a total length of 15,008 metres, at a cost of abont £5 13*s.* per metre. These included the first drain executed by tunnelling, the side walls of which were built in masonry and the arch in hrickwork, at a cost of £8 per metre. In 1834, there were twenty-eight works, having a length of 6,810 metres, and costing £3 17*s.* 6*d.* per metre. In 1835, twenty-two works were completed, being of the length of 8,713 metres, at a cost of £3 13*s.* 9*d.* per metre. In 1836, new drains were huilt in several places, and a sewer was constructed in a quicksand, the rate of progress of which was eight metres per day.

With regard to the sections of the drains, those of the old and of the new systems differed in two respects, the area of the latter was much larger though not more effective, and footpaths and rails for carrying waggons were provided. In the former it was arranged that, as far as possible, all the drains should have a clear height of 6ft., in order to insure their being properly cleansed. When this height could not be given, shafts were frequently added, to allow the workmen occasionally to stand upright. The minimum incliuation of the drains was 1 in 1,000; some were much steeper, and in these steps had been introduced in the inverts, principally at the points of junction with other drains. Up to the end of 1863 there were in operation 217 miles of drains, or more than four times the length in use in 1837.

As to the cleansing of the drains, hefore the introduction of the mechanical contrivances now in use, it was found necessary to employ hand labour, assisted by flushing, in many of the drains having an inclination of 1 in 1,000, as that slope was found to be insufficient to carry off in suspension the solid materials of the drainage. In the smaller drains, rakes or scrapers of wood, cut to the contour of the invert, were worked backwards and forwards, until the mud was drawn to a shaft, through which it was lifted. In the larger ones the brush and rake were still made use of, aided hy flushing. From both banks, and from the central islands, all the outlets poured direct into the river, and at the end of 1837 there were probably forty important outlets. Now, with three exceptions, all the discharging mouths had been abandoned, and longitudinal drains, parallel with the river, had been substituted. These finally discharged into the Seine at two places, one within, and the other beyond, the limits of the city.

A description was then given, showing the manner in which both the household and the rain-water was disposed of. Night soil, it was remarked, had no connection whatever with the drains, except in one case. Most of the houses in Paris were built in blocks, with a central court-yard common to all, in which there was usually a cesspool for receiving the soil, whence it was removed at intervals. A new plan was now under trial in a few places, chiefly at barracks. This consisted in leading the night soil into cylinders perforated with fine holes, which allowed the liquid portion to rise in an outer cylinder, while retaining the solid matter within. The liquid portion was drawn off daily, and the internal cylinder was emptied as required. In all cases the night soil was carted away from the city, and was deposited in appointed places. A large quantity was converted into manure, at deodorising works, but only what found a ready sale was thus operated upon, so that much still went to waste.

The method of cleansing and the appliances to effect it were next noticed.

Several of the main drains were composed of two principal parts, of which the lower, or water-way proper, formed but a small proportion of the entire sectional area. Those drains which had no separate water-way were cleansed by hand. The water-way, when forming a distinct part of the work, was of three standard sizes, all cleansed on one principle, but by appliances differing in detail. One was by a cleansing boat furnished with a scraper at the bow, which nearly filled the section, and was capable of motion in a vertical arc. This scraper formed a dam, and the water rising behind it afforded a motive power, which pushed the boat forward, carrying the mud with it. This scraper of course required constant adjustment; and instead of being a solid disc, it was provided with three openings, the central one of which was always open, while the others were fitted with sliding shutters. A simple arrangement at the stern of the boat kept it true to the axis of the channel. Under the most favourable circumstances it seldom happened that a length of more than 800 metres could be thoroughly cleansed in one day, owing to the necessity for going over some places several times. Some of the drains were cleansed by means of a small truck, used with apparatus like that of the boats.

In order to provide for the safety of the workmen, in the event of their being overtaken by a sudden rise of water above its normal level, safety chambers had been built in the roofs, which were reached by openings in the side walls of the drains. In June, 1855, the water rose in the outfall drain on the right bank of the Seine to a height of 4ft. 11in. above the level of the side footpaths, and in that on the left bank the water rose to 7ft. above the same level. Since then, many overflow weirs had been built along these main outfall drains, so as to carry off the surplus water after it had risen above the footpaths.

One leading feature of these works was the absence of small pipes, so constantly used in England; the smallest section ever built, under either the old or the modern system, being 5ft. 6in. in height. by 2ft. 3in. in width at the springing of the roof. As only a small portion of the total area was occupied by the water-way proper, the modern plan appeared to be very extravagant. In one case, the large space sacrificed for two water mains was instanced. Another source of heavy outlay arose from this circumstance: it might have been supposed that one drain of the prevailing large sizes would fully satisfy the requirements of one street. This, however, was not so. A recent Act compelled all householders to build, at their own cost, private branches in communication with the street drains; and, apparently with a view of reducing the pressure of this Act, it had been established that in all new streets having a width of 72ft., the City Commissioners should build a drain on each side of the street, so as to shorten the length of transverse drainage. These drains would be under the pavements, and the effect of this Act upon the householders would then be scarcely felt. During the early part of 1864, when the author was in Paris, he noticed the rapid progress of new works in several parts of the city; but in these no provision appeared to be made for the branch drains, which it might naturally be supposed would be proceeded with simultaneously with the main drains, to avoid the expense and inconvenience of opening the ground a second time.

The velocity of the current in the Seine was not sufficient to carry off the heavy matter discharged from the drains; consequently mud accumulated in the river-bed, which was cleared by dredging, at an annual cost of £3,200, being at the rate of tenpence to one shilling per cubic metre. The maintenance of the system was most expensive, involving an outlay, during a recent year, of about £30,000. With respect to the drains at work, the author stated, as the result of several personal inspections, that there was a complete absence of unpleasant smell.

The materials used in the construction of the works of the old system were a rough random rubble plastered—a superior kind coursed—and ashlar, chiefly for the inverts. Concrete was frequently employed in the foundations, as it is now; but the selection of lime for the masonry was formerly not considered important. At present, a coarse gritty sandstone was extensively used, set in random rubble fashion, the stone forming perhaps not more than 40 per cent. of the work, the staple material being mortar. The sand for this mortar was coarse and fine together, as taken from the pit, the result being a concrete rather than a mortar, which was employed in a dry stiff state. The work nevertheless was strong, attributable, it was believed, to good hydraulic lime being employed. Within the last three years a new building material, concrete, or béton "Coignet," had been introduced, the use of which had already been found to be satisfactory. This concrete was composed of sand, or ballast, dredged from the Seine, mixed with hydraulic lime and Roman cement. The cement was required to weigh 2,800lbs. to 3,100lbs. per cubic metre. This concrete cost £1 12*s.* per cubic metre in position in the drains, but the varieties of the mixture caused the price to fluctuate between £1 and £3 5*s.* per metre. The mode of building with this material was described in detail.

In conclusion, the author gave a schedule of the rates paid for masonry, and of the prevailing prices of the materials used in the construction of the works; and offered his acknowledgments to M. Belgrand, the Engineer-in-Chief, for courteously placing at his disposal all the records connected with the works, as well as for allowing him permission to inspect them.

WHAT HAS BECOME OF OUR FLEET OF GUNBOATS?

We have had this inquiry addressed to us several times during the last two years. During the recent debate on the navy estimates, we have been asked the same question by more than one correspondent. Doubtless Admiralty officials could answer the question, were they so disposed; but we are informed that considerable mystery pervades the subject, and the inquiries which have been made have not, we are told, received such straightforward and explicit replies as it is considered the public are entitled to receive in return for the large sums of the public money expended upon the gunboats in question, together with their engines and machinery, and the costly arrangement of sheds and other buildings for housing them, the steam machinery and apparatus for hoisting them out of the water, and shedding and unshedding, and launching them, upon which so much money was spent at Haslar.

Within the last few days we have with much difficulty ascertained a few facts concerning the gunboats and their machinery, although it is but a small instalment of the information with which the public have a right to be furnished; and though we are not able to answer the question "What has become of our gunboats?" we have succeeded in discovering that a shameful waste of the public money has taken place—an enormous amount has been uselessly squandered, and valuable property belonging to the nation insanely sacrificed.

Imperfect as our list may be as to the total number of gunboats constructed during and since the Crimean war, the following particulars as to the fate of thirty-eight of them will serve to throw some light upon the subject:—

Name of Vessel.	Horse-power.	No. of Engines.	Collective H. P.	No. of Boilers.	Name of Maker.	Date when broken up.	Remarks.*
Caroline	60	2	60	3	Penn	March 1862	
Mackerel	60	2	60	3	,,	May 1862	
Traveller	60	2	60	3	Maudslay	Dec. 1863	Engines taken to dockyard.
Savage	60	2	60	3	,,	Jan. 1864	
Tiny	20	1	20	2	Penn	,,	ditto.
Ready	40	1	40	2	,,	,,	ditto.
Pincher	60	2	60	3	,,	Feb. 1864	Engines & boilers taken to dockyard
Porpoise	60	2	60	3	Maudslay	,,	Engines fitting to Minstrel.
Pert..	20	1	20	2	Penn	March 1864	
Thrush	40	1	40	2	,,	,,	
Pickle	60	2	60	3	Maudslay	April 1864	
Cracker	60	2	60	3	,,	,,	
Flirt	20	1	20	2	Penn	,,	
Prompt	60	2	60	3	Maudslay	May 1864	
Garnet	40	1	40	2	Penn	,,	
Primrose	60	2	60	3	Maudslay	,,	
Braver	60	2	60	3	Penn	June 1864	
Garland	20	1	20	2	,,	,,	
Badger	60	2	60	4	,,	,,	
Camel	60	2	60	3	,,	,,	
Wolf	60	2	60	3	Maudslay	July 1864	
Grinder	60	2	60	3	,,	,,	
Crocus	60	2	60	3	Penn	,,	
Beacon	60	2	60	3	,,	,,	
Bullfinch	60	2	60	3	,,	,,	
Gnat	20	1	20	2	,,	Aug. 1864	
Brazen	60	2	60	3	,,	,,	
Parthian	60	2	60	3	Maudslay	Sept. 1864	
Redbreast ...	60	2	60	3	Penn	,,	
Confounder...	60	2	60	3	,,	Oct. 1864	
Blossom	20	1	20	2	,,	,,	
Rocket	60	2	60	3	Penn	,,	
Midge	20	1	20	3	,,	Nov. 1864	
Gadfly	20	1	20	2	,,	Dec. 1864	
Snapper	60	2	60	2	,,	Not broken up.	Vessel fitting for Coal Hulk.
Swinger	60	2	60	4	Maudslay	Dec. 1864	
Biter	60	2	60	3	Penn	Not broken up.	Engines partly out. Boilers on board.
Pet	20	1	20	2	,,	ditto	Vessel converting to Coal Hulk.

* Where no remarks are found in this column, the engines and boilers remain in store at Haslar.

It will be seen that, with the exception of two vessels which are being fitted for coal hulks, and one which, although not broken up, has the machinery partly removed, and is in an unseaworthy condition, this portion of our naval strength has entirely disappeared; and the engines, boilers, and machinery are, for the most part, in a condition little better than that of scrap iron; indeed, we understand that, except the very few engines which are either to be found in Portsmouth Dockyard or at Haslar, the copper pipes, and other valuable parts, have been consigned to the coppersmith's scrap heap, the cast iron work, which might have been allowed to remain, or been converted, has been consigned to the melting furnace; whilst the wrought ironwork has been cut up and converted to the scrap heap, or been worked up in the forge at Portsmouth yard.

LONDON ASSOCIATION OF FOREMEN ENGINEERS.

It affords us sincere pleasure to record from time to time the progress of this Society, and to note the increasing favour in which it is held by engineering employers generally. Much of its success in this latter respect is, no doubt, due to the fact that, from the earliest period of its existence to this hour, it has devoted its attention exclusively to legitimate objects—the practice of discriminating benevolence, and the pursuit of scientific inquiry. Had it done otherwise, there is every reason for believing that the Society would not now occupy the dignified position it has attained, nor boast, as it does, of having among its honorary members the principals of the chief Mechanical establishments of the metropolis, and the editors of the most influential Scientific journals of the country. Should it continue in the same course of unostentatious usefulness—and we see no symptoms of a deviation from that course—there is nothing to prevent the Association becoming one of the most flourishing institutions in the kingdom, and ranking next in professional and practical value to those of the Civil, and the Mechanical Engineers. The rules and laws by which the members are directed and governed, appear to be well calculated for the avoidance of any of those perplexing questions which are ever and anon arising between the capitalist and the labourer, and the discussion of which too often ends only in arraying class against class, and dividing employers and employed into two hostile bodies.

The Foremen Engineers have evidently discovered, and acted upon the discovery, that their interests are closely allied with those of their masters, and that, therefore, the individual friendship between them which exists in the factory, may with perfect propriety and with mutual advantage, be extended to collective meetings in the lecture-room. The intermediate office held by the manager, or foreman of an engineering establishment tends unquestionably to the isolation of the officer holding it, for he has the interests of those above, and of those below, him to consider, and those interests appear to be, and sometimes perhaps are, antagonistic. Hence the necessity for other qualifications besides the indispensable one of practical skill—as calmness of judgment, moral courage, and forbearance. With these to guide him, the foreman will steer clear of or surmount the difficulties pertaining to, his post. Without them, his life will be, in all probability, an incessant series of dissensions, ending in his own mental prostration, and the sacrifice of his employer's interests.

This is no imaginary or theoretical illustration of the important part played by the manager or foreman of an engineering establishment. Many of those who are acquainted with the internal economy of such places will, on the contrary, we feel confident, be able and willing to testify to its reality and truthfulness. As it is essential for the production of good work that the literal machinery of a factory should move smoothly, and without "back-lashing" or jarring, so is it of equal consequence to all concerned that the moral machinery controlling it should neither clash nor creak. It is to the accomplishment of such ends that the Association in question has to a great extent addressed itself. The discipline observed by its members in the meeting-room cannot fail to produce its effect upon them when in the active exercise of their duties in the workshop, and thus, from the master down to the labourer of the third class, all within its walls are likely to be benefited. Of the scientific discussions which periodically take place at the monthly gatherings of the Society we have frequently spoken on former occasions, and our columns have been, and will be, open to abstracts of the papers read thereat; but we have the evidence of Mr. J. Newton, its President, and of other gentlemen, that they are attended with much unseen gain to masters as well as to men. Among so large a body as that which constitutes the Association—apart from its honorary members, we mean—and where each branch of the trade, from the drawing office to the foundry and the erecting shop, are represented, it is easy to imagine that some would be distinguished for special knowledge of special objects; and this is so. It is, therefore, no uncommon thing for the foreman of one establishment to be seen consulting with the foreman of another at these meetings, and obtaining the result of his neighbour's riper experience as to the best mode of performing a task which he himself had never been called upon to perform before. It is needless to dwell upon the material saving which must accrue to masters from such a course as this, because it is self-evident. If the foreman who on Saturday night was puzzling over the solution of a practical problem, which had to be solved by some means—and, perhaps, by a series of costly experiments, would in time be solved—had the opportunity of returning to business on Monday morning armed with the key to the knotty question, supplied him by one who had discovered it before, it is clear that his master, as well as himself, has gained by the transaction. This, we are informed on the best evidence, is one example, among many of a similar kind, of the usefulness of the Institution.

In all ways, then, it deserves encouragement, and the recent contribution of £500 to its benevolent fund by friends of the Association in London affords a substantial proof that that encouragement is not withheld. That sum, however, must be largely augmented before it will be available for its destined purpose—that of yielding a sufficient amount of interest to allow of the superannuation and partial, if not entire, support of aged, necessitous, or infirm members of the Association. It will afford real satisfaction to us to be called upon to chronicle the gradual increase of that fund, for the faithful disposition of which the Associated Foremen intend giving the best possible guarantee by electing two trustees from among the donors to act with the three existing trustees, Messrs. Briggs, Hosken, and Newton.

On another page will be found a brief report of the twelfth anniversary festival of the Association—for which space could not be spared in the last number of The Artizan.

REVIEWS AND NOTICES OF NEW BOOKS.

The British Rainfall, 1864. Compiled by G. J. Symons. London: Edward Stanford, Charing-cross. 1865.

A very interesting record of observations made at about nine hundred stations in Great Britain and Ireland, systematically collected and deductions drawn therefrom by Mr. J. G. Symons. There are some useful remarks on rain gauges, with hints on observing them.

Bradshaw's Illustrated Handbook to Spain and Portugal. A Complete Guide for Travellers in the Peninsula. With Maps, Town Plans, and Steel Illustrations. By Dr. Charnock, F.S.A., F.R.G.S. London: W. J. Adams ("Bradshaw's Guide" office), 59, Fleet-street, E.C. Manchester: Bradshaw and Blacklock, 106, Cross-street. And of all booksellers in various other provincial and continental towns.

A great improvement upon what has gone before it, but not nearly as correct or perfect as it might be, although the preface is dated "Gray's Inn, January, 1865." Either Dr. Charnock has not travelled very much in Spain and Portugal very recently, or he has utterly failed to profit by his journeyings.

The Dictionary Appendix, and Guide to Correct Speaking and Writing, containing upwards of Seven Thousand Words not found in the Dictionary. London: John F. Shaw and Co., Paternoster-row and Southampton-row.

A really admirable work; and one cannot be surprised that it should have reached the twenry-sixth thousand. It should not only be on every office desk, but on every library table, and constantly within reach.

The Year Book of Facts in Science and Art. By John Timbs, F.S.A. London: Lockwood, and Co. 1865.

Additional interest attaches to each succeeding volume of the collection of facts and notes on passing events in Science and Art annually made by Mr. Timbs and put forth by him to the public. Scarcely a circumstance of any importance escapes the indefatigable compiler of the "Year Book of Facts." The present volume exceeds in interest those which have preceded it.

The Office and Cabin Companion for Engineers and Officers of Steam Vessels, consisting of Observations, Rules, and Tables, to facilitate such Calculations as Naval Officers and Engineers are called upon to make. By J. Simon Holland, Assoc., I.N.A., Chief Draughtsman in the Steam Branch of the Controller of the Navy's Department, formerly Chief Engineer, R.N. 2nd edition.

A very useful work, the greatest fault of which is there is too little of it. We trust Mr. Holland will in the next edition treat of a number of subjects, and give additional observations, rules, and tables, which the present limited space precludes the possibility of giving, but which might with great advantage and propriety be given in the "Office and Cabin Companion for Engineers and Officers of Steam Vessels."

The Limited Liability Joint Stock Company's List, Almanack, Register, and Directory. London: Charles and Edwin Layton, 150, Fleet-street. 1865.

A very useful work; one for which great necessity existed. It is compiled with the utmost care, the arrangement of the matter is good, and altogether it is a very excellent and cheap book.

The Engineer's Handy-Book, containing a series of Useful Calculations for Engineers, Toolmakers, Millwrights, Draughtsmen, &c. London: Simpkin, Marshall, and Co. 1865. Leeds: Alice Mann, Central Market.

A very useful little work suitable for the apprentice and operative machinist, containing a great number of useful tables, rules, and general information upon practical subjects, published in a cheap form.

The Flax and Tow Spinners' Complete Calculator. A Clear and Concise System of Calculating Through Every Process of Line and Tow Preparing and Spinning. By William Pickles. London: Simpkin Marshall and Co. 1865. Leeds: Alice Mann, Central Market.

We have often been asked for such a book, chiefly by foreign correspondents, and we are glad to find so complete and handy a work as this little treatise by Mr. Pickles, of Leeds. It is written and arranged in a very plain, sensible, and practical manner, and available for use by the workman, and in the office and warehouse.

The Gas Works of London. By Zerah Colburn, Mem. Ins., C.E., &c. London: E. & F. N. Spon, Bucklersbury. 1865.

Mr. Colburn has performed a public service by republishing in a collected form the interesting series of articles upon the Gas Works of London, written by him about three years since for the *Engineer.*

Impending further legislation affecting Gas Companies gives additional interest to the re-publication of Mr. Colburn's articles, and every one interested in the production or consumption of gas should possess the book and carefully peruse its contents.

BOOKS RECEIVED.

"The Social Science Review. A Quarterly Journal of Political Economy and Statistics." Edited by Alex. Delmar and Simon Sterm. Vol. I., No. 1; January, 1865. New York: Published for the proprietors at 161, Broadway. London: Trubner and Co., Paternoster-row.

And the books above noticed and reviewed.

NOTICES TO CORRESPONDENTS.

A. M. L.—Referring to our answer to you in last month's issue, we have since received further information upon the subject, which rectifies an inaccuracy in the statement first received, and as given by us. The valves, we are now on reliable authority informed, are double ported short D slides connected in the usual way, with rods, and packed at the back, according to Mr. Waddell's patented system (described and illustrated in The Artizan vol. for 1854) which renders them, perhaps, the nearest approach to perfect equillibrium slide valves.

W. L. B., W. M., and J. J. B.—Thanks for your communications, &c., of which you will see we have availed ourselves.

Silentio.—1. No; you may order through the publisher the number with or without the index and title-page. 2. Our arrangements for the issue of plates are sometimes unavoidably altered, as in the case referred to. The plate which you mentioned, will be given in an early issue. 3. You will find a copy of the printed specification in the Free Library in your city. The price you will find endorsed upon it, to which you will have to add the book post charge. 4. Write to the inventor, asking him for the information you require; or you may address yourself to the editor of the paper quoted by us. 5. The price of Hall's "Vocabulary of Technical Terms"—published by Mr. Stanford, of Charing-cross, and noticed by us in our March issue—is 2s. 6. We have not tried the metal for the purpose to which you wish to put it; and we presume that any respectable lathe or tool maker in your city would readily supply you with what you want.

R. N. (Portsea).—The lectures delivered at the Royal Institution of Great Britain *are* printed, but merely for circulation amongst the members and the scientific journals. We receive printed copies of the lectures, and insert those which we consider best adapted to present to our readers. You will find one of these in our present issue.

Mechanic (Dublin).—You seem to labour under the delusion that *momentum* is identical with pressure. This is by no means the case; on the coutrary the dynamic momentum is equivalent to the *moving force,* which is the product of the mass of the body into the accelerating force. In the instance you quote, we find by the usual formula—

$$v = 2800 \sqrt{\frac{B}{C}}$$

(v = velocity per second, B = weight of ball, C = charge) that the velocity of the ball will be about 9,600ft. per second. The required momentum you may find by means of the formula—

$$M = \frac{B\,v^2}{32 \cdot 16}$$

We must leave to you to reduce the result to the square inch, if you choose. You will find some very good practical information on the subject in Nystrom's "Pocket-Book of Mechanics."

R. B. (Folkestone).—Your letter is to hand, though too late to enable us to answer you so fully as we could wish. A work such as that you mention is much required; it is, however, a desideratum yet to be supplied, as no such book has yet been published. We shall, however, in our next be glad to give you some particulars which may serve for your guidance and information in the absence of any published book upon the subject.

PRICES CURRENT OF THE LONDON METAL MARKET.

	Mar. 4. £	s.	d.	Mar. 11. £	s.	d.	Mar. 18. £	s.	d.	Mar. 25. £	s.	d.
COPPER.												
Best, selected, per ton	89	0	0	89	0	0	89	0	0	89	0	0
Tough cake, do.	87	0	0	87	0	0	87	0	0	87	0	0
Copper wire, per lb.	0	1	0	0	1	0	0	1	0	0	1	0
„ tubes, do.	0	1	1	0	1	1	0	1	1	0	1	1
Sheathing, per ton	94	0	0	94	10	0	95	0	0	95	0	0
Bottoms, do.	100	0	0	100	0	0	100	0	0	100	0	0
IRON.												
Bars, Welsh, in London, per ton	7	5	0	7	0	0	7	0	0	7	2	6
Nail rods, do.	8	10	0	8	10	0	8	10	0	8	10	0
„ Stafford in London, do.	9	2	6	8	15	0	8	10	0	8	10	0
Bars, do.	9	0	0	9	0	0	9	0	0	9	0	0
Hoops, do.	9	15	0	9	12	6	9	12	6	9	12	6
Sheets, single, do.	10	10	0	10	7	6	10	7	6	10	7	6
Pig, No. 1, in Wales, do.	4	10	0	4	10	0	4	10	0	4	10	0
„ in Clyde, do.	2	11	6	2	11	3	2	11	3	2	11	6
LEAD.												
English pig, ord. soft, per ton	20	7	6	20	7	6	20	5	0	20	5	0
„ sheet, do.	21	0	0	21	0	0	21	0	0	21	0	0
„ red lead, do.	22	0	0	22	0	0	22	0	0	22	0	0
„ white, do.	26	0	0	26	0	0	26	0	0	26	0	0
Spanish, do.	19	10	0	19	10	0	19	10	0	19	10	0
BRASS.												
Sheets, per lb.	0	0	9½	0	0	9½	0	0	9¾	0	0	9½
Wire, do.	0	0	9	0	0	9	0	0	9½	0	0	9
Tubes, do.	0	0	9¾	0	0	9¾	0	0	9	0	0	9¾
FOREIGN STEEL.												
Swedish, in kegs (rolled)	15	10	0	15	10	0	15	10	0	15	10	0
„ (hammered)	16	0	0	16	0	0	16	0	0	16	0	0
English, Spring	19	0	0	18	0	0	18	0	0	18	0	0
Bessemer's Engineers' Tool	44	0	0	44	0	0	44	0	0	44	0	0
TIN PLATES.												
IC Charcoal, 1st qua., per box	1	7	0	1	7	0	1	7	0	1	7	0
IX „ „ „	1	13	0	1	13	0	1	13	0	1	13	0
IC „ 2nd qua., „	1	5	0	1	5	0	1	5	0	1	5	0
IC Coke, per box	1	1	6	1	1	6	1	1	6	1	1	6
IX „ „	1	7	6	1	7	6	1	7	6	1	7	6

The London Association of Foremen Engineers.—The twelfth anniversary of the formation of the above-named society was celebrated by a dinner at the Bridge House Hotel, London Bridge, on Saturday the 18th Feb. John Penn, Esq., C.E., F.R.S., presided on the occasion, and among the guests were the following gentlemen:—Henry Maudslay, Esq., C.E.; E. J. Reed, Esq., Chief Constructor of the Navy; Robert Mallet, Esq., C.E.; Bennet Woodcroft, Esq.; J. Ravenhill, Esq.; E. Humphreys, Esq.; W. Smith, Esq., C.E., F.G.S.; Capt. McGregor; Commander Reed, R.N.; Capt. Routh, R.N.; John Anderson, Esq., of Woolwich Arsenal; William Naylor, Esq., C.E., who officiated as vice-chairman; J. Bazalgette, Esq.; John Dinnen, Esq., R.N.; James Robertson, Esq.; William Todd, Esq., and many others. Joseph Newton, Esq., of the Royal Mint, President of the Association, supported the chairman, and the Rev. Dan Greatorex officiated as chaplain. After the usual loyal toasts had been given, that of "The Army, Navy, and Volunteers" was responded to by Mr. Reed, who acknowledged that naval gentlemen were now obliged to come to the engineering profession for advice and assistance in forming devices for the purposes of naval attack and defence. The principal things wanted were marine engines to give high speed to the ships, good armour plates to protect their sides, and good guns to inflict destruction on our enemies; but with all, we could not succeed without the gallantry of our sailors. The Secretary next read his annual report, stating that the total amount in hand was £121, apart from the Superannuation fund, which had been proposed last year by Henry Grissell, Esq., and which amounted to about £400 more. The library had been materially increased by donations from several gentlemen. During the last year papers had been read on practical engineering subjects by Messrs. Oubridge, Stanley, Walker, Briggs, Naylor, and Hayes, and which had been followed by discussions. The chairman then proposed the toast of the evening, namely, "Prosperity to the London Association of Foremen Engineers," coupling with it the name of Mr. Joseph Newton, who, for so many years, had been the president of the society and to whose abilities and indefatigable exertions it owed its present prosperous condition. Mr. Newton, in responding, went at some length into the merits of the society, and clearly showed that it was in many ways desirable for employers to encourage it. A proof of their success was the fact that four of the largest employers in London were at the head of their table. In conclusion he proposed "Success to our employers, and to the engineering trade," and coupled with it the name of Mr. Henry Maudslay.—Mr. Maudslay, in a very eloquent speech, acknowledged the obligation which employers owed to those whom they employed, not only while in health but also in sickness. As an encouragement to others he mentioned that there were several gentlemen present who had raised themselves from working men to employers; and they were not born with "silver spoons in their mouths," but owed all to their own exertions. Other toasts were proposed, and a number of donations acknowledged.

RECENT LEGAL DECISIONS

AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

Under this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least—less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

Principal and Contractor.—It has been decided, in the case of Gray *v.* Pullen, that where a duty is by statute imposed upon a person in respect of work which the statute authorises him to do, and he employs a contractor to do it, and, by an act of omission on the part of the contractor, a breach of the duty arises, the employer is responsible. The owner of premises within the Metropolis Local Management Act was authorised, under sec. 77 of the Act, to make a drain from his house into one of the public sewers. He employed a contractor to do the work, and in the course of doing it a trench was cut across the public footway, which was afterwards insufficiently reinstated, and in consequence thereof the defendant sustained an injury. The Court of Exchequer Chamber held (reversing the judgment of the Queen's Bench) that the defendant was personally liable for the breach of duty occasioned by the negligent omission of the contractor.

Directors' Personal Liability.—In the case of Betts *v.* De Vitre, it appeared that the directors of a limited liability company had been active parties in giving directions so as to produce an infringement of the plaintiff's patent right, and the question was whether they were to be made personally and individually liable for their acts. Vice-Chancellor Wood said it was perfectly novel to him to hear the question discussed whether directors could, under such circumstances, be made responsible for their acts, because, forsooth, they had acted under the directions of a "limited company." If that were so, there would be no end to the mischief and injury they might do. The Court had always held that anybody who took part in a wrong of this description was personally answerable to the party against whom that wrong had been committed, and it was no answer to say it had been done by the direction or on behalf of a limited liability company, or any other company. In the present case the directors had been wrong doers, and a decree must be made against them, with costs, to which they would be personally and individually liable.

Winding-up Companies with Less than Seven Shareholders.—An important question was raised in the Court of Stannaries in connection with the winding-up of the Hammett Consols. The petitioner was a shareholder who had been sued by a merchant, in consequence of which she presented a petition to the Court for an order to wind-up the company under the Companies' Act, 1862. The Vice-Warden made the usual order to wind-up, and also granted an injunction to restrain the action which had been brought, the effect of which would be to stop the proceedings against her, and to compel the shareholders in the mine to hear their due proportion of the liabilities. When, however, the books of the company came to be investigated by the Registrar of the Court, he discovered that there were not seven shareholders in the mine when the petition was presented—that there were only eight shareholders from September 23rd to October 20th, 1859, and again from November 2nd to December 12th, 1861, one or two of the original shareholders having abandoned their shares—and that it was only from August 12th to November 2nd, 1861, that there were nine persons in the company. He was consequently of opinion that the Court had no jurisdiction to proceed with the winding-up, the 199th section of the Companies' Act enacting that a company to be wound-up under the Act must consist of more than seven members, whereas in this case it did not consist of more than seven during the whole time of its existence, with the exception of the short periods mentioned. Mr. Marrack contended that if the company, at any time whilst the debts in question had been incurred consisted of more than seven members, then the Court had jurisdiction to proceed with the winding-up; and in this case the list of contributories, if it were issued, would contain the names of more than seven shareholders. His honour considered that the case was not free from doubt, and intimated that it would not be safe to proceed further, and that the remedy for the petitioner was by a petition for an account.

The London Engineering and Shipbuilding Company (Limited) *v.* Barton.—The plaintiffs sued the defendant, a resident in the neighbourhood of Sheffield, to recover £160 due upon the allotment of 40 shares to the defendant in the company. The defendant pleaded fraud. It appeared that the company was formed at the end of July, 1864, for the purpose of purchasing the business of Messrs. Westwood and Baillie, of the Isle of Dogs, and that it was introduced to the public by the Oriental Finance Company, who received £5,000 as promotion money for so doing. The prospectus stated that the capital of the company was to consist of £500,000, in 10,000 shares of £50 each, the first issue to be 5,000 shares, "of which a large proportion had already been applied for." The defendant applied for an allotment of 40 shares, and paid £40 deposit, being £1 on each share. Forty shares were allotted to him, and he was requested to pay £160, being £4 per share, to the bankers of the company. The defendant had never paid any part of the sum, and this action was brought to recover the amount. The defence was that the company was a bubble company, and that the statement in the prospectus that a large proportion of the shares had been already applied for was false and inserted without any just foundation. The defendant called no witnesses in support of his plea, but relied on the cross-examination of the two witnesses called for the plaintiffs; they were the secretary and the chairman of the company. The chairman said that before this statement was put forth the directors made inquiries, and they were informed by the manager of of the Oriental Finance Company on this point, and they *bonâ fide* believed that they were justified in making it. From the books of the company it appeared that 3,556 shares had been allotted, and that the defendant was the only person who had not paid the £5 due on the allotment; that a call had since been made, and that only seven or eight persons were in arrear in respect of it, and that 950 shares had been taken under the arrangements which led to the introduction of the statement in the prospectus which the defendant alleged to be false. It was further shown that the company were engaged on contracts to the extent of £120,000 or £130,000, and that they employed at the present time about 700 men on their works. After the learned Judge had summed up the case, the jury at once returned a verdict for the plaintiffs for £160 and £4 interest.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

Life Statistics, Paris.—A letter has been addressed by the Prefect of the Seine to M. Le Verrier, stating that the municipal administration of the capital are about to issue a monthly bulletin of municipal statistics, comprising, for Paris, all the facts which can be expressed numerically. This sheet is to contain principally a return of births and deaths, with the nature of the malady in the latter case, and is to be completed by a return of climateric and meteorological events observed at the same period. It is to be in form somewhat similar to that of the weekly official return published in London, a copy of which accompanied the letter.

Engineering Prize.—M. Perdonnet, engineer-in-chief, president of the Society of Civil Engineers, Paris, has offered a prize medal of 2,000 francs for the best treatise furnishing the results of new experiments, undertaken by the competitors, in an engineering point of view, on one or more questions comprised in the following programme:—To determine by a great number of experiments the resistance of vehicles and locomotives to traction on a railway, taking into account all the circumstances which can modify them, such as the state of the rails, vehicles, and engines; the force and direction of the wind; the surfaces of the carriages and the length of the trains; the dimensions of the axles and the wheels; the method of attaching the carriages; the distribution of the load and construction of the engines; friction of mechanism, coupling of wheels, escape of steam and draught of chimney, gradients, curves, &c.; to determine separately the influence due to each of these above circumstances. To analyse the causes which, in curves, modify the resistance, whether for an isolated vehicle or a series of carriages, and to guide the reasoning by experience. To find by experiment a practical formula for calculating the load that a locomotive of given form and dimensions can draw, taking into consideration adherence to the rails and other important conditions. To study the circumstances which modify the production of steam per square metre of heating surface, such as—the position of the sides in relation to the fire-box, the thickness of the plates, the interspacement of the tubes, &c. To determine the resistance opposed to the passage of the steam from the boiler to the valve-box, and from this into the cylinder; to determine the difference of the pressure of the steam in the boiler and in the cylinder in different conditions. To inquire into the effects of "priming" upon these differences of pressure; to examine the causes which influence the counter-pressure; to determine the influence of draught upon the dimensions of the exhaust pipe, and the pressure and velocity of the exit of steam and the dimensions of the chimney; to examine the resistance met with by the air in its passage from the fire-box to the chimney. These *mémoires* are to be written in the French language, and all the measures indicated are to correspond with the units of the metric system.

New Petroleum Engine.—Mr. F. H. Wenham, of Clapham, has patented an invention, which consists of two pistons contained in a cylinder with open ends. The first piston works a crank by means of a connecting-rod, the second is disconnected. During the revolution of the crank the second piston follows close to the first by atmospheric pressure until near the termination of the up stroke. They then separate for a short distance, at which time a mixture of gas and an explosive vapour is drawn in between them. When the first piston arrives at the end of the stroke it uncovers a small touch-hole, a flame is drawn in through the side of the cylinder, the gases take fire, and by explosion drive the second piston to the opposite end of the cylinder; here is fixed a cross-bar, through which the flat-rod of the second piston passes, this is now instantly held fast by two wedges driven into the cross-bar against the flat sides of the rod; this, and the wedges may be grooved to increase the grip. A vacuum is formed between the pistons, and the one connected with the crank in approaching the other by atmospheric pressure causes the revolution of the shaft. The piston before again coming into contact drives the products of combustion from between them through an outlet valve in the side of the cylinder. The loose piston is again released by withdrawing the wedges, and follows after the other for the succeeding stroke. The next improvement is for a means of igniting the gaseous mixture. A gas-jet pours directly into the touch-hole in the side of the cylinder. Surrounding the flame of the jet there is a platinum coil to retain heat. There is a similar arrangement round the touch-hole, and both coils remain red-hot whilst the engine is at work, and prevent the flame from being blown out by the force of the explosion through the touch-hole. He gives increased pressure and intensity to the gas by means of a small pump or bellows. A further improvement consists in passing the gas or air through naphtha, petroleum oil, or other volatile liquids, to obtain an inflammable vapour. The receptacle containing the liquid may be heated to assist vaporisation.

Improved Helical Turbines.—Mr. J. E. Stevenson, hydraulic engineer, of the Broadway, New York, has invented an improved turbine, which combines the helical curve with the Jouval wheel proper in a neat, compact, and portable form. The helix is so constructed that the velocity and force of the water acts upon all the buckets at once; the *vis viva* of the water is not lost by friction on the sides of the helix before acting on the wheel. The step is made of hardened steel, and is of peculiar form; it is placed above the wheel, resting on a stationary spindle inside the hollow shaft, which the wheel is keyed to, thus doing away with the large wooden step below the wheel, which causes a loss of power by friction. In the hollow shaft is an opening suitable for oiling and adjusting the step, and also for regulating the height of the wheel to the helix by means of a screw and nut, so as to prevent loss of water from leakage. There can be no loss of power by the rubbing at the periphery of the wheel, caused by the lateral wear of the step, as in common scroll wheels after running a year or two. The power of the wheel can be perfectly regulated by the gate, and when machinery is thrown on and off, an ordinary governor will keep an uniform speed. These wheels are applicable to all mill powers, and the inventor claims that when properly put up and geared, 80 per cent. of the useful effect will be obtained.

A Strong Room for cash and securities has been recently constructed for a London bank. The walls are 2ft. thick, of hard bricks, laid in cement, and with strong hoop-iron in the courses. In the interior there is placed a fire-proof Chubb's safe, weighing 13 tons. This is 10ft. long, 8ft. high, and 8ft. deep, made of plates 1in. thick, and secured by two iron and steel doors, having twenty-eight bolts. The remaining part of the brick room is lined with iron ½in. thick. The whole is again further secured by an iron and steel door, having ten bolts, let into the centre of the brickwork; and there is a gate for ventilation in the daytime. A large alarum is fixed in the bed-room of a clerk on the second-floor, which goes off whenever the outer door is opened; and a porter who sleeps in the office, and whose bed is in front of the door, can also, by pulling a trigger, set the alarum going.

Steam Engines and Machinery.—The exports of steam engines and machinery from the United Kingdom were on a larger scale than ever last year, although the foreign demand for this branch of our manufactures has been greatly increased during the last decade. Thus the total value of the steam engines and machinery exported in 1864 was £4,854,190, as compared with £4,368,012 in 1863, £4,092,673 in 1862, £4,213,670 in 1861, £3,837,821 in 1860, £3,731,301 in 1859, £3,599,352 in 1858, £3,883,669 in 1857, £2,716,453 in 1856, and £2,243,166 in 1855. Comparing 1864 with 1855, we have thus an increase of £2,611,024, or considerably more than 100 per cent. The large advance in the value of the machinery and steam engines exported in 1863 as compared with 1864 may, however, be attributable, to some extent, to the increased cost of the iron and steel used in their construction. The value of the steam engines exported in 1855 was £833,370; in 1856, £819,067; in 1857, £1,069,249; in 1858, £1,097,278; in 1859, £973,340; in 1860, £1,238,333; in 1861, £1,258,164; in 1862, £1,624,876; in 1863, £1,595,036; and in 1864, £1,626,342. The value of the other machinery exported in 1855 was £1,359,796; in 1856, £1,897,386; in 1857, £2,814,420; in 1858, £2,502,074; in 1859, £2,757,961; in 1860, £2,599,488; in 1861, £2,955,406; in 1862, £2,467,797; in 1863, £2,772,976; and in 1864, £3,227,848. Considering the increased attention devoted by France and other Continental nations to mechanical pursuits, it is gratifying to find the products of Great Britain still in better demand than ever.

Artesian Well, Paris.—The interesting work of the boring of the artesian well at the Place Hébert (eighteenth arrondissement) continues actively, in spite of the enormous difficulties met with at almost every step. The first 72ft. of the shaft are lined with masonry; then succeeds wrought-iron "tubbing," in sections 6ft. 7in. in diameter, and 3ft. 3⅜in. high, forced in by screw pressure. When this lining had been carried down through thirty-six beds of different strata a zone of sand was reached, mingled with such a quantity of water that it was almost in a fluid state. This dangerous sand might have been traversed by driving the tubbing with extreme precaution, had it not been for another obstacle which presented itself. It was found that the undercurrents of water had actually driven the tube out of the perpendicular. To obviate this was impossible, so that nothing remained to be done but to remedy the defect radically by taking up the tubes altogether, and continuing the masonry lining, which afforded a better guarantee of stability. The cylinders having been removed with enormous difficulty, it was plain that the masonry could not be continued on the ordinary conditions, and that a new method must be devised. This was done as follows: after several yards had been excavated below the existing masonry, and the sides properly shored up, a strong cradle of timber, exactly fitting the circumference of the well, was lowered and held suspended by stout chains to beams over the orifice of the well. This being done, the masonry was rapidly carried up from the cradle or platform as far as the existing lining, the chains being sealed up in the work. One section being thus terminated, another space was cleared away, and another circular platform let down, by other chains, and the masonry laid upon it. By this ingenious method the *calcaire grossier* was at last reached, and a firm footing gained, though not without its share of complicated difficulties. One of the upper platforms of the tier was found to have been crushed by the enormous weight upon it, and it was necessary to replace it by a new one; but, in piercing the masonry all round for this purpose it was found, with surprise, that a large hollow or bell-shaped cavern was behind the masonry. Fortunately this sort of vault was strong enough to prevent the top soil from falling in, and to fill up the cavity no less than 700 fascines had to be stowed away. Other obstacles have arisen since the calcaire grossier has been reached; the water springs up in such abundance, that the two pumps at work are not sufficient, and as there is not room for a third, the sinking of the well by manual labour must be abandoned, and recourse had to the trepan. This boring implement weighs no less than 5 tons, and is composed of six branches, each armed with a steel chisel. At the orifice of the well a space has been cleared 13ft. square, and 20ft. deep; this is a sort of chamber in which the various operations of boring will be conducted. It is not expected that the works will be free from unforeseen obstacles, till the chalk is reached at an estimated depth of 472ft., only one-fourth, or 118ft. being at present gained.

The Wholesale and Import Timber Company (Limited).—A new company is being formed in London under this designation with a capital of £250,000 in 25,000 shares of £10 each, with power to increase to one million. The company is for the ordinary purpose of purchasing British and foreign timber, deals, and other woods, for supplying, wholesale, the trade generally with wood goods of every description, and is said to be originated by parties of great experience in the timber trade, who regard such an undertaking as a necessity in trade at the present moment.

The Paris Exhibition of 1867.—A new feature of the Universal Exhibition of 1867 is to be living specimens of the human race, who are to accompany the productions of the remotest corner of the globe to Paris. The committee of the Exhibition is busily engaged in organising the necessary means of transit. The committee have issued the necessary orders for the commencement of the buildings which will be required for the Exhibition; and as 160,000 metres of ground have to be covered in, there is no time to be lost.

The Trades of Soldiers.—A return, recently issued, shows the number of non-commissioned officers and men in every regiment at home who have learnt some trade before enlisting, and of the number who have worked at their trade since they entered the army. The largest numbers are shoemakers, of whom there were 3,279 enlisted, and 1,197 have practised their trade since enlisting. The smiths are not far behind them, 2,732 of these having enlisted, and 1,083 afterwards practised their trade. It is a sign of the times that 2,756 weavers are among the enlisted men; only three of them have practised their trade since entering the army. There were also among the men 2,151 tailors, 2,053 carpenters, 1,289 bakers, 984 painters, 973 masons, 855 butchers, 813 bricklayers, 556 gardeners, and 546 printers.

Shipping of 1864.—The return of vessels employed in the foreign trade of the United Kingdom shows, as usual, an increase in the year 1864. The vessels entered inward here with cargoes (including repeated voyages) rose from 41,913 of 11,137,946 tons in 1863 to 42,108 of 11,302,296 tons in 1864. The increase was in vessels belonging to the United Kingdom and its dependencies, for these rose from 23,773 vessels of 7,299,417 tons in 1863 to 24,962 of 7,812,634 tons in 1864; but foreign vessels declined from 18,140 of 3,838,529 tons to 17,146 of 3,489,662 tons. The return of clearances outwards tells the same tale, the British rising from 27,624 vessels of 7,951,797 tons in 1863 to 28,229 of 8,590,780 tons in 1864, and the foreign falling from 20,773 of 3,934,550 tons to 19,026 of 3,578,793; the total being 48,397 vessels of 11,886,347 tons in 1863 and 47,255 of 12,169,573 in 1864. In 1863 there came to our shores, with cargoes, 1,417 ships of the United States of 1,361,021 tons; in 1864 only 429 vessels of 457,273 tons. On reckoning vessels of all nations coming from the United States to this country with cargoes, they were in 1860 1,931 of 1,724,801 tons, and in 1864 only 1,098 of 994,467 tons. The number of French vessels arriving here with cargoes declined in 1864, but the vessels of all nationalities arriving from France reached the unprecedented number of 7,467 of 1,035,456 tons.

The Supply of Cotton.—Definite information as to the receipts of raw cotton last year can now be given. They amounted to 893,304,720 lbs., as compared with 669,583,264 lbs. in 1863, 523,973,296 lbs. in 1862, 1,256,984,736 lbs. in 1861, 1,390,938,752 lbs. in 1860, 1,225,989,072 lbs. in 1859, 1,034,342,176 lbs. in 1858, 969,318,896 lbs. in 1857, 1,023,886,304 lbs. in 1856, and 891,751,952 lbs. in 1855. The great year in the cotton trade was 1860, and if we compare 1862 with 1860 we see that the supplies declined to the extent of 866,965,456 lbs., while, comparing 1864 with 1862, we find a recovery of 369,331,424 lbs. The receipts of last year were still, however, below the level of 1860 by 497,634,032 lbs., although it will be seen that last year's figures were somewhat in excess of those of 1855, when no special influence depressed the imports. It is worthy of remark in connection with this question that the exports of cotton from the United Kingdom have very greatly increased of late years, having amounted to 244,702,304 lbs. last year, against 241,352,496 lbs. in 1863, 214,714,528 lbs. in 1862, 298,287,920 lbs. in 1861, 250,339,040 lbs. in 1860, 175,143,136 lbs. in 1859, 149,609,600 lbs. in 1858, 131,927,600 lbs. in 1857, 146,660,864 lbs. in 1856, and 124,368,160 lbs. in 1855. It will be seen that the exports of cotton have very materially expanded since the ordinary course of the trade was disturbed by the complications still prevailing across the Atlantic.

The London Coal Trade.—The quantity of coal entered at the Coal Exchange, and registered by Mr. James R. Scott, the clerk, as coming into London by sea, canal, and rail for the month of February last was 453,756 tons 15 cwt., against 512,900 tons 3 cwt. for the corresponding month of 1864, the decline, therefore, being 59,143 tons 8 cwt., of which the sea-borne takes rather more than 50,000 tons. The supply for February of the present year has been in the following proportions, as relates to the sea-borne, viz.:—Newcastle, 105,945 tons in 210 ships; Seaham, 9,345 tons, in 38 ships; Sunderland, 65,407 tons, in 152 ships; Middlesborough, 7,658 tons, in 23 ships; Hartlepool and West Hartlepool, 32,813 tons, in 113 ships; Blyth, 813 tons, in 3 ships, Scotland, 1,795 tons, in 7 ships; Wales, 9,811 tons, in 21 ships; Yorkshire, &c., 747 tons, in 11 ships; 3,907 tons of small coals, in 7 ships; and 692 tons of cinders, in 5 ships. The railway supply has been as under:—London and North-Western, 83,908 tons 6 cwt.; Great Northern, 73,925 tons; Great Western, 26,034 tons; Great Eastern, 16,224 tons; Midland, 13,259 tons 13 cwt. to St. Pancras depot, and 1,113 tons 10 cwt. to King's-cross—total, 14,373 tons; South-Western, 51 tons 8 cwt.; total, 214,535 tons 14 cwt. The tonnage for the two months of the present year has been—per sea, 633,899 tons, in 1,621 ships, as against 576,830 tons, 1,538 ships, for the first two months of 1864, being an increase in favour of the present year of 83 ships and 57,069 tons. The railway tonnage for January and February, 1865, was 468,830 tons 15 cwt., as against 409,827 tons 17 cwt. in January and February, 1864, being an increase of 59,002 tons 18 cwt. The canal receipts have declined from 1,527 tons 5 cwt. for the first two months of 1864 to 1,363 tons for the same period of 1865. The tonnage from these three sources has advanced from 988,185 tons 2 cwt. for January and February, 1864, to 1,004,093 tons 5 cwt. for the corresponding period of 1865, so that the actual tonnage so far of this year exceeds that of last year (deducting the canal decrease) 115,908 tons 3 cwt.

An International Exhibition of Agricultural Machinery will be held at Cologne in June next, under the auspices of the Cologne Horticultural Society. We understand that premiums will be awarded, amongst others one of £75 for the best steam fire-engines, one of £75 for the best steam carriage, and £120 for the best steam plough. Messrs. Marcan and Son, of Cologne, have been authorised by the committee to represent and receive applications for space from intending exhibitors. We purpose giving further details in our next issue.

NAVAL ENGINEERING.

The Iron Frigate "Achilles," 20 guns, 1,250 horse-power of engines, Capt. E. W. Vansittart, made her final official trial over the measured knot course in Stokes Bay, on the 14th ult., with her new four-bladed propeller, which has recently been supplied to her at Devonport. The ship drew 25ft. 11in. forward and 26ft. 11in. aft. She was supplied with "Royal Yacht" coal for the trial. This is of the kind known as Nixon's Aberdare, from the 4ft. lower seam, and from its superior quality was supplied to the *Warrior* on the day of her trial. The *Achilles'* new screw was of the same diameter and pitch as the one she broke during her last trial over the course in Stokes Bay. Plenty of steam was generated, and the result of the trial may be stated to be as follows:—Mean speed of the ship in six runs over the mile with full boiler power, 14·322 knots; indicated horse-power of the engines, as developed on the indicator diagrams, 5,724; pressure of steam in boilers, 26·16lb.; presssure of steam in cylinders, 25·34lb. The speed of our three largest ironclads that have yet been placed under trial is relatively thus:—*Warrior*, full power, 14·354 knots; *Achilles*, ditto, 14·322; *Black Prince*, ditto, 13·584. According to these figures, therefore, the *Warrior* still maintains her position as the fastest ship in Her Majesty's navy by about 32 thousandths of a knot in excess of the *Achilles'* speed. The hull of the *Achilles* has a mean immersion of about 3in. in excess of the hull of the *Warrior*, and this excess will fully account for the slight difference in speed between the two ships. Both vessels have engines made from the same patterns by Messrs. John Penn and Sons, and the detailed working out of the trials gives an astonishing similarity in the results attained by the power exerted by the engines in comparison with the area of each ship's amidship section.

Trial of the "Scout."—The screw steam corvette *Scout*, 21 guns, 1,462 tons, 400 horse-power, after having been thoroughly repaired, both in machinery and hull, and fitted with a new forecastle and poop, has been taken to the measured mile off Maplin Sands to test her speed and steaming qualities. The *Scout* made six runs at full boiler power, and full speed on the measured mile, with the following results:—Average speed, 10·568 knots per hour; revolutions of engines, 55; pressure of steam, 20lb. Two runs were made at half-boiler power with an average speed of 7·804 knots per hour. The vessel was also tested on the circle at full and half power—at full speed, with helm 26½ deg. to port; time of turning the circle, 4 min. 50 sec.; at half power, with helm 28 deg. to starboard, time, 5 min. 18 sec. She is fitted with Smith's propeller, with the leading corners cut off. Diameter, 16ft.; pitch, 23ft. 6in. The ventilation is very good, and the distilling apparatus, which was also tried, worked most satisfactorily. Full pressure of steam could not be maintained during the whole of the trial, in consequence of the boilers priming. Notwithstanding this, however, the trial was considered satisfactory, and the ship reported as ready for sea.

A New Invention for working Ships' Pumps by the capstan in case of fire, for which a patent has been registered by Mr. Matthew Blank, engineer, was tried on the 6th ult. on board the *Irresistible*, in Southampton-water. Sixty revolutions were obtained with one man to each bar of the capstan, and 73 with two men to each bar; while 100 men would, as we are informed, he required, under ordinary circumstance, to get 70 revolutions. The trial was successful, and the invention was pronounced very valuable. Extra hands were put to the capstan to force a column of water to the upper deck. This pressure was hardly fair to the inventor, but, notwithstanding the immense force applied, nothing gave way.

Our Ironclads.—Instructions have been received at Chatham dockyard from the Admiralty directing the construction at that establishment of another large ironclad frigate of the improved *Bellerophon* class, to be named the *Hercules*, the building of which will be commenced as soon as the ironclad ships *Bellerophon* and *Lord Warden*, are sufficiently advanced to allow of the required number of hands being taken off them. The order also directs the construction at Chatham dockyard of one of the new class of *Amazon* sloops, from Mr. E. J. Reed's designs, to be named the *Blanche*, of 1,080 tons, and 300 horse-power, which is to be laid down in No. 7 slip as soon as the iron-clad frigate *Lord Warden*, is launched. From the programme of shipbuilding work to be undertaken at her Majesty's dockyards during the year 1865-6 it appears that Chatham and Pembroke are the only dockyards at which any new iron ships are to be constructed during the present year. With the exception of the ironclad frigates named, the only other vessels intended to be laid down at the several Royal dockyards are gun sloops of the *Amazon* class, two of which are to be built at Deptford, one at Devonport, two at Pembroke, and one at Chatham. Although no new work is to be undertaken at Portsmouth dockyard during the present year, the return alluded to shows that the *Royal Alfred*, *Helicon*, *Minstrel*, *Cherub*, *Minotaur*, *Scorpion*, and *Valiant*, are all to be completed for sea at that establishment, although, with regard to the last three mentioned ironclads, the return states that the time for their completion is "uncertain." At Sheerness dockyard the *Minotaur*, *Star*, *Bellerophon*, and *Lord Warden*, are to be completed, the *Bellerophon* and *Lord Warden* being returned as "uncertain." The vessels to be sent to Devonport for completion are the ironclads *Lord Clyde*, *Agincourt*, and *Wyvern*, and the unarmoured sloop *Amazon*. The official programme also states that it is intended to complete the *Favourite*, *Prince Albert*, *Endymion*, *Niobe*, *Viper*, and *Vixen* at Woolwich dockyard during the present year, the *Viper* and *Vixen*, however, being set down in the return as "uncertain." A portion of the hands at Chatham and Pembroke dockyards are to be employed in taking down the ships' frames, the orders for the taking to pieces of which have been received from the Admiralty.

The Machinery of the "Pallas" consists of four boilers, and are supplied by Messrs. Humphrys and Tennant. The engines are constructed on the double cylinder system, and are of the nominal power of 600 horses, intended to indicate 3,600 horses. The small cylinders are 51in., and the large cylinders 102in., stroke 3ft. 3in. There are four boilers, each 18ft. long, by 12ft. wide, containing collectively 11,400ft. of heating surface, and 420 of fire bar. The propeller is 18ft. diameter, 20½ft. pitch, and is intended to make 75 revolutions per minute, at which speed the vessel is expected to go 14 knots per hour.

Trial of the "Terrible."—The paddle-wheel steamer *Terrible*, 21 guns, 1,850 horse-power (nominal), having been under repair nearly two years, was on the 10th ult. taken to the Maplin Sands for the purpose of making her official trial of speed at the measured mile. The *Terrible*, which is the largest and most powerful paddle-wheel steamer in the navy, was some time since ordered to be broken up, but on being surveyed by the dockyard officials, her engines were found to be in such good order, notwithstanding the length of time they had been in the ship, that the Admiralty reconsidered their former order, and it was decided to put the vessel into thorough repair, and retain her in the service. These repairs have resulted in the *Terrible* being almost reconstructed. The day was favourable for the trial, the wind being from the northward with a force of 4 to 5. The draught of water was 19ft. 6in. forward, and 19ft. 2in. aft., but her trim was subsequently altered by the removal of four of her heaviest guns aft. The engines, which during the trial were in charge of Mr. J. Rollinson, chief engineer, were manufactured by Messrs. Maudslay, Son, and Field. They are fitted with double cylinders, each 6ft. in diameter, and of 8ft. length of stroke. During the time the *Terrible* was in dock her engines underwent complete repair, and in addition to several new fitments, the intermediate shaft, formerly belonging to the *Retribution*, was fitted on board. The four boilers, each of which hold 30 tons of water, are fed by 24 furnaces, and during the trial yesterday the boilers generated an abundance of steam. The *Terrible* is fitted with the common float paddle-wheels, each of which has a diameter of 34ft. The floats, 13ft. wide, have an immersion of 7ft. 6in., with nine in the water. On reaching the trial ground the *Terrible* was at once placed on the measured mile, and six runs taken at full boiler power. It should be remarked, however, that in consequence of the unusually large fleet of colliers and other vessels passing and repassing, the runs could not be satisfactorily made, the vessel having repeatedly to go out of her straight course when running over the mile. The following are the results of each run:—First mile—time, 6 min. 8 sec.; speed in knots, 9·783; number of revolutions of paddle-wheels, 13; pressure of steam, 9·5lbs.; vac. 28. Second mile—time, 5 min. 26 sec.; speed, 11·043 knots; revolutions of paddle-wheels, 13; pressure, 11·5lbs., vac. 25. Third mile—time, 5 min. 30 sec.; speed, 10·619 knots; revolution, 14; pressure, 12lbs. vac., 26·5. Fourth mile—time, 6 min. 13 sec.; speed, 9·651 knots; revolutions, 13; pressure of steam, 13lbs.; vac., 23. Fifth mile—time, 5 min. 19 sec.; speed, 11·285 knots; revolutions, 14; pressure, 11lbs.; vac., 26. Sixth mile—time, 6 min. 12 sec.; speed, 9·647 knots; revolutions, 13; pressure, 12; vac., 28; giving a mean speed of 10·470 knots per hour. Two runs were afterwards taken at half-boiler power, when with ten revolutions of the engines per minute an average speed of 8·436 knots was attained. From the reasons already given it would seem that the *Terrible* did not attain such a high rate of speed on this occasion as on her previous trial trip. In making circles, with the rudder at an angle of 28 deg., and with 10 revolutions of the engines, the full circle was made in 6 min. 8 sec., and at half-boiler power the full circle was made in 6 min. 32 sec.

The "Scorpion," ironclad ram, built by Laird Brothers, of Birkenhead, and purchased from them by the Government, left the Mersey on the 18th ult. for Holyhead and Devonport, under the command of Capt. Paynter, of her Majesty's ship *Donegal*. The *Scorpion's* dimensions are—Length, 225ft.; breadth, 42½ft.; and depth, 20ft.; and tonnage, 1,890. Her nominal horse-power is 350. Her armour consists of 4½in. iron plates and 10in. of teak. The thickness of the plating is reduced towards the ends, so as to insure buoyancy. Her machinery, turrets, and magazines are thoroughly protected. Her decks are of iron cemented over. She has two turrets, each pierced for two 12 ton 300-pounder Armstrong guns, so that the weight of her broadside will be 1,200lbs. The turrets, which are on Capt. Cowper Coles's principle, are plated with 5½in. armour-plates, doubled at the portholes. In order to avoid the necessity of running back the guns by manual labour, as is the case on board the *Royal Sovereign*, Messrs. Laird have introduced a small winch, which enables two men to do the work. Since the vessel was bought by her Majesty's Government several alterations have been made in the arrangement for the accommodation of the officers and the crew. The officers' cabins are roomy, light, and well ventilated, and forward a complement of 165 men can be carried without the least crowding. The gun slides have been fitted in the turrets, and it was the intention of the Admiralty to have put the guns on board before the vessel left Birkenhead. Unfortunately, however, the vessel which was bringing them round was wrecked on the coast of Ireland, and it was thought better to send the vessel to Devonport without them. When the *Scorpion* got under way she had in her bunkers coal for six or eight days' consumption, and drew 15ft. 10in. aft, and 13ft. 6in. forward. It is expected that when she has her guns, armament, and stores on board her draught will be about one foot more. There was a strong breeze, and after passing the rock at the mouth of the Mersey all her square canvas was set, the wind being nearly right aft. The vibration of the screw was scarcely perceptible; and although a pretty heavy sea was running, she rolled very slightly, and that easily, shipping a little water occasionally through her scuppers. There was no lack of steam, and she made with the tide against her about 11 knots an hour, the engines making 59 revolutions a minute (they have been worked to nearly 70). When near Holyhead, Captain Paynter furled the sails and put her about. She came round very easily and showed great buoyancy.

The Paddlewheel Steamer "Sheerness," 2, 114 horse-power, employed on harbour service between Chatham and Sheerness, after having been fitted with new boilers and the Lumley steering apparatus, was taken to the trial ground at Maplin Sands for the purpose of testing her speed and steering qualities. The result as to speed was satisfactory, the vessel making an average of nine knots per hour. It was, however, to the trials made to test her steering capabilities that the greatest interest was attached, as testing the value of the Lumley rudder. The *Sheerness* made the complete circle in an average of 2 min. 40 sec., while with the paddlewheels disconnected, and one working ahead and the other astern, the full circle could not be made under nine minutes.

Naval Appointments.—The following appointments have taken place since our last:—R. Holman, Chief Engineer to the *Fisgard*, for the *Alecto*; J. R. H. Potam, of the *Black Prince*, and W. Hallowell, of the *Liverpool*, promoted to First-class Assist.-Engineers; J. T. Trickett, Acting Second-class Assist.-Engineer to the *Fisgard*; J. Dearden, Chief Engineer, J. Clift, Engineer, and J. Bates, First-class Assist.-Engineer to the *Sparrowhawk*: P. T. Gruchy, and G. F. Boothe, promoted to be Chief Engineers; E. Miles, Engineer to the *Blenheim*, for the *Escort*; J. Ireland, Acting Engineer to the *Blenheim*, for the *Raven*; J. Knight, Second-class Assist.-Engineer to the *Indus*, for the *Lord Clyde*; C. H. Newbury, Engineer, confirmed to the *Fisgard*; W. Head, of the *Hawke*, promoted to Engineer; J. Dingwall, of the *Fisgard* promoted to be First-class Assist.-Engineer; R. Drummond, Chief Engineer to the *Indus*, for the *Renown*; A. M'Farlane, Chief Engineer to the *Indus*, for the *Topaze*; W. Todner, Engineer to the *Asia*, for hospital treatment; G. Roe, of the *Indus*, promoted to be Engineer; J. M'Kie, Chief Engineer to the *Achilles*; J. J. Greatheard. Chief Engineer to the *Cumberland*, for the *Hood*; W. Roberts, Engineer to the *Suturn*, for the *Asp*; H. Meredith, Acting First-class Assist.-Engineer to the *Asia*, for the *Lightning*; W. W. Watts, Second-class Assist.-Engineer to the *Saturn*, for the *Asp*; W. H. Sedgwick, G. T. Allison (acting), T. Scott (acting), J. G. Taylor, J. Daly, T. Bramby (acting), E. J. Murphy, and A. Purvis (acting), promoted to the rank of Engineers; E. Keen, Acting Engineer, additional, to the *Frederick William*; T. A. Weeks, Second-class Assist.-Engineer to the *Indus*, as Supernumerary; W. E. Campion, Chief Engineer to the *Fisgard*, for the *Pallas*; R. Drummond, Chief Engineer to the *Indus*, for the *Renown*.

MILITARY ENGINEERING.

The Breech-Loader Carbine.—The Government have determined to arm the whole of the cavalry with carbines on the breech-loading principle, and have selected the Westley Richards' arm as the arm of the service. Its weight is about 6lb., and the barrel, which is rifled on the Whitworth principle, is about 20in. in length, and is sighted up to 800 yards, at which distance it makes most wonderful practice. It has also a hardened projectile, which gives it greatly increased power of penetration. Two thousand of these arms are already in the hands of the troops; they are much approved, and 20,000 more are now in course of manufacture at Enfield; they will be finished this year. Two thousand infantry muskets on the same principle are also being manufactured for the Government by the inventors, Messrs. Westley Richards and Co., of Birmingham; These will be served out to the infantry this year for an extended trial. This arm, like the carbine, is rifled on the Whitworth principle, and is sighted up to 1,000 yards, at which distance it gives an average mean figure of merit under 2ft.

STEAM SHIPPING.

Iron Shipbuilding at Preston.—On Feb. 25th the Preston Iron Shipbuilding Company launched their first vessel, the *Ada Wilson*, 220ft. water line, 28ft. beam, 17·6 deep, 850 tons, 120 horse-power; and they have now on the stocks a screw steamer, 175 × 26 × 166 = 573 tons and 80 horse-power. A barque for the San Francisco trade, 160 × 28 × 20·3 = 597 tons. A coast-ing schooner 95 × 21 × 12 = 193 tons. A barque for East Indies 170 × 29 × 21 = 682 tons. They are also erecting new smithy and joiners shops 245ft. long, and are just about to commence a dry dock 240 × 46, the water on blocks will be about 14ft. deep.

Double Screw Steam Vessels.—An interesting trial has just been made on the Thames with a small steamer fitted with an elegant set of double engines, having two screw propellers. In this arrangement there are a pair of engines to each propeller shaft which can be worked singly or both together or reversely as may be desired. In the present instance the vessel was steered occasionally, entirely by the engines, through various impediments, showing that in an emergency the rudder could be dispensed with. Also by the engines alone she was turned round in her own length with great facility, and worked ahead and astern at a proportionately reduced speed with one propeller and a pair of engines; quite enough was demonstrated to show that this system of propulsion must supersede the present single propeller arrangement in very many cases where the navigation is intricate, or the water shallow. The vessel is fitted by Messrs. Jackson and Watkins, the Engineers of Poplar, and we understand this is the twelfth vessel of the kind built by them.

The Twin Screw.—The trial trip of the *Mary Augusta*, an exceedingly handsome, clipper-looking vessel, of 970 tons, took place on the 11th ult. She is of iron, and built and engined by the Messrs. Dudgeon, of Cubitt-town. Her principal dimensions are:—Length 251ft.; breadth, 28ft.; depth, 14ft. 6in.; engines, 250 horse-power nominal, having cylinders of 40in. diameter and 22½in. stroke, driving two three-bladed screws of a diameter each of 9ft. 2in., and with a pitch of 17ft. 3in. The *Mary Augusta* passed Gravesend on her trial down the river at 20 minutes past noon drawing 7ft. of water forward and 9ft. 6in. aft, the tide then wanting about one hour of high water off the Town-pier, and the wind being very fresh and squally from N.N.W. As the vessel approached the Lower Hope on her way down the river the wind increased to a fresh gale, and veered out to N.N.E., and continued so the greater part of the remainder of the day. The Mucking Light was passed at 12·38, Southend-pier at 1·15, and the Nore Light-vessel at 1h. 28min. 30sec. From the Nore to the Mouse Light-vessel, a distance of 7¾ knots, the vessel ran in 26min., the tide being about high-water slack, and the wind very strong on the vessel's port bow, with a considerable swell of the sea. In running past the measured mile on the Maplin Sands, between the Nore and the Mouse Light-vessels, the ship's time was found to be 3min. 43sec., which gave the ship a speed of 16·143 knots, a rate that was even excelled by the 26 minutes total time between the two light vessels, notwithstanding the strong wind on the vessel's port-bow. The time from Gravesend Town-pier to the Mouse Light—the extremity of the course run—was only 1 hour and 46 minutes, the exact distance being, as given on the charts, 22½ miles to the Nore, and 7¾ knots and 100 yards from the Nore to the Mouse. The speed attained was really unprecedented for a screw vessel, but the *Mary Augusta* had not been "pushed" in any way, and a greater result could, it is stated, have been realized had it been thought necessary. In returning back to the river from the Mouse Light the vessel was put over the measured mile on the Maplin Sands, with only one engine and screw working, the tide being a first quarter ebb and the wind just abaft the beam on the starboard side. The distance was run over under these conditions in 4 minutes and 44 seconds, which gave a speed of 12·676 knots, a rate of speed equally satisfactory with the full-power results, both results stamping the ship as one of the fastest screw steamships afloat. The vessel was steady and free from all vibration in every part throughout the trial.

Steam Shipbuilding on the Clyde.—The *Tarifa*, another of the Mediterranean steamers belonging to Messrs. Burns, has made a trial trip. She is upwards of 2,000 tons burden, and has engines of 300 horse-power; she was built by Messrs. Thomson, of Govan. In "running the lights" she attained a speed of 13 miles per hour—a rate which is expected to be considerably increased when she is under canvas. The *Tarifa* has since left the Clyde for Liverpool, from which port she will make her first voyage for Egypt. The Turkish Government has ordered an iron-plated ram on the Clyde. She is to carry guns of heavy calibre, and will be provided with an iron beak upwards of 20ft. in length, projecting underneath from the stem. The directors of the Wemyss Bay Steamboat Company intend putting on the Millport station the *Largs*, a new steamer built by Messrs. Wingate and Co., of Whiteinch. The *Kyles*, built by Messrs. Caird and Co., of Greenock, and belonging to the same company, is also ready, and will be put on the Rothesay station early in May. A third steamer, which is also being built by Messrs. Caird and Co., is expected to be launched in a few days. Messrs. J. and R. Swan, of Kelvin Dock, have launched an iron screw steamer of 400 tons burden, named the *Valencia*. This vessel is owned by Messrs. Mories, Munro, and Co., of Glasgow, and has been built for continental trade; she is being engined by the Greenock Foundry Company. Messrs. Hedderwick and Co., of Govan, have launched for the Madras and Colombo Steam Navigation Company (limited) a smart screw of 340 tons, named the *Negapatam*. She is being fitted with engines of 60 horse-power by Messrs. J. Howden and Co.

LAUNCHES.

The Launch of the Ship "Pallas," which differs materially from any other hitherto constructed took place on the 17th ult., from her building slip at Woolwich. The principle on which she has been constructed is that of an armour-plated ship of moderate dimensions, to carry a few heavy sheltered guns, and a belt of armour to protect the most important parts. She will be capable of steaming with sufficient speed to capture with certainty wooden vessels like the late *Alabama*, or men-of-war or privateers of much greater speed. She has been made a comparatively short ship, in order that she may be handy under the action of her rudder. She will be full-rigged, so that she may keep the sea for months together. That she may possess sea-going qualities of a high order, she has been made a very lofty ship above the water, the height of her fixed bulwarks being no less than 18ft. above the level of the sea. Her ends have also been kept as light as possible, to give her that peculiar buoyancy at the bow and stern which Admiral Dacres has reported upon so favourably in the *Enterprise*. Another peculiar feature in the *Pallas* is that she is constituted for fighting "end on" in the manner lately advocated so strongly. This is not, however, her only mode of fighting, as she will carry two powerful guns, under armour, at each broadside, in addition to two other guns. The *Pallas*, in which these arrangements have been carried out, was designed by Mr. Reed early in 1863, but the order to build the ship was not given till the end of that year, so that she has been so far completed in little more than fifteen months. Her armour-plates are not yet fitted, nor are her engines on board, but these works will be proceeded with rapidly, and the ship, it is stated, will be got to sea by the end of the present year. The engines, by Messrs. Humphreys and Tennant, are of 600 horse-power (nominal) on the improved plan introduced by these engineers, and used with so much advantage, as regards the saving of fuel, in several ships of the Peninsular and Oriental Company's packets. In consequence of the great power of these engines, Mr. Reed has considered it desirable to introduce a new system of construction at the stern of the ship, for the purpose of enabling the wooden hull to bear without injury the enormous strains which the screw propeller will effect. This system consists in connecting the stern posts and dead wood with the side, by means of internal iron bulkheads, decks, and flats, and external brass castings of a new description. The following are the dimensions of the *Pallas*:—Length between perpendiculars, 225ft.; length of keel for tonnage, 187ft. 8in.; breadth extreme, 50ft.; breadth moulded, 48ft. 1in.; and breadth for tonnage, 48ft. 9in. Depth in hold, 16ft. 6in.; burden in tons, 2,372 33-94; mean draught of water, 21ft.; height of ports, 7ft. 9in.; distance between ports, 14ft.; weight of 4½in. armour, 600 tons; weight of guns and powder, 120 tons; and weight of stores and water, 180 tons. She will be a faster vessel, it is stated, than any wooden frigate in the navy. The fastest wooden frigate now afloat and complete is the *Mersey*, which on one occasion steamed 13¼ knots an hour; but the *Mersey* is 300ft. long and of nearly 4,000 tons' burden. She carries no armour, and the designer of the *Pallas* has engaged that the latter ship shall exceed the *Mersey* in speed. The *Pallas* is provided with Mr. Reed's new bow, known as the U bow, on account of its section having the form of that letter, the object of this shape being to correct the pitching tendencies of armour-plated ships. The extremity of the bow or prow, which projects many feet in front of the ship, is armed with an enormous brass cleaver, or ram, intended to penetrate any ship against which it may be driven.

The First Iron Sea-going Steamship built in Austria.—On the 11th ult., the *Austria* was launched from the building yard of the Naval Arsenal of the Austrian Lloyds, Trieste. The *Austria* is stated to be the first iron sea-going ship built in the country whose name she bears. She is 1,680 tons builders' measurement. Length between perpendiculars, 276ft. 8in.; length over all, 296ft.; breadth of beam, 35ft.; depth of hold, 24ft.; displacement at 17ft. 6in.; draught of water, 3,000 tons. She is to be fitted with 300 horse-power surface condensing engines. The *Austria* is built of Austrian iron under the direction of Herr Otto Dingler, the engineer to the I.R. Austrian Lloyds Company, to whom considerable credit is due, when it is considered that those under his command were native workmen only, they having to be trained for this kind of work, of which previously they had no knowledge.

Launch of the "Agincourt."—This monster armour-plated ram, of 6,680 tons burden, and 1,350 horse-power, was floated on the 27th ult., at half-past ten p.m., at the ship building yard of Messrs. Laird Brothers, Birkenhead, in the presence of about 30,000 spectators. The christening part of the proceedings were performed by Mr. John Laird, and, punctual to a minute, the immense hull of the *Agincourt*, with nearly all the machinery on board, was slowly, but surely, undocked with the assistance of six powerful steam tugs, viz., the *Cruiser*, *Sea King*, *Iron King*, *Blazer*, *Hercules*, and *Emperor*. The scene as the *Agincourt* emerged from the dock in which she was constructed was one of great animation, and a round of cheers, mingled with a thundering salute of twenty-one guns by Laird's Artillery Volunteers, from the esplanade in front of the works, welcomed the floating of one of the most powerful vessels of war ever constructed. The vessel was hauled out stern foremost, and as soon as she was clear of the docks and pier, she was taken in tow by the head by the tugs *Emperor* and *Hercules*, the other tugs lying respectively on the starboard and larboard quarters. The *Agincourt* was then towed down to to the south side of the Morpeth dock, where she will be completely equipped, and, it is expected, she will be ready for sea in about two months.

TELEGRAPHIC ENGINEERING.

Direct Telegraphic Communication between Sweden, Norway, and Great Britain.—A company is in course of formation, having for its object the establishment of a direct telegraphic communication between Sweden, Norway, and Great Britain. It is proposed to lay down a submarine cable between Egersund, on the west coast of Norway, and Peterhead in Scotland. The distance is about 300 miles, and the capital required to be raised in the three countries is estimated at £60,000. The undertaking is got up quite privately amongst persons directly interested in the trade. It is calculated that by this intended route a saving of 60 per cent. will be made as compared with existing rates.

RAILWAYS.

Exportation of Railway Carriages.—An official paper just issued states that the value of railway carriages exported last year amounted to £328,420, being a great increase on the preceding year. A similar return shows that there was also an increase in the value of the steam engines exported compared with that of the preceding year. The amount was £1,626,342.

The Great Western, Bristol and Exeter, and South Devon Companies have signed an agreement with the West Cornwall Company, by which they undertake to work the West Cornwall at 65 per cent. of receipts from 1st July, 1865, to 1st January, 1866. On the 1st of January, 1866, the West Cornwall is to transfer their property to the associated Companies in consideration of a rent-charge of £21,000 a year, to be increased from the 1st of January, 1870, to £23,000, and again to be increased from 1873 to £25,000 in perpetuity, deducting £3,000 per annum for repairs, &c., including laying down the broad gauge.

A System of Communication between Railway Passengers and Guards has been in operation on part of the London and South Western Company's lines for the last few weeks, and is said to work satisfactorily. The signalling is effected by a small electric train, invented by Mr. Preece, the superintendent of the Company.

The Great Western Railway Company has decided upon raising a new capital of a million by the issue of a 5 per cent. preferential stock.

The effect of the passport system established by the United States' authorities on the Canadian frontier is shown in a remarkable manner by the returns of railway traffic. The receipts of the Great Western Railway of Canada for the week ending the 17th Feb. were only £4,713, against £12,912 for the corresponding week last year, showing a falling off of upwards of 60 per cent.

Conveyance of Passengers and Goods.—The *Gazette* announces the appointment of the Duke of Devonshire, the Earl of Donoughmore, Lord Stanley, the Hon. E. F. Leverson-Gower, the Right Hon. R. Lowe, Sir Rowland Hill, the Messrs. J. A. Roebuck, T. B. Horsfall, R. Dalglish, G. C. Glyn, A. S. Ayrton, D. Galton, E. T. Hamilton, and J. R. M'Lean to be her Majesty's Commissioners to inquire into the charges made for the conveyance of passengers and goods on the railways of Great Britain and Ireland, and the practicability of reducing such charges with a due regard to safety, punctuality, and expedition.

RAILWAY ACCIDENTS.

Accidents on Railways.—It appears from the statistics collected by the Board of Trade, that 1 railway passenger is killed in each 16,000,000 carried, and that only 1 in about 315,000 is even injured. The result of the Railway Passengers Assurance Company's fifteen years' experience only gives the proportion as 1 in 10,700, though it can readily be understood that the insurers therein would embrace a large proportion of continual travellers, and that many claims would be made upon the company which would not be returned to the Board of Trade.

Accident on the Brighton Railway.—An accident took place on the morning of the 26th ult., near Croydon. The Brighton Railway Company, desiring to take down a railway bridge in that neighbourhood and replace it by a more convenient one, employed a number of men to weaken the supports, while a locomotive was to haul it down. Whether by mismanagement or by accident it happened that the bridge fell while the men were working under it, and six men were buried in the mass of brickwork. Two were were taken out dead, another died shortly after, and the others were seriously injured.

DOCKS, HARBOURS, BRIDGES.

Improvement in Chatham Dockyard.—The sum of nearly £100,000 has been taken by the Admiralty in the Navy Estimates for 1865-6, for the new works to be executed during the year for the enlargement and improvement of Chatham Dockyard, as well as for the other undertakings connected with the extension of that establishment. Of this amount the sum of £70,000 will be required this year for the construction of the additional docks and basins, and other works for the enlargement of the dockyard. The original estimate for the extension of the dockyard by throwing into the establishment the whole of St. Mary's Island, containing between 300 and 400 acres, was £943,876—a further sum of £306,124 being required for additional work, now proposed to be executed by contract, making the total estimated outlay £1,250,000. Hitherto the whole of the works have been executed by convicts, some 800 or 900 of whom have been daily employed on the undertaking for some years past; but the Admiralty have decided on supplementing their efforts by the employment of skilled labour, at an additional outlay of £300,000.

New Docks at Blackwall.—In anticipation of the increasing demand for graving docks to receive the largest class of vessels, the Thames Iron Works Company are now constructing two dry docks at Blackwall:—One will be 450ft. long, 64ft. entrance, and 23ft. deep; the other 350ft. long, 55ft. entrance, and 21ft. deep. The works, which are being executed by Messrs. John Aird & Sons, from the designs of Mr. Alfred Giles, C.E., will, it is expected, be completed in October, at a total cost of about £80,000, inclusive of pumping engines.

Menai and Conway Bridges.—A Parliamentary return shows that the principal debt still due on account of advances for building the Menai-bridge, and purchasing the rights of ferry, amounts to £231,498. The interest on the debt amounted, in April, 1864, to £432,902, towards which £41,421 had been received for tolls, and £106,768 for additional postage received on Irish letters. Adding the cost of maintenance, the total due to the Exchequer a year ago was £539,065. In respect to the Conway-bridge there was £68,720 due to the Exchequer a year ago, but the tolls taken at this bridge exceed the expenditure.

MINES, METALLURGY, &c.

New Zealand Coal.—At the Royal Society of Scotland, the Rev. T. Brown read an abstract of a communication by Dr. Lander Lindsay, on the Tertiary Coal of New Zealand. The coal beds of New Zealand were found, the paper stated, in strata along the sea shore, extending in some instances from 50 to 100 miles. They generally accompany the gold fields, and the distribution of the strata was very general. The coal occurred at all levels through the whole of the tertiary formations. Investigations recently made had left no doubt that New Zealand coal belonged to the same formations as the brown coal of Germany. The colonists were at first inclined to believe that the coal was true palæozoic coal, similar to that found in the Lothians and in Fife in Scotland; but this was incorrect, for the coal would not burn unless combined with a good quantity of firewood or Newcastle coal, and it had been found by experiment that it would not produce gas. This appeared now to be fully understood by the colonists, for while Newcastle coal sold at the ship's side at 40*s*. per ton, and in Dunedin at 80*s*. per ton, the New Zealand coal brought only 10*s*. per ton at the pit's mouth. The consumption of the native coal appeared to be considerable, and it is an important product of the country, being useful in smelting, brickmaking, &c.

Extracting Silver from Lead.—Don F. M. Millan del Real, of Bordeaux, has brought forward an invention the object of which is the improvements in extracting silver from lead. For this purpose lead from which the silver is desired to be extracted is run from the reverberatory furnace into a heating pan, under which a strong fire has been previously made, that no cooling of the lead may take place, but that its temperature may be raised in a short time. The surface of the lead is then skimmed, after which he introduces about one part by weight of carbonate of ammonia to every 100,000 part by weight of lead contained in the heating pan: the carbonate of ammonia is introduced by means of a covered ladle perforated with small holes. This instrument, with the carbonate of ammonia therein, is stirred about in the lead for about five minutes, and re-inserted, charged with one part of sea salt to 10,000 parts of lead. This is stirred in for ten minutes, the quantity of sea salt being increased, when the quantity of silver contained is high. The skimmings are place in heaps, and afterwards heated in a close retort. One per cent. of zinc is then added, in the same way as the carbonate of ammonia and sea salt, the mass being stirred for five minutes with each charge of zinc until sufficient zinc is introduced. The fire is then withdrawn, that the mass may cool as quickly as possible. As soon as the surface is slightly crystallised it is skimmed and retorted with the other skimmings, the silver being separated by distillation.

Method of Working Poor Ores of Lead.—The operation on lead ores, which contain too little lead and too much quartz to be smelted profitably, Lampadius treats with muriatic acid, with heat, upon plates on stone or lead, by which the galena is completely converted, if the ore has been properly prepared, into chloride of lead. The mass is then lixivated in tubes, with double bottoms, holding each 15 or 20 cwt., with boiling water, to extract the chloride of lead, which crystallises out in great part on cooling, the mother water being again heated to boiling, and used over again continually. The deposited chloride of lead is reduced to the metallic state by zinc, forming a spongy lead, which may be either melted down or used for making white lead, &c. Some iron having been thrown down from the chloride of zinc solution by chloride of lime, the zinc must be precipitated by lime as pure white oxide of zinc, suitable for pigmentary purposes.

Coal, Copper, and Quicksilver in California.—The amount of coal brought to San Francisco during 1864 from mines on this coast was—the Nanaimo Mines, Vancouver Island, 12,745 tons; Coose Bay, 300 tons; Bellingham Bay, 11,485 tons; and from the mines of Monte Diablo, 13,710 tons, which have been sold at prices ranging from 7 dols. to 12 dols. per ton, being a reduction of from 3 dols. to 5 dols. on the prices current the preceding year. This coal is of the bituminous variety, and is found to answer all the purposes of a fuel both for domestic uses and the generation of steam. The mines are well opened, the coal easily accessible, and enough to supply the consumption of the entire coast, or any demand likely ever to be made upon them. The mines at Copperopolis and several other points in the State are being developed with prudence and a good degree of energy. The amount of copper received at San Francisco during 1864 was 14,300 tons, valued at 1,094,660 dols., against 5,900 tons, valued at 512,000 dols., the preceding year. The amount raised the coming year, it is believed, will be much larger than last. All the ore containing 10 per cent. or more of metal delivered in San Francisco sells readily for cash. The quantity of quicksilver produced this year at the New Almaden Mine, the only one worked to any extent, was 26,000 flasks of 75lbs. each; the whole valued at 1,527,000 dols. against 26,000 flasks last year valued at 966,000 dols.

The Rating of Coal Mines.—At a meeting of the North of England Institute of Mining Engineers held on the 2nd ult., Mr. G. C. Greenwell read an interesting paper on "The Rating of Coal Mines." The writer introduces his subject by remarking that the principle of rating mines is contained in the Parochial Assessment Act, 6 and 7 William IV., c. 96. It is there enacted that no rate for the relief of the poor should be of any force which should not be made on an estimate of the nett annual value of the property rated—that is to say, of the rent at which the same might reasonably be expected to let from year to year, free of all usual tenants' rates and taxes, and tithe commutation rent charge, if any, and deducting therefrom the probable annual average cost of the repairs, insurance, and other expenses necessary to maintain them in a state to command such rent. The writer proceeds to show that this is not the principle on which coal mines are ordinarily rated; and then submits for the consideration of the institute a proposal whereby the principle may be applied so as practically to meet every case, and to avoid the anomalies to which its general use has hitherto given rise. It is submitted that a mine should be viewed in the same light as a house or a factory, and that all peculiar circumstances should be completely discarded. It is suggested that the rateable value of a colliery should be based on such rent as would be given to a landlord for the immoveable plant necessary on the average of the whole kingdom to produce the quantity of coal worked at any given colliery. It appears from Mr. Hunt's statistics that the average production is about 30,000 tons per colliery per annum. It is assumed, for the sake of argument, that the average depth of the collieries is 120 fathoms, and that the average cost of shafts, engine houses, and other immoveable plant necessary to produce 30,000 tons per annum is £10,000. House property usually produces 6 per cent., and the same per centage is applied in this case for assessment, which would produce £600 per annum. Still applying the custom of rating houses to collieries, a reduction might be made of one-sixth for repairs, &c., thus making the rateable value of collieries £500 per annum for every 30,000 tons of coal raised. Thus a colliery producing 150,000 tons per annum would be rated at £2,500, and one producing 300,000 tons, at £5,000. The writer considers the plan here suggested to be easy of general application, and at the same time consistant with the Parochial Assessment Act, and calculated to avoid what has been, and as at present conducted will always be, a fruitful source of source of litigation and annoyance. Some general conversation then took place on the subject, after which the meeting broke up.

Quartz Mining in California. Large Profits.—It is impossible to name any average value for the gold-bearing rock of this State—it can be worked with some profit if it yields no more than 6 dols. to the ton, and a great deal of that class is now being reduced. This, however, is below the general average. Many mills run steadily on, rock yielding 20 dols. and 30 dols. per ton, while a few crush scarcely any but yields as high as 60 dols. The average yield of the rich mines at Gold Hill is about 30 dols. to the ton. The owners of the celebrated Allison Ranch claim at Grass Valley run a 10-stamp mill steadily on 70 dols. and 80 dols., they having crushed some ore that paid as high as 10,000 dols. to the ton. The weekly earnings of their mill is between 10,000 dols. and 12,000 dols. At a depth of 300ft. they are working a strip of rich rock from 2ft. to 4ft. The Soulsby claim, near Sonora, has at times yielded equally as well as that of the Allison Ranch Company. From the Fellows claim, also near Grass Valley, two men took out 100,000 dols. with a hand mortar in six weeks. The Empire Company, Nevada county, have crushed 26,000 tons of rock, averaging 40·76 dols. per ton, and giving a gross yield of of 1,043,720 dols., 300,000 dols. of which have been paid out in dividends, and the balance spent on the mine and in the erection of mills, of which they have two, built at a cost of 135,000 dols. The cost of working and making improvements has all been defrayed from the proceeds of the mine, no assessment ever having been levied. It is estimated that they have still in their mine 4,000,000 dols. worth of ore above their lowest level. The Crescent Company, operating in Plumas county, divided for the quarter ending July 1, 50,000 dols., being at the rate of 100,000 dols. a year nett savings earned on a moderate investment. Ten steam mills in Mariposa county, running 22 stamps each, crush 250 tons of 15 dols. rock per day, producing 1,250,000 dols. per annum. The owners of the Indian Valley ledge, Plumas county, have declined an offer of 120,000 dols. for it, believing it would yield them 15 per cent. per month on that sum. The Spring Creek Company, Shasta county, have lately been cleaning up 300 dols. a day with an 8 stamp mill. The deepest shaft in the country is that at the Eureka Mine, 800ft. down. Many of them are from 300ft. to 500ft. in depth. The cost of raising ores is, on an average, about 2 dols. per ton. Crushing, where water power is used, can be effected at from 2 dols. to 3 dols. per ton; with steam power it is a little more expensive. At some of the mines, engines of nearly 100 horse-power have been provided for the hoisting works. The wages paid vary from 3 dols. to 4 dols. a day, according to service.

GAS SUPPLY.

The Chelmsford Gas Company announce a dividend of 10 per cent. per annum, free of income-tax, and a reduction of price to 4*s*. 7*d*., and for public lamps 4*s*. 2*d*.

The Stratford-on-Avon Gas Company have agreed to a dividend of 10 per cent. on ordinary shares, and 5½ per cent. on preference shares.

The South Shields Gas Company have made so large an expenditure on the erection of new works, that their usual dividend is absorbed in the meantime. They also speak of an increase of £436 on the cost of coal, but an increase of revenue to the amount of £600 more than covers that. A dividend of 4½ der cent. was declared.

APPLIED CHEMISTRY.

Arborisations Produced by Sulphate of Copper in Solutions of Alkaline Silicates.—By placing a few crystals of sulphate of copper or iron in a very diluted solution of silicate of potash, a mineral vegetation is formed in a few hours, of the same colour as the sulphate employed; this arborisation is remarkable, as it seems to reproduce in the solution of silica the mossy appearance seen in agates; by attentively following its growth some curious phenomena are observable. The stalks very often rise in the form of an arch; this takes place when the solution is at a certain degree of saturation; if it is very much diluted the arborescence rises vertically and in a straight line. If it is too much concentrated no arborisation takes place, the sulphate of copper merely becomes covered with a black coating. But in a properly dense solution a curious fact is observable; after the formation of the vertical stalks, fresh branches form upon them, inclining horizontally at an angle which is the same for all in the same solution. In solutions of different densities the most concentrated gives to these branches the most acute angle. What can be the cause of this regularity in the incline of such tenuous fibres? This problem is certainly as yet unresolved, but until it be resolved we hazard the following explanation:—The helicoidal form of certain fibres sufficiently indicates that they are arrested in their development by the density of the liquid, they then curve in the line which most easily enables them to overcome this resistance; but there must be another cause for those fibres which follow an oblique line always equally inclined, for they evidently follow this direction on account of the slight resistance thus offered to their development. The reason for this appears to exist in a kind of invisible cleavage possessed by the solution; if it be admitted that this cleavage exists according to a rhombohedral, as silica belongs to this system, all will be explained, for the terminal edges as well as the faces of this form are inclined horizontally. The arborisation produced by this experiment is very curious, for in the space of one day a prepared solution may be filled with vegetation varied according to the sulphate employed, and presenting an exact miniature representation of a forest. To render the experiment more interesting the bottom of the glass jar may be strewn with well-washed sand, and the addition of a few pieces of bichromate of potash will give to this the natural colour of soil, and parts of it powdered over with sulphate of copper will have the appearance of grass. It is hardly necessary to add that the vessel should never be moved when once the experiment is commenced.

On the Employment of Acetate of Sodium for the Separation of Iron and Aluminium from other Bases, by Wolcot Gibbs, M.D., Rumford Professor in Harvard University, U.S.—The facility with which iron and aluminium are precipitated from neutral solutions of the sesquioxide by boiling with acetate of potassium or sodium has led to frequent analytical applications, though the method is not so generally employed as it deserves. Mr. C. F. Atkinson has devoted much time to a careful study of the subject, and has arrived at the following results, which appear to me worthy of attention:—The sesquioxides of iron and aluminium may be perfectly separated from the protoxides of manganese, cobalt, nickel, zinc, magnesium, and calcium, and from sesquioxide of uranium, by boiling the neutral, or nearly neutral, solutions with acetate of sodium, provided that the following precautions are observed:—The solutions from which the sesquioxides are to be precipitated must be dilute; half a litre of the solution should not contain more than one grain of either sesquioxide or of the two, when both are present. The quantity of acetate of sodium should be sufficient to convert by double decomposition all the bases present into neutral acetates. The acetate should be added to the metallic solution when cold, and the whole should then be heated together and boiled for a short time. It is not necessary to filter upon a water-bath funnel, but the beaker containing the solution should be kept nearly at the boiling point during filtration, and a ribbed filter should be employed. In all cases it is best to add a few drops of free acetic acid to the solution, to prevent the formation of basic acetates of the protoxides. This is especially necessary in separating iron and aluminium from zinc and nickel. Finally, it is best, whenever possible, to have all the bases present in the form of chlorides. The iron and alumina upon the filter in the form of basic acetates must, whenever an absolutely complete separation is necessary, be re-dissolved in chlorhydric acid, and again be precipitated by boiling with the acetate after rendering the solutions nearly neutral by means of carbonate of sodium. In this manner only it is possible to separate the last traces of the stronger bases. Finally, the basic salts of the iron and aluminium, after washing, must be re-dissolved in chlorhydric acid, and precipitated by boiling with ammonia in the usual manner, to free them completely from alkali. The precaution of a second treatment with acetate of sodium is more necessary with alumina than with sesquioxide of iron alone. It is scarcely worth the trouble in the separation of iron from calcium and magnesium. According to my own observations the sesquioxides of iron and aluminium cannot be separated from sesquioxide of chromium by boiling with acetate of sodium, although the last-mentioned oxide is not precipitated when alone in solution. In this case it is necessary to oxidise the chromium to chromic acid by chlorine in the manner already pointed out.

LIST OF APPLICATIONS FOR LETTERS PATENT.

We have adopted a new arrangement of the Provisional Protections applied for by Inventors at the Great Seal Patent, Office. If any difficulty should arise with reference to the names, addresses, or titles given in the list, the requisite information will be furnished, free of expense, from the office, by addressing a letter, prepaid, to the Editor of "The Artizan.".

Dated February 24th, 1865.

516 J. Jacob & R. Pilzinger—Generating heat
517 W. E. Gedge—Shearing and burling all sorts of woven fabrics
518 C. W. Lancaster—Cartridges for breech-loading guns
519 H. E. Clifton, S. Myers, and A. Hoffnung—Cap carriers for fire-arms
520 J. K. Donald—Permanent way and rolling stock of railways
521 W. Oram—Hydraulic pumps
422 J. Howard—Steam engines applicable to agricultural purposes
523 S. W. Worssam—Sawing wood
524 J. Shortridge—Chain cables, the links of which are without welds
525 C. J. Rowe—Bed tables
526 J. Huudy—Raising weights
527 W. Winter—Sewing machines
528 J. Nicholas—Converting coal oil into gas suitable for illuminating purposes
529 J. Badcock—Crinolines
530 G. Score—Communicating with the guard of a railway train
531 E. P. H. Gondouin—Cotton gins

Dated February 25th, 1865.

532 T. Routledge & T. Richardson—Utilisation of certain products obtained in the manufacture of paper
533 J. H. Rawlins & J. Ckappell—Paper
534 F. Claudet—Iron ores
535 J. Starley—Sewing machines
536 T. Dronsfield, T. E. Jones, and J. Ashton—Blocking woven fabrics
537 J. Askew—Portable vehicle for teaching children to walk
538 P. A. le Comte de Fontaine-Moreau—Treatment of madder
539 W. Calvert—Signalling on railways
540 E. H. Eldredge—Breech-loading rifle
541 R. Smyth—Organs and harmoniums

Dated February 27th, 1865.

542 C. Whiting—Frames and joints for tables
543 W. H. Tucker—Fire and thief-proof safes
544 A. H. Henson—Railway chairs, fastenings, and sleepers
545 F Duncart—Communication between passengers and guard of railway trains
546 G. K. Geyelin—Air-tight jars for preserving eggs and fruits
547 C. Ching—Fluid valve
548 M. B. Nairn—Floor cloths
549 W. Sim—Extracting gases from mineral oils
550 T. W. Roys & G. A. Lilliendahl—Rocket guns and rocket harpoons
551 R. Barclay—Sewing machines
552 R. A. Brooman—Combined key and weapon of defence
553 J. Blackie—Signalling apparatus
554 G. Haseltine—Mirrors
555 G. T. Ellwick—Baking biscuits

Dated February 28th, 1865.

556 S. S. Gray—Paper collars
557 M. Mason—Cutting paper
558 G. Lauder—Machinery for mining coal
559 J. M. Hart—Safes
560 A. Davy—Iron scales
561 W. Clark—Decorticating grain
562 W. B. Dalston—Atmospheric pressure lamp for burning volatile oils
563 D. Chalmers—Textile fabrics
564 J. Fordred—Treating hydro-carbon oils
565 G. Weigmann—Dies for cutting screws
566 J. Hartshorn & W. Redgate—Manufacture of lace
567 S. Whiting—Shop and other counters and surfaces
568 T. S. Hall—Gas burners

Dated March 1st, 1865.

569 J. B. Touissaint—Gaiters, spatter-dashes, and other similar articles
570 S. Whitfield—Locks and fastenings for doors and drawers
571 J. Young—Distilling bituminous substances
572 G. H. Barth—Refrigeration of liquids
573 W. Holiday—Presses for blocking the tyres of railway wheels
574 C. J. Falkman—Distillation
575 M. Bayliss—Pointing or drawing down railway spikes
576 N. Henwood—Reaping machinery
577 J. Dodd—Mules for spinning
578 W. E. Kochs—Supports for bridges, viaducts, roofs, and arches
579 A. T. Godfrey—Musical instruments in which reeds are employed

Dated March 2nd, 1865.

580 T. Horton—Treatment of certain products obtained in the smelting of iron
581 J. Park—Manufacture of paper
582 J. M. Hetherington—Joints of steam generators
583 S. Brooks—Looms
584 S. & E. Hopkinson—Smoke-consuming apparatus
585 S. Chatwood—Safes
586 J. Kirkland—Apparatus for counting passengers
587 D Hartley—Core for casting pipes
588 W. S. Thomson—Crinolines
589 P. Rothwell—Drags for vehicles
590 W. E. Newton—Impregnating wood with chemical solutions
591 C. Rahn—Concentrating light for surgical and dental operations
592 R. Johnson—Wire fences
593 J. M. Dunlop—Carding machines
594 W. Clark—Buttons
595 C. L. Roberts—Cigars

Dated March 3rd, 1865.

596 W. R. Bowditch—Carburetting gas
597 D. & J. Maxwell—Driving piles
598 Sir J. S. Lillie—Atmospheric pressure
599 R. A. Brooman—Refining sugar
600 S. Spencer—Apparatus for operating engineers' and carpenters' tools

Dated March 4th, 1865.

601 H. E. Clifton & A. Hoffnung—Sewing machines
602 L. Thomas—Side propellers for vessels
603 H. A. Bonneville—Drying apparatus
604 H. A. Bonnevil e—Rinsing and drying by centrifugal force
605 H. A. Bonneville—Washing machines
606 J. H. Johnson—Stopping bottles
607 J. H. Johnson—Steam generators
608 H. Taylor—Lace
609 D. Morris—Coupling and uncoupling railway carriages
610 L. le C. Cottam—Sliding partitions
611 R. A. Brooman—Obtaining motive power from ammoniacal gas
612 W. Clulow—Sheep shears
613 E. Humphreys—Marine steam boilers
614 J. Whitley—Steel railway wheel tyres
615 W. E. Newton—Packing tobacco
616 T. Turton—Shaping files
617 A. Akeroyd—Dyeing cotton, worsted, and silk warps
618 E. Pettit—Photographs called Binographs

Dated March 6th, 1865.

619 C. F. Varley—House protector
620 R. A. Brooman—Pumps
621 S. Phillips—Safes
622 S. & W. Smith—Machinery for combing wool and other fibrous substances
623 T. S. Sperry—Springs for clothing
624 F. Cruickshank—Coatings for ships
625 T. Craig & D. Carlow—Numbering machines
626 W. J. Oliver—Protecting the india rubber rings of buffer springs of railway carriages
627 A. Potts—Scutching flax
628 W Riddle—Binding bales
629 T. Nicholson—Caustic liquor
630 G. Nimmo—Crucibles
631 W. Clark—Hides

Dated March 7th, 1865.

632 W. Bunger—Ascertaining the quality and condition of seed
633 E. W. Young—Bridges
634 R. A. Brooman—Tubular boilers
635 J. H. Wilson—Apparatus for measuring the human body
636 L. Perkins—Apparatus for heating and cooling atmospheric air
637 A. E. A. A & G. E. M. Gerard—Shoes
638 W Clark—Cork cutting machinery
639 W. Clark—Shoes for horses
640 H. W. Wimshurst—Joints for hoxes
641 J. Dodge—Steam hammers

Dated March 8th, 1865.

642 F. Tolhausen—Breech-loading fire-arms
643 J Dean—Marine steam engines
644 J. & Wadsworth—Cutting metals
645 A. C. Henderson—Preserving meat
646 G. Ireland—Stoppers for bottles
647 F. Wise—Packing for piston rods
648 J. Shanks—Water closet apparatus
649 M. Morgans—Converting cast iuto wrought iron and steel
650 R. Howson—Smelting iron ores
651 W. Clark—Motive power engines
652 F. W. Turner—Machinery for grinding corn and other substances
653 A. E. Taylor—Safes
654 W. Clay—Iron forgings

Dated March 9th, 1865.

655 W. T. Hamilton—Facilitating the proper action of the hands of players upon keyed instruments
656 B. Collins—Cutting sheets of india rubber into strips
657 R. Mushet—Steel
658 E. Carchon—Closing spatter dashes
659 W. Clark—Revolving fire-arms
660 J. T. Harris—Iron doors
661 W. H. James—Carriage ways
662 R. G. Fisher—Covering roofs
663 W. J. Dorning—Bands or hoops used in packing bales
664 W. H. Hudson—Burglary alarum
665 W. D. Allen—Tyres
666 J. Cliff—Construction of hot air stoves for blast furnaces
667 E. Leahy—Strengthening and ornamenting soft metal tubes
668 G. F. Ansell—Ascertaining the presence of explosive gases
669 V. Delperdange—Connecting pipes used for conveying gas and water

Dated March 10th, 1865.

670 J. Freeman, E. G. Freeman & C. H. Freeman—Preparation of varnishes
671 E. A. Philips—Digging machine
672 W. Smith—Fastenings for window sashes and other purposes
673 E. Leigh—Cotton gins
674 J. L. Field—Machine for cutting or forming the tips of candles
675 G. Wright—Agricultural implement
676 T. Startin—Venetian blinds for carriages
677 T. Reissig—Ascertaining the presence of fixing agents in photographic productions
678 H. W. Cook—Electric telegraphs
679 A. Westhead—Communication between passengers and guard of a railway train
680 J. Samuel & S. Milbourn—Preparing flax
681 R. P. Roberts—Coating the bottoms of iron ships and other surfaces
682 J. Jones & R. D. Jones—Bending the ends of walking sticks

Dated March 11th, 1865.

683 P. Marvand—Apparatus for promptly disconnecting horses from carriages
684 C. Johnson—Combined tee-piece and valve
685 E B. Wilson & J. Howden—Steam boilers and furnaces
686 J. Hird & J. Walker—Machinery for scouring stones
687 J. Garelly—Machinery for cutting button holes
688 C. M. Keruot & N. Symons—Construction of railway plant
689 J. Henderson—Iron and steel
690 T. Whitehead & H. W. Whitehead—Machinery for hackling flax
691 J. Henderson—Freezing liquids
692 E. B. Wilson—Furnaces
693 J. M. Napier—Wine glasses
694 G. Carter—Toast racks
695 J. Tann—Fire and burglar-proof safes, chests, doors, and iron safes
696 C. Huntley—Tennis halls

Dated March 13th, 1865.

697 R. M. Roberts—Apparatus for treating metals and metallic ores
698 J. Bragg—Traps to prevent the uprising of noxious gases in sewers
699 J. Atkins—Metallic bedsteads
700 J. Wright—Furnaces
701 R. Marsden—Forging metals
702 H. Hill—Securing safes
703 J. Webb—Preparation of certain materials for the manufacture of paper
704 W. Clark—Regulating the position of lamp shades
705 F. Wise—Preparing certain colouring matters for dyeing
706 W. D. Napier—Dental operations
707 R. G. Attray—Supplying regulated quantities of fluids

Dated March 14th, 1865.

708 F. A. Braendlin—Breech-loading fire-arms and in cartridges for the same
709 J. Deas—Levers for railway switches and signals
710 G. Evans—Heels for boots
711 R. A. Brooman—Breech-loading fire-arms
712 R. A. Brooman—Photographic images
713 A. Bertsch—Protecting telegraphic instruments from injury
714 E. D. Hodgson—Safes
715 F. H. Warlich—Drying and sorting coal and mineral ores
716 J. Wilkie—Manufacture of lace in twist lace machines
717 G. T. Bousfield—Vaporising hydro-carbon liquids
718 L. Gantert—Dyeing, bleaching, and finishing yarns
719 A. V. Newton—Securing low and uniform temperatures
720 J. P. Booth—Trimming dresses
721 I. Baggs—Colour printing

Dated March 15th, 1865.

722 N. N. Solly—Water tuyers for blast furnaces
723 W. Clark—Electric piles
724 T. Kennedy—Chimneys
725 H. Owen—Stockings
726 H. Chevob—Keyless watches
727 W. E. Newton—Distilling oil and other liquids from coal
728 E. Loysel—Safes for protecting and securing valuable property
729 A. P. Price—Sulphurous acid
730 J. F. Bridges—Cooling charcoal
731 H. Smith—Gas engines
732 C. Morfit—Purifying oils
733 G. S. Bousfield—Despatch bags

Dated March 16th, 1865.

734 S. B. Boulton—Treating timber with preservative fluids
735 M. Meisel—Machinery for thrashing grain or seed
736 J. Ramsbottom—Shaping metals
737 J Farrar—Mining or working coal and other rocks
738 W. Loeder—Permanent way of railways
739 J. Seaman—Implements used in the cultivation of the land
740 R. Bell—Working railway signals
741 W. Brookes—Musical instruments
742 J. Marshall—Grinding grain and other agricultural products
743 A. V. Newton—Steam generators

Dated March 17th, 1865.

744 J. Standfield—Wheel gearing
745 H. A. Bonneville—Railway breaks
746 C. A. Wheeler—A combined pencil shield and india-rubber
747 H. Wethered—Hardening or tempering all descriptions of cutlery
748 B. Lawrence—Increasing the mechanical value of steam
749 G. Dibley & F. Braby—Posts or supports for telegraph wires
750 J. Bullough—Looms
751 J. Goodfellow—Pumping water, air, or gases
752 W. M. Williams—Preparing canvas
753 A. V. Newton—Bracket, pillar, and suspended lamps
754 W. Roberts—Valves

Dated March 18th, 1865.

755 J. Cookson & P. Billington—Blowing smiths and other fires
756 T. Ogden—Preparing cotton and other fibrous substances
757 J McConnell—Weighing machines
758 G. Ralston—Clothing
759 E. Pilling and J. Harper—Weft stop motions for looms
760 J. H. Wathew—Peeling almonds
761 J. Walls—Drawing off liquids from casks without the use of pumps
762 T. Kenyon—Preparing and mordanting cloths and yarns
763 F Wise—Attaching buttons
764 J. Vero—Brooms
765 J. C. Stevenson—Preparation of hyposulphite of lime
766 O. Robinson—Sewing machines
767 C. W. Spark, T. S. Cross, & W. Adkins—Bricks and tiles
768 J. H. Kidd & J. C. Mather—Manufacture of floor cloth

Dated March 20th, 1865.

769 S. S. Gray—Paper collars
770 T. Oliver and J. W. Musto—Mouthpieces for cigars
771 J. T. Rammingеr—Generating steam
772 J. T. Cook and J. T. Cook—Breech-loading fire arms
773 M. Eley—Scarf fastening
774 I. Philippsthal—Yarns for shawl and other textile fabrics
775 A. G. Browning—Socket for fencing and telegraph posts
776 A. V. Newton—Sewing machinery
777 R. T. Crawshay and I. A. Lewis—Puddled iron bars
778 S. Chatwood—Locks
779 W. Menelaus—Puddled balls or blooms of iron and steel
780 A. R. Mackenzie—Engines and carriages for common roads

Dated March 21st, 1865.

781 C. H. Pennycook—Gasometers, tanks, casks, and similar vessels
782 J. W. Midgley—Lubricating vertical spindles and shafts
783 W. V. Greene—Ordnance
784 D. Gourley—Boots and shoes
785 C. Farmer and T. Turner—Manufactures of pins and nails
786 J. H. Johnson—Manufacture of looking glasses and mirrors
787 W. Arthur—Registering the course steered by a vessel
788 R. A. Brooman—Preparation of hydrated oxide of chromium
789 W. Clark—Cutting pasteboard
790 R. J. Gatling—Battery gun
791 J. Smith and S. A. Chense—Raising water
792 W. Berry—Apparatus for cutting bread and bread and butter
793 R. J. Webber—Thrashing and rubbing barley and other grain

Dated March 22nd, 1865.

794 H. S. Jacobs—Dressing and rounding the inner surfaces of fellies
795 G. Farmer—Cutting through sheet metal by means of tools and dies
796 W. M. Williams—Distillation of coal
797 H. Potter—Treating the waste liquors obtained in bleaching certain vegetable substances
798 W. Lane—Propelling carriages and other vehicles by hand power
799 W. J. Coleman—Composition for clarifying fermented liquids
800 A. P. Troncbon—Fire-arms
801 W. Clarke—Manufacture of fabrics in lace machinery
802 V. Baker—Obtaining motive power
803 J. J. Carter—Jewellery esses and other similar cases
804 A. Paraf—Dyeing
805 J. Wright—Preparing China and other clays for potters' use
806 M. Morgans—Manufacture and refining of iron and steel
807 R. A. Brooman—Engraving on metal
808 G. E. Donisthorpe—Washing wool, hair, and other fibres
809 W. W. Baker—Gas burners

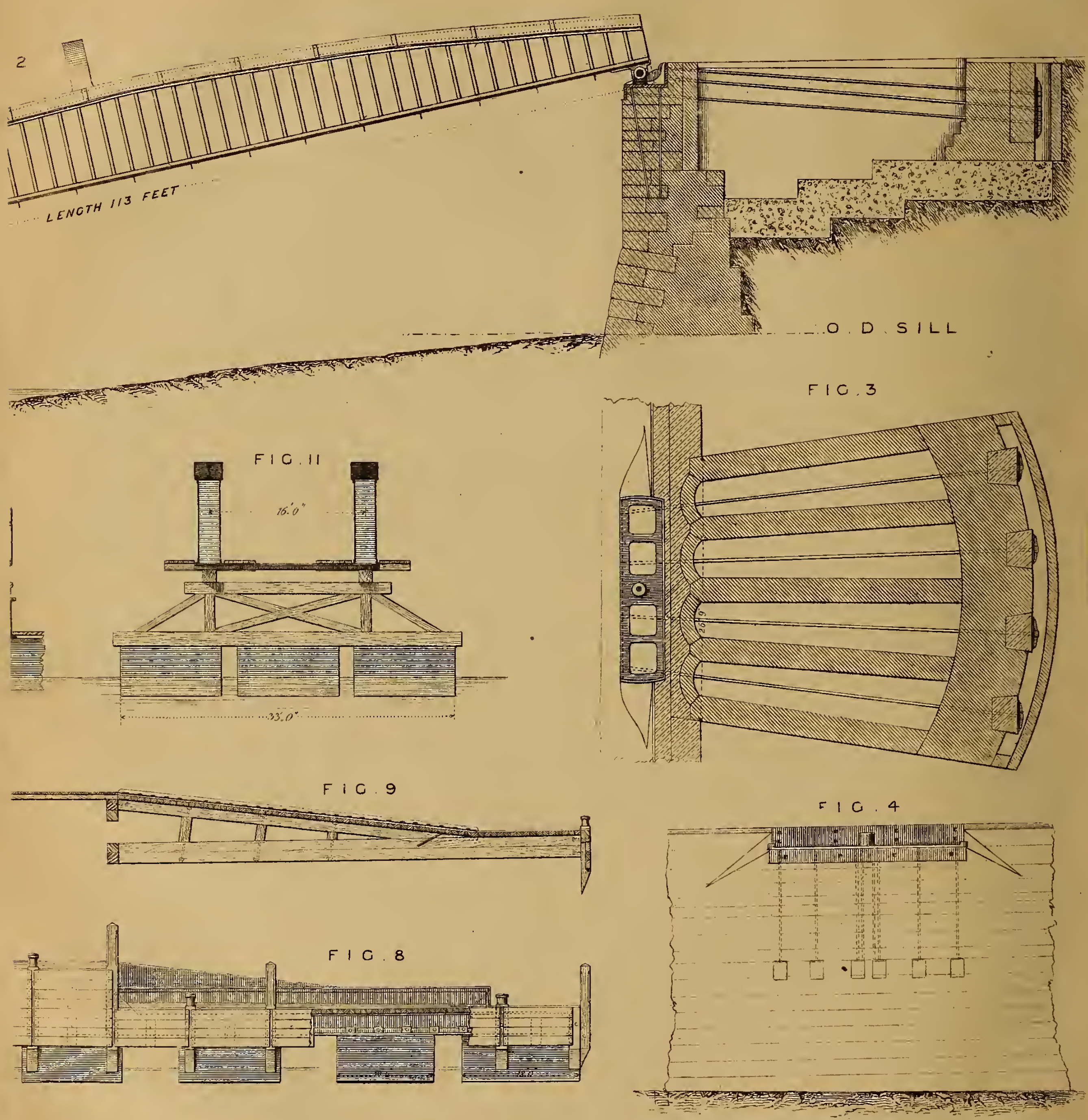
Dated March 23rd, 1865.

810 J. Macaulay and R. Watson—Weaving ornamental fabrics
811 J. Burley and L. Glover—Manufacture of toast racks
812 E. Field—Apparatus for feeding paper to printing machines
813 T. H. Saunders—Perforated tubular cornices for ventilation
814 C. H. Crewe—Stoppers for bottles, jars, and other vessels
815 D. Mackenzie—Selecting and reading in such records of designs as are transferred on cards
816 L. A. Leius—Securing the frame carrying the fittings in travelling bags
817 R. A. Brooman—Treating fats for the manufacture of candles
818 A. Bernhard—Imparting motion to all kinds of machinery
819 R. W. Morrell—Machinery for sewing and stitching
820 H. Cakes—Carding machinery
821 J. Lees and M. Mellor—Manufacture of cloth and other fabrics
822 J. Tall—Construct. on of walls, houses, and other buildings
823 T. Roberts—Twin scales for weighing grain and other ponderables
824 G. H. Castree and J. A. Castree—Looms for weaving
825 R. Tidmnn—Paying out and raising telegraph cables
826 J. C. Morgan—Stoves or fire-places, ash pans, and fenders
827 M. P. W. Boulton—Obtaining motive power from liquids

lower layer 6in. wide × 4½in. thick, placed longitudinally upon the stage, and fastened down upon the beams by means of coach screws, and of an

axis of the bridges. These were to have been carried, according to the original specification, by ⊤ irons, 6½in. × 6½in. × ¾in., placed 6ft. apart

LANDING STAGE, LIVERPOOL.



582 J. M. Hetherington—Joints of steam generators
583 S. Brooks—Looms
584 S. & E. Hopkinson—Smoke-consuming apparatus
585 S. Chatwood—Safes

673 E. Leigh—Cotton gins
674 J. L. Field—Machine for cutting or forming the tips of candles
675 G. Wright—Agricultural implement

DATED MARCH 18th, 1865.

755 J. Cookson & P. Billington—Blowing smiths and other fires

826 J. C. Morgan—Stoves or fire-places, ash pans, and fenders
827 M. P. W. Boulton—Obtaining motive power from liquids

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MAY 1st, 1865.

HISTORICAL AND DESCRIPTIVE SKETCH OF THE MERSEY DOCKS AND HARBOUR.

By J. J. Birckel.

(*Illustrated by Plate* 279.)

We proceed by laying before our readers such portions of the mechanical structures forming part of the dock estate as may be of general interest, and having been favoured with drawings of the Prince's landing stage by Messrs. Vernon, the eminent shipbuilders of Liverpool who, with the exception of the bridges, built this structure, we are enabled to illustrate the same in the accompanying plate. This stage, of which a general plan is shown in Fig 1, was erected in 1857-58 for the special use of coasting steamers, and lies to the northward of the St. George's stage described in our paper for February of this year; its axis is almost in a right line with that of the latter, so that the subject has lately been discussed in real earnest by the Dock Board of uniting the two stages into a single one.

Its length as it stands at present is 1,002ft. 2in., and its width 82ft. 2in. measured over all, and it is carried by 63 rectangular and flat-bottomed pontoons, 49 of which measure 80ft. in length, 10ft in width, and 5ft. in depth; other 12 which carry more immediately the four bridges are 96ft. long, and of the same width and depth as the former, and the two end ones are 12ft. wide.

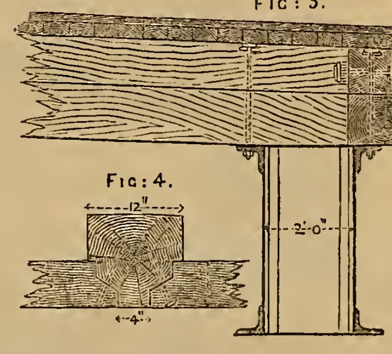
The pontoons are illustrated in Figs. 5 to 7, and are constructed of ¼in. plates, jump-jointed, and united by means of covering strips 3in. wide by ¼in. thick; the sides, top, and bottom, and the ends are joined by means of 3in. angle irons, ½in. thick, and lengthwise they are stiffened by means of bulkheads placed 10ft. apart, and made alternately of the entire depth and of part the depth only of the pontoon; the bulkheads as well as the ends are stiffened by means of ⊤ irons, and the seams are made throughout with ½in. rivets.

The pontoons are connected and kept in their respective places by means of five longitudinal wrought iron kelsons, to which they are bolted through stiff angle iron ears rivetted against their sides with one 1½in. bolt through each ear, and the depth of the kelsons is respectively 4ft., 4ft. 9in., and 5ft., giving the deck a camber of 12in. These kelsons are constructed in the shape of hollow box girders, and have their top and bottom flanges made of two thicknesses of ½in. plates 3ft. in width, which is made up of two plates respectively 1ft. 9in. and 1ft. 3in. wide, the upper and lower layer being so placed that the wide plate overlaps the narrow one by 6in., through the whole length of which overlap the plates are rivetted together; their transverse joints, moreover, are made good by means of ½in. covering plates placed alternately inside and outside the hollow of the girder. The sides are made of ¼in. plates jump-jointed and covered on the outside by a strip 4in. wide and $\frac{3}{16}$in. thick, and on the inside by a ⊤ iron 4in. × 3in. × ⅜in., rivetted together with ½in. rivets. The top and bottom flanges are united to the sides by means of strong angle irons 6in. × 6in. × ¾in. which are rivetted to the top and bottom plates with ¾in. rivets, and to the sides with ⅝in. rivets. A section through one of these kelsons is shown in the accompanying woodcut, Fig. 5.

The deck or flooring is carried on timber beams 2ft. deep and 12in. wide, running across the stage and placed at distances of 4ft. throughout the upper portion of the deck, where they rest upon the top flanges of the kelsons to which they are bolted; the deck planking consists of a lower layer 6in. wide × 4½in. thick, placed longitudinally upon the stage, and fastened down upon the beams by means of coach screws, and of an upper layer 6in. × 1½in., placed transversely upon the stage; portions of this upper layer of planking are made of hard wood, but the remainder of the timber used in this structure is generally of a soft kind. The deck is lowered 4ft. at each end of the stage over a length of 48ft. 7in. by reducing the kelsons to a depth of 2ft., and by laying the intermediate

Fig: 5.

Fig: 4.

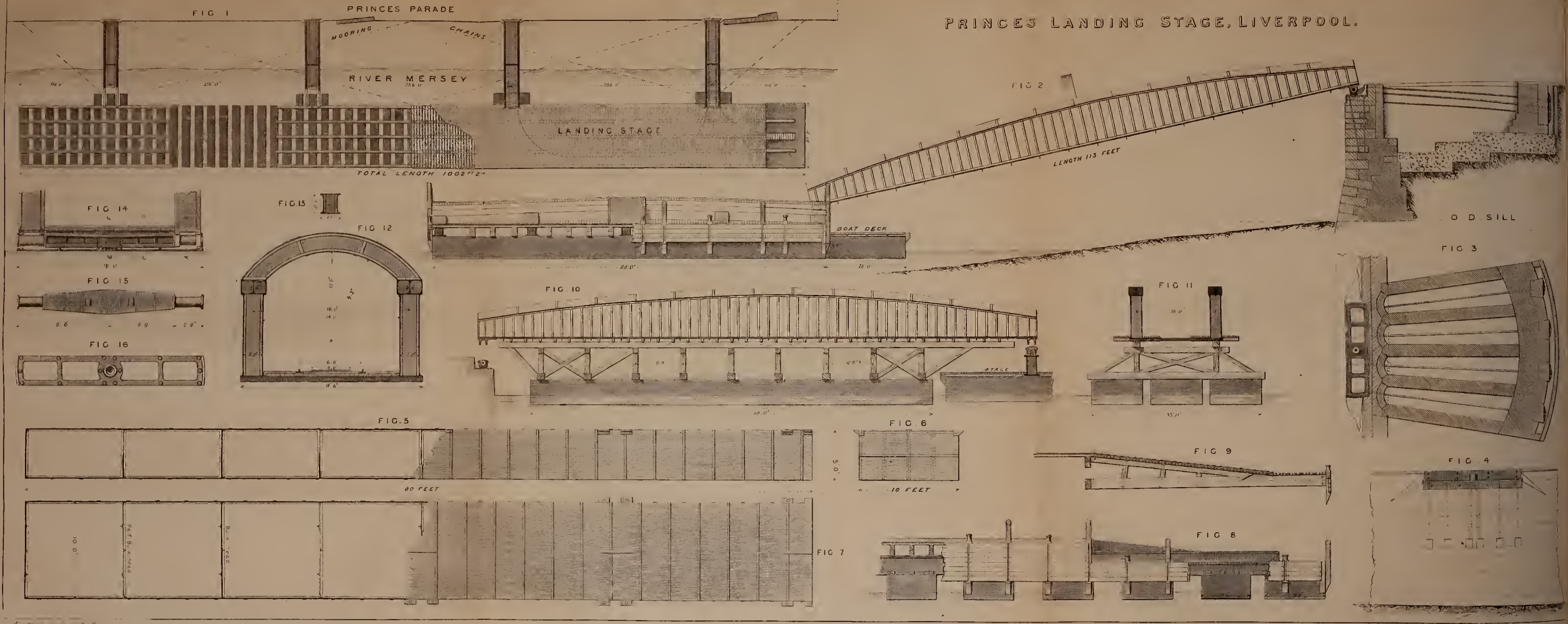


wooden deck beams, which in those portions run parallel to the kelsons, directly upon the pontoons. Access may be had to the lower decks by means of an incline placed in the centre of the stage, and by means of two small stairs placed on either side, and the intermediate space along the margin of the upper deck is guarded by strong wrought iron hand railing. This provision no doubt was made for the convenience of smaller craft. The entire front and ends of the stage are provided with a layer of 6in. apron planking reaching nearly to the water's edge, and was no doubt originally intended for a protection to the boats laying alongside the stage; but it would seem that it was afterwards discovered to be too weak, and a deep layer of rubbing beams 12in. thick has since been placed over this apron, suspended only from the guard posts by means of strong shackles and chains so as to admit of easy removal.

These guard posts are placed at distances of 16ft. and are made of timber 12in. square, standing 4ft. 6in. high above the deck, bolted to the deck beams by means of strong wrought iron knees, and also to the kelson on the outside. In the spaces between these are placed mooring posts, made also of 12in. timber, fixed to the deck beams by means of a strong wrought iron strap. These posts, however, have been covered with cast iron caps since the stage was built, which are themselves provided with a large base, through which they are bolted down upon the deck. An end elevation of the stage, together with a longitudinal elevation of the bridges as they stand at low water, is shown in Fig. 2, and a partial longitudinal elevation of the stage is shown in Fig. 8; a section through the incline leading down to the lower deck is shown in Fig. 9, and a detail of the mode of fastening the apron planking to the guard and mooring posts is shown in the accompanying woodcut, Fig. 4.

The bridges, a cross section of one of which is shown in Fig. 12, were constructed by Messrs. Fairbairn and Sons, and are made of two hollow girders of equal dimensions, 113ft. span, with a clear roadway of 11ft. between them. The flooring of the roadway consists of a lower layer of planking 6in. wide and 4in. thick, and of an upper layer 6in. wide by 2in. thick, the first being placed parallel and the other transversely to the axis of the bridges. These were to have been carried, according to the original specification, by ⊤ irons, 6½in. × 6½in. × ⅞in., placed 6ft. apart

PRINCES LANDING STAGE, LIVERPOOL.



as shown in Fig. 2, but it seems that these supports were afterwards deemed of inadequate strength and were altered to double T cross girders, 8in. deep, made of a central web of ¼in. plate, stiffened by two 3in. angle iron, ⅜in. thick at the top and at the bottom. Two strong cast iron curbs placed 6ft. apart, define the space allotted to carts and carriages.

Fig: 1.

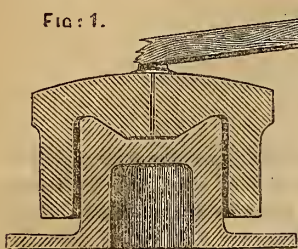


Fig: 2.

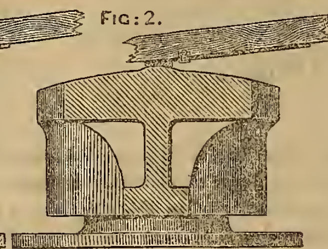
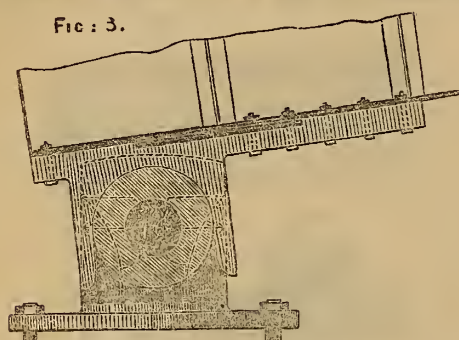


Fig: 3.



The girders are constructed on the cellular principle in the top or compression flanges, and are 10ft. deep in the centre, tapering down to 5ft. at the ends. The tension flanges are made of two plates ½in. thick in the centre, reduced to ⅜in. at the ends, and 2ft. 6in. wide; they are rivetted to the sides by means of two 3in. angle irons ½in. thick, with ⅞in. rivets. The joints of the plates are made by means of long covering plates, chains rivetted. The cellulæ of the top flanges are 18in. deep and their top and bottom plates are ⅜in. thick in the centre, reduced to $\frac{5}{16}$in. at the ends; their sides and mid feathers are made of plates of the same thickness, and they are rivetted together, as well as to the main webs of the girders, by means of 3in. angle irons, ⅜in. thick with ⅝in. rivets. The main webs are made of plates 2ft. wide and ¼in. thick in the centre increasing to ⅜in. at the ends. Their joints are covered outside by means of ¼in. strips, 4½in. wide, and inside by means of T irons, 4½in. × 3in. × ⅜in., and the whole of them are rivetted together with ⅝in. rivets.

The axles and swivels upon which the bridges swing with the ebb and flow of the tide are illustrated in Figs. 14 to 17, and in the accompanying woodcuts Figs. 1 to 3, and upon comparing them with those of the St. George's stage it will be observed that in principle they are identical with the latter, namely, they admit of a lateral deviation of the bridges under the influence of the velocity of the tidal current, as well as of vibration in a vertical plane. The original idea, however, is here clothed in a somewhat simpler habit—an invariable result in mechanical engineering of renewed thought upon the same subject. The land fastenings of the bridges, are shown in Figs. 2, 3, and 4, and differ from those of the St. George's stage, in so far that several radiating walls have been inserted between what may be termed the abutments of the arched wall to which the foundation plate of the swivel is fixed by means of a number of bolts. These radiating walls, however, can offer no other advantage than that due to the increase of weight to the masonry.

The stage is moored to the river wall by means of six chains of 2in. iron, whose fixings are generally similar to those of the St. George's stage.

Convenient sheds for the use of passengers', underwriters' and water-bailiffs' offices are erected upon the stage, which is also efficiently lighted with gas.

The following is a calculation of the weights, displacement, and carrying capabilities of the stage proper, and of the bridges:—

	Lbs.	Tons. cwt.	Tons. cwt.
Pontoons:—			
One pontoon 80ft. × 10ft. × 5ft.—			
Top and bottom ¼ plates 160ft. × 10ft. = ...	16000		
Sides ¼ plates 160ft. × 5ft. = ...	8000		
Bulkheads and ends ¼ plates 50ft. × 5ft. = ...	2500		
Half bulkheads ¼ plates 40ft. × 3ft. = ...	1200		
545ft. L iron 3in. × 3in. × ½in. at 10lb. per ft. =	5450		
111ft. T iron 4in. × 3in. × ½in. at 11½lbs. „ =	1277		
810ft. strips 3in. × ¼ at 2½lbs. per ft. = ...	2025		
15ft. bearing plate 6in. × ½in. at 10lbs. = ...	150		
23ft. L iron ears 6in. × 6in. × ⅝ at 30lbs. = ...	690		
	37292		
Add $\frac{1}{12}$ for rivet heads	3100		
Total	40392		
For 49 similar pontoons, say		883 16	
For 12 pontoons 96ft. long		259 4	
For 2 pontoons 12ft. wide		40 16	
Total for 63 pontoons			1183 16
Kelsons:—			
One 4ft. kelson as follows—			
Sides and ends ¼ plates { 1816ft. × 3ft. 10in. =	69610		
184ft. × 1ft. 10in. =	3380		
4ft. × 3ft. =	120		
Top and bottom ½in. plates 4000ft. × 3ft. = ...	240000		
Outside covering plates 248ft. × 3ft. = ...	14880		
Inside „ „ 248ft. × 2ft. = ...	9920		
4004ft. L irons 6in. × 6in. × ⅝ at 30lbs. = ...	120120		
3840ft. T irons 4in. × 3in. × ⅜ at 8¾lbs. = ...	33600		
2840ft. covering strips 4in. × $\frac{3}{16}$ at 2½lbs. = ...	7100		
	498730		
Add $\frac{1}{12}$ for rivet heads	41580		
Total for one kelson	540210		
For two 4ft. kelsons, say			482 8
For two 4ft. 9in. kelsons			499 10
For one 5ft. kelson			253 0
Bridges:—			
One girder as follows—			
Top flange — 115ft. × 2ft. 6in. × $\frac{5}{16}$ = ...	3595		
113ft. × 2ft. 6in. × ⅜ = ...	4255		
197ft. × 1ft. 6in. × $\frac{5}{16}$ = ...	3695		
145ft. 6in. × 1ft. 6in. × ⅜ = ...	3275		
1252ft. L irons 3in. × 3in. × ⅜ = ...	9400		
Covering strips = ...	450		
Sides — 711ft. 6in. × 2ft. × ¼ = ...	14230		
36ft. 4in. × 2ft. × $\frac{5}{16}$ = ...	910		
16ft. 4in. × 2ft. × ⅜ = ...	490		
15ft. × 1ft. 6in. × ⅜ = ...	340		
790ft. strips 4½in. × ¼ = ...	3160		
790ft. T irons 4½in. × 3in. × ⅜ = ...	7900		
Ends — 10ft. plates 2ft. 6in. × ¼ = ...	250		
33ft. L irons 2½ × 2½ × ⅜ = ...	210		
Bottom flange 94ft. × 2ft. 6in. × ⅜ = ...	3520		
48ft. × 2ft. 6in. × $\frac{7}{16}$ = ...	2100		
84ft. × 2ft. 6in. × ½ = ...	4200		
10ft. 8in. covering plates 2ft. 6in. × ⅜ =	405		
10ft. 8in. „ 2ft. 6in. × $\frac{7}{16}$ =	470		
24ft. „ 2ft. 6in. × ½ =	1215		
90ft. packing strips 3⅜ × ⅜ = ...	385		
37ft. „ 3⅜ × $\frac{7}{16}$ = ...	175		
77ft. „ 3⅜ × ½ = ...	430		
260ft. L iron 3in. × 3in. × ½ = ...	2600		
	67650		
Add $\frac{1}{12}$ for rivet heads	5640		
Total for one girder	73290		
For two girders, say		66	
333ft. T iron for flooring 6½ × 6½ × ⅜ = ...		5	
One arched stay of the two girders = ...		1 18	
Lower layer of planking 510 cubic feet at 40 lbs.		9 2	
Upper „ 265 „ „		5 6	
226ft. cast iron curb at 45lbs. per ft. = ...		4 11	
Spikes, screws, and bolts		1	
Total weight of one bridge say		93 tons.	
Carried over			2418 14

		Tons.	cwt.
Brought forward		2418	14
The maximum load upon the stage occurs at lowest tides, and may be computed by means of a diagram similar to the one given with the calculation of the *George's* stage at 50 tons 12 cwt. for one bridge, and for four bridges		202	8
DECK:—			
226 deck beams 80ft. × 2ft. × 1 =	36160		
160 mooring and guard posts =	1885		
Deck beams & cross beams of lower decks =	3395		
Apron planking =	5950		
Rubbing beams =	5000		
Deck planking =	41100		
	93490c. ft. at 40lb.	1670	
4 boat decks		32	8
Spikes, bolts, and screws		40	
Cast iron caps to mooring posts		13	
Iron straps and knees for guard and mooring posts		15	
Mooring chains and fixings		26	
Guard chains, railings, chains for suspending rubbing beams		4	10
Saddles, axles, and pivots of bridges		28	
Approximate weight of sheds		70	
Lamp posts, landing bridges, and sundries		10	
Total load		4530	0

The total displacement in cubic feet, therefore, will be,

$$35\text{ft.} \times 4{,}530 = 158{,}550 \text{ cubic feet.}$$

The total horizontal area of the pontoons is

$$49 \times 80 \times 10 + 12 \times 96 \times 10 + 2 \times 80 \times 12 = 52{,}640 \text{ square feet;}$$

and as the pontoons are square, assuming the load to be equally distributed, the total depth of immersion due to the load of the structure will be

$$\frac{158{,}550}{52{,}640} = \text{say 3ft.}$$

The remaining available depth of immersion under external load is therefore 2ft., and the total displacement

$$52{,}640 \times 2 = 105{,}280 \text{ cubic feet,}$$

or,

$$\frac{105{,}280}{35} = 3{,}008 \text{ tons.}$$

The area of the stage may be taken at 80,000 square feet, to which must be added one-half the clear space of the bridges, amounting to 2,164 square feet, giving a total of 82,164 square feet; and the load per square foot required to submerge the pontoons entirely may now be ascertained to amount to

$$\frac{3{,}008 \times 20}{82{,}164} = 0{\cdot}73 \text{ cwt. per sq. foot.}$$

It may not be without interest here to ascertain whether the extra length of 16ft. of the three pontoons under each of the bridges furnishes the necessary area required to obtain a displacement corresponding to the weight which immediately rests upon them, with a depth of immersion corresponding to that calculated for all the pontoons under the hypothesis of a load equally distributed. To that effect it may be assumed that one half of that portion of the weight of the bridge carried by the stage is supported immediately by the prolonged portion of the pontoons, which

	Tons	Cwt.
Weight amounts to	25	6
Weight of the boat deck	8	2
Weight of that portion of the pontoons	10	13
Total	44	1

corresponding to a displacement of 1541·75 cubic feet; and as the area corresponding to that extra length of pontoons amounts to

$$3 \times 16 \times 10 = 480 \text{ square feet,}$$

the depth of immersion corresponding to this displacement amounts to

$$\frac{1{,}541{\cdot}75}{480} = 3{\cdot}2\text{ft.}$$

which is nearly identical with the depth of immersion calculated for the entire stage.

The aggregate areas of the bottom flanges of the two girders of each of the bridges in the centre amount to 72 square inches, namely,

2 plates each 2′ 6″ × ½	= 60	sq. inches.
2 L irons each 3″ × 3″ × ½	= 12	"
Total	72	"

and as the girders have a clear span of 113ft., with a depth of 10ft. in the centre, if the ultimate strength of iron be taken at 20 tons per square inch, the breaking weight at that point will be obtained from the general formula,

$$\frac{W\,L}{4} = 20 \,.\, a \,.\, d$$

whence,

$$W = \frac{80 \,.\, a \,.\, d}{L}$$

a, d, and L representing respectively the aggregate areas of the bottom flanges, the depth of the girder and the span; in the present instance therefore we shall find

$$W = \frac{80 \times 72 \times 120}{1{,}356} = 509 \text{ tons,}$$

or 1,018 tons of a load equally distributed. If the safe load be taken at ¼th the breaking load it follows that each bridge will carry safely 254½ tons, from which should be subtracted the weight of the bridge itself (93 tons) leaving 161½ tons for the external or useful load, which calculated for the unit of area amounts to

$$\frac{161{\cdot}5 \times 20}{1{,}082} = 2{\cdot}98 \text{ cwt,}$$

or nearly 3cwt. per square foot.

This calculation shows that the carrying capability of the bridges is considerably greater than that of the stage itself, or in other words that the factor of safety adopted in the calculation of the strength of the bridges is considerably larger than that which we have assumed above. In Figs 10 and 11 we have illustrated the scaffolding used for the erection of the bridges which, owing to the position of the stage, had to be built up in their respective places; in order to lower them on to their bearings when finished, it was necessary only to throw ballast into the pontoons upon which the scaffolding was erected.

The estimated cost of this stage was £130,000, and the actual cost £110,000.

(To be continued.)

ELASTICITY OF VAPOURS.*

By W. J. MACQUORN RANKINE, C.E., LL.D., F.R.SS.L. & E.

Mr. Alexander, quoted by Professor Potter in the *Philosophical Magazine* for February, was surely mistaken when he claimed as *new*, in 1848, the formula,

$$p = (a + b\,T)^6$$

for the pressures of saturated vapours. The general formula of which it is a particular case, $p = (a + b\,T)^n$, was first proposed by Dr. Thomas Young nearly sixty years ago. The same formula, with the index $n = 5$, was used by Arago and Dulong in 1829†, and with the index $n = 6$, by Tredgold about 1828‡.

The history of that and many other formulæ is given by M. Regnault in his "Relation des Expériences," &c., vol. i. pp. 582, *et seq.* He gives the preference, for purposes of interpolation, to the formula proposed by Biot in 1844,

$$\log. p = a + b\,\alpha^{\tau} + c\,\beta^{\tau},$$

the five constants a, b, c, α, β, being deduced from five experimental data for each fluid.

Young's formula, it is true, contains three constants only, a, b, and n; but, as M. Regnault has shown, it is deficient in exactness. It has, in particular, two faults—that for a certain temperature, $T = -\frac{a}{b}$ it makes the pressure of the fluid disappear and become negative below that temperature, which is exceedingly improbable; and that it makes the pressure of

* From the *Philosophical Magazine* for April, 1865.
† "Mémoires de l'Institut."
‡ "Treatise on the Steam Engine."

every vapour increase without limit as the temperature rises—a result contradicted by the experiments of M. Regnault, which (as he states in vol. ii. p. 647) point to the conclusion that "the elastic force of a vapour does not increase indefinitely with the temperature, but converges towards a limit which it cannot exceed."

The first of those faults, but not the second, exists in Roche's formula,

$$\log. p = a - \frac{b\,T}{1 + m\,T}.$$

So far as I am aware, no formula has yet appeared containing three constants only, which agrees so closely with experiment as that which I proposed in the *Edinburgh Philosophical Journal* for July, 1849, viz.,

$$\log. p = a - \frac{b}{t} - \frac{c}{t^2};$$

where t denotes the absolute temperature, measured from the absolute zero, 274° C. below melting ice, and a, b, and c are determined from three data for each fluid.* This formula, besides agreeing very closely with experiment at all temperatures, gives the following results:—That every substance can exist in the state of vapour at all temperatures above the absolute zero; and that the pressure of saturation of every vapour tends towards a limit as the temperature increases—the latter result being in accordance with the conclusion deduced by M. Regnault from his experiments.

It may be remarked that if vapours at saturation were perfectly gaseous, it can be proved from the laws of thermo-dynamics that their pressures of saturation would be given by the formula

$$\text{hyp. log.}\, p = a - \frac{b}{(c' - c)\,t} - \frac{c'' - c'}{c' - c} \cdot \text{hyp. log.}\, t;$$

where c is the specific heat of the gas at constant volume, c' its specific heat at constant pressure, c'' the specific heat of the liquid, b the total heat of gasefication of the fluid at the absolute zero, from which t is reckoned, and a a constant to be determined by experiments on the pressure corresponding to a given boiling-point. So fas as I know, this proposition has not before been published, but its demonstration will be obvious to anyone acquainted with the priuciples of thermo-dynamics. When the formula is applied to steam, it gives pressures agreeing very closely with actual pressures of steam from 0° to 160° C., but above the latter temperature the effect of the deviation of the vapour from the perfectly gaseous condition becomes considerable; so that at 220° C. the pressure given by the formula for a perfect gas is about one-fiftieth part less than the actual pressure.

Since the above was written I have seen the formula proposed by Mr. Edmonds in the *Philosophical Magazine* for March, 1865. In the notation of the present paper that formula is thus expressed:—

$$\log. p = b\left\{1 - \left(\frac{a}{t}\right)^n\right\}.$$

It obviously possesses the same general character with my formula of 1849, viz., it makes the pressure a function of the reciprocal of the absolute temperature, containing three constants, vanishing at the absolute zero, and converging towards a limit when the temperature increases indefinitely; and it is satisfactory to me to see that Mr. Edmonds, by an independent investigation, has arrived at a result which thus agrees in the main with mine.

ROYAL SOCIETY.

ON THE SIZE OF PINS FOR CONNECTING FLAT LINKS IN THE CHAINS OF SUSPENSION BRIDGES.

By Sir Charles Fox.

In the construction of chains of this kind, it is of the highest importance that the pins, which pass through and connect together the links of which the chains are composed, should be of the right size, inasmuch as their being too small, as compared with the links through which they pass, renders ineffective a portion of the iron contained in the latter, which then exists only as a useless load to be carried by such links; while, at the same time, if the pins and heads of the links be too large, they become uselessly cumbersome and expensive.

Careful examination and experiments made upon a large scale (which will be explained hereafter) have brought out facts by which a simple rule has been arrived at—a rule that may safely be adopted as a guide in deciding upon the relative sizes of these two parts.

* For values of those constants for various fluids see also the *Philosophical Magazine* for December, 1854, and "A Manual of Prime Movers," p. 237.

On this rule mainly depends the economical use of iron in the construction of such chains.

In this paper the term chains for suspension bridges implies such as are usually employed, and are composed of several flat bars of equal thickness throughout, placed side by side, but having their ends swelled edgeways, so as to form what are technically termed heads, and which are coupled together by pins passing through holes in such heads, as shown in Figs. 5 and 6 of the accompanying drawing.

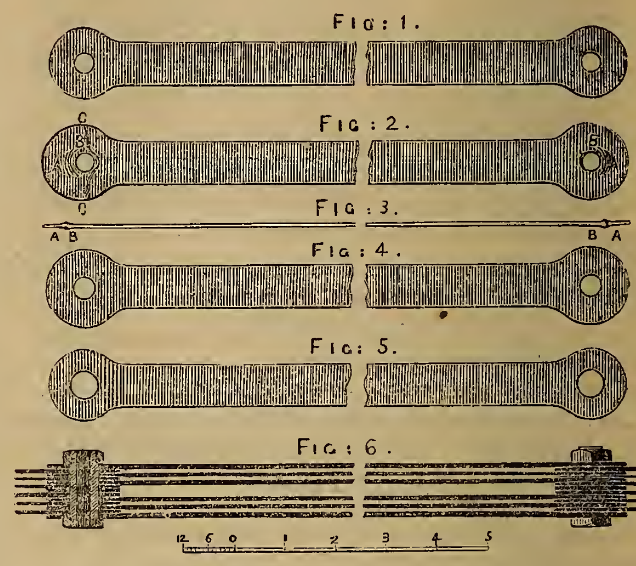


Fig. 1. Link for Kieff Bridge. Depth of head 16½in., of centre 10¼in., diameter of hole 4½in.
Fig. 2. Elevation showing result of proof.
Fig. 3. Section through centre, showing result of proof.
Fig. 4. Experimental link, with wider head. Depth of head 18¾in., diameter of hole 4½in.
Fig. 5. Link with properly proportioned hole for pin. Depth of head 17½in. diameter of hole 6½in.
Fig. 6. Plan of chain, and section of pin and links.

In deciding upon the size of the pins, it has often been assumed, as a close approximation, that, as about the same force is required for shearing as for breaking wrought iron by extension, it would be necessary to give the pin a cross section equal to the sectional area of the smallest portion of the link only. The fact of the possibility of links being torn and destroyed by the pin being too small to present the necessary bearing surface, although quite large enough to resist the calculated shearing force brought to bear upon it by the links, seems hitherto not to have attracted notice; but as the strength of a chain depends upon the proper extent of surface being offered by the pins of the links to pull against, such a mode as the one described has been proved by experiment to be altogether fallacious. For by this mode of estimating, the size of a pin passing through links 10in. wide and of uniform thickness (that is, not having the head thicker than the body of the link) would be something less than 3½in. in diameter, whereas (as will presently be shown) in order to get the whole benefit from such a link, the pin must be somewhat more in diameter than 6in., and for the following reasons:—

In wrought iron, the initial forces necessary to extend or diminish by compression the length of a bar are practically the same; and hence it arises that unless the surface of the pin on which the semicylindrical surface of the hole in the link bears is as great as the smallest cross section of the link itself, the head will be torn by the pin; and since to provide this necessary surface it is essential to have a pin of much larger size, the question of its ability to resist the operation of shearing never arises, and the whole subject resolves itself into one of bearing surface.

If the pin be too small, the first result on the application of a heavy pull on the chain will be to alter the position of the hole through which it passes, and also to change it from a circular into a pear-shaped form (*vide* Fig. 2), in which operation the portions (A A, Figs. 2 and 3) of the metal in the bearing upon the pin become thickened in the effort to increase its bearing surface to the extent required. But while this is going on, the metal around the other portions (B B, Figs. 2 and 3) of the hole will be thinned by being stretched, until at last, unable to bear the undue strains thus brought upon it, its thin edge begins to tear, and will, by the continuance of the same strain, undoubtedly go on to do so until the head of the link be broken (or, rather, torn) through, no matter how large the bead may be; for it has been proved by experiment that by increasing the size of the head, without adding to its thickness (which, from the additional room it would occupy in the width of the bridge, is quite inadmissible) no additional strength is obtained.

Acting upon the principle above described, most engineers have made the pins of their chains far too small, whereby much money has been wasted in making the links of a size, and consequently of a strength, of which it was, through the smallness of the pins, impossible to obtain the full benefit. Indeed, to such an extent has this been carried, that in one of the most noted suspension bridges hitherto constructed, a very large sum has been thrown away upon what is worse than wasted material, inasmuch as that material, remaining as load only, has to be carried by the chains, and correspondingly weakens the structure.

I am also acquainted with a very recently constructed suspension bridge in which some of the links, which are 10in. wide, have the holes in their heads but 2in., instead of 6½in., in which case more than two-thirds of the iron in the links is useless.

The first time my attention was seriously called to this important subject was when Mr. Vignoles entrusted my late firm of Fox, Henderson, and Co., with the manufacture of the chains of the great suspension bridge for carrying a military road over the Dnieper, at Kieff, which was constructed by him for the Russian Government.

As the chains for this bridge weighed upwards of 1,600 tons, upon which the expense of transport was very heavy, they having to be shipped to Odessa, and thence carted over very bad roads for upwards of 300 miles to Kieff, it was considered of the first importance to ascertain whether or not they were well proportioned; and accordingly a proving-machine was specially prepared, of power sufficient to pull into two any link intended to be used on this bridge.

These links, as shown in the drawing attached to the contract (see Fig. 1), were, for convenience of transit, but 12ft. long from centre to centre of pin-holes, 10¼in. wide by 1in. thick in their body or smallest part, with a head at each end also 1in. thick, swelled out to 16½in. in width, so as to allow of holes for receiving pins 4½in. in diameter. The cross sectional area of these pins was 15·9in., or rather more than 50 per cent. in excess of the cross sectional area of the link at its smallest part.

According to the usual mode of ascertaining the size of these pins, by making them of such dimensions as to resist the force required to shear them, they possessed upwards of a third more section than was thus shown to be necessary. Still, in practice, a pin of this size proved altogether disproportionate to the size of the links, and required to be increased from 4½in. to 6¼in. diameter before it was possible to break a link in its body or narrowest part—fracture in every previous case taking place at the hole, and through the widest part of the head, as shown in Fig. 2.

The iron in the links for this bridge was of a very high quality, and was manufactured by Messrs. Thorneycroft and Co., from a mixture of Indian and other approved pig iron, and required a tensile strain of about 27 tons per sectional inch to break it; so that taking the narrowest part at, say 10in., a strain of 270 tons ought (had the size of the pin been in proper proportion) to have been required to pull it into two; instead of which, so long as the pins were but 4½in. in diameter, the head tore across (as shown at Fig. 2) at its widest part with about 180 tons, or two-thirds only of the strain desired and provided for, as far as the size of the body of the links was concerned.

This unexpected result led to the belief that the size of the heads was insufficient; and accordingly a few experimental links were prepared with their beads 2in. wider than before (as shown in Fig. 4); but these nevertheless were found to require no additional force to tear asunder; hence it became obvious that fracture arose from some cause not yet ascertained.

As has already been stated, the rupture took place across the widest part of the bead (C C, Fig. 2); but on attempting to adjust the piece broken off to the position it originally occupied in the link, it was observed that, while the fractured surfaces came in contact at the outside of the head, they were a considerable distance apart at the edge of the pin-hole (see Fig. 2).

This at once proved that during the application of the tension, which at last ended in producing fracture, the various portions of the head had been subject to very unequal strains; and upon careful examination, the rationale of this fracture became apparent from the consideration that the hole, which orginally was round, had become pear-shaped (see Fig. 2), having altered its position, and that the iron of the link which, during the application of the load, bore upon the pin, and was consequently in a state of compression, had become considerably thickened in consequence, as was now evident, of an effort to obtain a greater bearing surface (see A, Figs. 2 and 3), while the other portion of the iron around the pin-hole, being subject to tension, had been so weakened and thinned by being stretched, as to cause a tearing action to take place, which, having once commenced, would obviously, by the continuance of the same strain, rend through the entire head, no matter what its width might be.

From this it was clear that any increase of size in the head (unless by thickening, which, as I have before stated, is inadmissible) was of no avail; and it was now that the principle which forms the subject of this paper became manifest—viz., that there was a certain area of the semi-cylindrical surface of the hole having a bearing on the pin proportionate to the transverse section of the body or narrowest part of a link, and quite essential to its having equal strength in all its parts; and that any departure from this proportion could not fail to bring about either waste of iron in the body of the links, if the pin were of insufficient size to offer proper bearing surface, or waste of metal in the heads of the links and in the pins, if the latter were larger than necessary for obtaining this fixed proportion of areas.

Having arrived at this point, a link, similar in all respects to the previous one, with holes 4½in. in diameter, and which broke across the bead with 180 tons, was taken, and its holes enlarged to 6in., but without increasing the width of the head, which still remained 16½in.; so that the only difference was the removal of an annular piece ¾in. in width from the hole, and so making it 6in. instead of 4½in. in diameter, thereby actually diminishing the quantity of iron in the head to this extent—when it was most interesting to discover that by this slight alteration, by which the semicylindrical surface bearing on the pin had been increased from 7·0 to 9·4 sectional inches, the power of the link to resist tension had increased in about the like proportion, having rendered a force of nearly 240 tons necessary to produce fracture.

From subsequent experience, it has become evident that had the pins of these chains been increased to 6½in. diameters, giving a bearing surface of 10·2 sq. in., the proper proportion between them and the body of the links would have been very nearly arrived at, while with those of only 6in. diameter about an inch of the body of the links was wasted.

The practical result arrived at by the many experiments made on this very interesting subject is simply that, with a view to obtaining the full efficiency of a link, the area of its semicylindrical surface bearing on the pin must be a little more than equal to the smallest transverse sectional area of its body; and as this cannot, for the reasons stated, be obtained by increased thickness of the head, it can only be secured by giving a sufficient diameter to the pins.

That as the rule for arriving at the proper size of pin proportionate to the body of a link may be as simple and easy to remember as possible, and bearing in mind that from circumstances connected with its manufacture the iron in the head of a link is perhaps never quite so well able to bear strain as that in the body, I think it desirable to have the size of the hole a little in excess, and accordingly for a 10in. link I would make the pin 6⅝in. in diameter instead of 6½in., that dimension being exactly two-thirds of the width of the body, which proportion may be taken to apply to every case.

As the strain upon the iron in the heads of a link is less direct than in its body, I think it right to have the sum of the widths of the iron on the two sides of the hole 10 per cent. greater than that of the hody itself (see Fig. 5).

As the pins, if solid, would be of a much larger section than is necessary to resist the effect of shearing, there would accrue some convenience, and a considerable saving in weight would he effected, by having them made hollow and of steel.

In conclusion, I would remark that my object in writing this paper has been, first, to call attention to the fact that a link is far more likely to be torn by the pin being too small, than a pin to he sheared hy a link; and secondly, to try to estahlish a simple rule by which their proper comparative sizes may always be arrived at; and I have been induced to investigate this very important subject from having generally found in existing suspension hridge chains a wide departure from what is right in this respect, in having the pins far too small.

SOCIETY OF ARTS.

ON MARINE ENGINES FROM 1851 TO THE PRESENT TIME.

By Mr. N. P. Burgh, Engineer.

The history of the origin of the marine engine, and its slow advauce, has heen so often written, that I feel assured I shall not cause much disappointment if I pass over that already worn-out subject. I propose, therefore, to introduce to your notice the marine engine as it was in 1851, and the improvements which have taken place from that period to the present time. As the present paper alludes to the year 1851, it will not be deemed out of place to describe briefly the marine engines shown in the Exhibition of that date. The screw propeller was then making but slow progress, consequently the attention of our engineers was diverted from straining their talents to produce more perfect arraugements. The following examples of marine engines were exhibited:—

For the paddle-wheel, the engines were arranged as follows:—Vertical, angular or inclined, direct-acting, and oscillating; for the screw-propeller, a more varied and numerous collection was given, comprising disc, rotary; for the horizontal direct-acting types, were the following—double piston-rod, return connecting-road, trunk; after which, annular cyliuder, vertical direct-acting, inclined direct-acting, single piston rod; and, lastly, a beam engine. The largest pair of engines were 700 horse-power collectively, horizontal, direct-acting, single piston-rod. The trunk engines were 60 horse-power collectively; these two examples were adapted for the the screw. For paddle-wheels, the engines of the greatest power were a pair of 140 horse-power, of Belgian repute, the framing and paddle-centres heing of wrought-iron, thus ensuring sufficient strength with a reduction of material and weight. To describe each engine in detail would be tedious, as well as of little value to the engineer of the present day. Allusion to the defects and improvements will be found under the different descriptions of the necessary appendages.

I will now proceed with a brief notice of the marine engines exhibited in the year 1862, when it will be seen that a great improvement has taken place between the two dates alluded to. We are, I am happy to state, still making an advance, and I trust to be ahle this evening to describe these improvements; but, at the same time, I heg to suggest that there is plenty of room for further improvement in the detail of marine engines, which, doubtless, will be ere long taken into consideration by those interested in these matters.

In the year 1862, our International Exhibition was again held, and with much success as far as regards marine engines. The class exhibited showed great improvement, both in design and arrangement. The oscillating engines adapted for the paddle-wheel did not exhibit much alteration, although it cannot but be said that in detail a change for the better was perceptible. With reference to the engine adopted for the screw, a complete revolution had taken place since the Exhibition of 1851. Valves and gear were altered, starting gear simplified; positious of condensers, air pumps, and valves, in a much more correct state; numher of details lessened; and, in fact, the entire arrangement fast approaching to a nearer state of perfection, viz., accessibility to all the parts in action without disarrangement. The following is a brief account of the writer's observation of the class of marine engines exhibited:—The paddle engines were vertical and iuclined, oscillating, of the ordinary type and arrangement. The valve gear was of two kinds—the counter-balanced eccentric, and the ordinary link motion. The air pumps were worked by eccentrics in some instauces, and in others by cranks. The mode of starting was hy the ordinary ratchet or wheel and pinion—the hilge and feed pumps were, in some cases, worked by the oscillation of the cylinder, and in others by separate eccentrics. The means for disconnecting were of the disc and the drag-link kinds. Paddle-wheels were exhibited with fixed and feathering floats. Five examples of oscillating engines were exhibited, including models and drawings. The engines for the screw propeller was as follows:—One pair of douhle trunk engines, having injection condensers with an improved arrangement of air-pumps and valves. The double piston-rod return connecting-rod type was well represented; this arrangement is used on account of the great length of stroke and connecting-rod attainable in a given space. In the Exhibition now alluded to there were six pairs of engines of this class, with iujection condensers and air-pumps of the ordinary kind. The single trunk arrangement was represented by one pair, with single-acting trunk air-pumps in the condensers. The air-pump truuk with double piston-rods return connecting-rod engine was shown hy drawings only. Vertical direct-acting engiues were represented thus—one pair with annular cyliuders, double piston-rods, and injection condensers of the ordinary kind; one pair with single piston-rods and surface condensers; and another pair as the last, with ordinary condeusers.

It will be understood that in the previous examples the cylinders were arranged in pairs, the cranks being at right angles. In order to obviate the strains imposed at the extremity of each stroke, one firm exhibited engines with three cylinders, with spur gearing for reversing, stopping, &c., which were termed the expansive and economical principle. Lastly, I allude to the writer's invention, "Burgh and Cowan's patent antifriction trunk engine," or arrauged, that the friction of the trunks is dispensed with, and no area lost in the cylinder. This arraugement was represented by a pair of engines and drawings. Having thns briefly alluded to the marine engines exhibited in the two International Exhibitions of 1851 and 1862, I will now proceed to give a detailed description of each portion.

The arrangement of marine engines in the hold of the ship is, perhaps, not generally thought to be of so much importance as it really is. It should be strictly uuderstood that the attention required for engiues of river steamers bears no comparison with that required for marine engines; imagine a ship in a gale, and heated bearings, and a faint idea can he formed of the duties required, and the reason for a free access to all the working parts.

For the purpose of illustratiou to those present, not professional engineers, I will briefly specify what the necessary component parts of a pair of mariue engines of the present day consist of, viz., cylinders, pistons, slide valves, piston-rods, slide casings, expansion valves, blow-through valves, piston-rod guides, connecting-rods, cross-heads, main frames, crank-shaft, eccentrics, rods, liuks, valve rods, guides, condensers, air-pumps and valves, injection valves, sniftiug valves, discharge valves, bilge and feed-pumps, valves for the same, starting gear, and turning gear, lubricators, and all the necessary levers, bolts, nuts, &c. It will thus he seen that marine engineers have more difficulties to coutend with than is generally known. To understand the use and real character of each of the above details is not the work of weeks or months, hut years. It should not be forgotten, either, that the honour of our nation, and the lives of its representatives, are often in the hands of the marine engineer. I will now proceed with the descriptive illustration of details, showiug defects, improvemeuts, and suggestions for the future, commencing with slide valves.

These valves govern the entrée and exhaust of the steam to and from the cylinders. Two kinds or classes of valves are now universally used, the common and the equilibrium; the former is so well known that a description of it is scarcely necessary. I will only observe that its use for larger engines is much on the decrease, on account of the stroke of the valve being due to its outside lap, which for large ports is considerahle. Equilibrium valves are so called from the equal action of the steam teuding to lift the valve from, as well as to press it on its stroke. One firm has lately iutroduced three-ported valves, to still further reduce the stroke. In order to reduce the friction of the valves on the facings, rings are used encircling the hody of the valve, adjustment beiug gained by screws, ratchets, and spriugs to prevent looseness. In some cases a communication from the back of the valve to the condeuser is arrauged, to still further reduce the pressure on the valve facing. Slide rods are usually one to each valve, but latterly two have been introduced for larger valves, which no doubt greatly assist in guiding the valve during its action.

The next portion in rotatiou will be that for workiug, reversing, and stopping the action of the slide valve, universally known as the "valve-link motion." The date of the origin of this motion is doubtful. Mr. Zerah Colburn, in his new work on locomotive engineering, tells us, however, that 1832 is the earliest period of its application for locomotives. Marine engineers introduced it firstly for oscillating paddle-wheel engines; afterwards for fixed, horizontal, and vertical engines adapted for the screw propeller. The object of the link motion is to reverse the action of the slide valve without disconuection. The links now in use are of two kinds—slotted and solid. The slotted link has the sliding block within it, whereas that of the solid kind slides within the block. The means adopted for raising and lowering the link are various. One maker prefers to use a lever, secured on a weigh-shaft, passing over the front part of the cylinders, motion being given by a worm and wheel, the former being keyed on or forming part of the starting wheel shaft. Another firm deems it better to impart motion to the lever by a ratchet and pinions. A third authority raises and lowers the link hy a rod connected to a block surrounding a coarsely-pitched screw, motion being given to the screw by mitre gearing; whilst another firm prefers to fix the block, with the screw to he elevated and lowered. These two last are undoubtedly the most powerful of the examples giveu.

The systems at present adopted for guidiug the slide valve rod are of three kinds. First, the dove-tailed guide, similar to that used hy tool makers for the arm of a shaping machiue. Secondly, a block of gun metal slidiug on two fixed turned rods as guides over and under the valve rod. Thirdly, the valve rod secured to a square bar, working in a hracket, and cap to correspond. This last may be said to be the most simple, but perhaps not so rigid as the first example. The double guides are complicated, hut at the same time produce the rigid resistance to the strains imposed on the valve rod by the vibratiou of the link.

Some makers of mariue engines prefer to allow the link to rest or haug on the block piu inserted in the lever of the slide rod weigh shaft. Such a practice dispenses with guides. Excessive vibration of the liuk on or in its block greatly deteriorates the action of the valve, it being understood that whilst the link has au ascending or desceuding motion, as well as sliding, the strain on the valve rod is increased, and at the same time the stroke is effected. The excess of the vibratory motion is painfully perceptible in the ordinary slotted link; the eccentric rods being connected beyond the block piu, a direct action cannot ensue. The distance between the centres of the eccentric rods and block regulates the amount of indirect actiou. Links of this kind are often hung from a rod connected in the centre to the link, either to the clip or at the back. This is far better than at the lower end, as the connection of the suspension rod regulate the ascending and descending motion of the link whilst at work. The link resting on the block when for going a-head, obviates, to a certain extent, some of the evils alluded to. The gain by the introduction of the solid link, with the eccentric rods connected at its extremities, is strength with less material, but the vibrating motion is not decreased. In order to obtain a more direct, and, if possible, a perfect action, the eccentric rods have been secured to the link, so that the centre of connection may be on that of the block, and by this the vibratory motion is effectually got rid of. There have been two distinct modes for accomplishing this, which I have had the opportunity of observing. The first example is this—two solid links, one on each side of the block, the eccentric rods being connected to pins on the outer face of each link, the inner face and sides being sustained in a groove in the block, which oscillates on its axis, in the eye of the valve rod, the links being one on each side. The second example is like the first in principle, but one solid link only is used, of a dove-tailed form in section, at the inner face, to prevent the link from slipping out of the groove in the block; the eccentric pins are fixed in the extremities of the link, and the rods are attached as in the last example, but with a single eye. The writer has designed a solid link and connection, which, although not superior in principle of action to the two last examples, is more simple in construction, and has less working portions; therefore it may be held to be worthy of introduction. A solid bar of iron is slotted at each end, to receive the single eye of each eccentric rod, so that the entire surface of the link remains unbroken; it is secured in a block with an adjusting portion and key at the back, the front being open sufficiently to admit of the ascent and descent of the eccentric rods; adjustment in front can be attained by loose portions and set screws, but this last is not imperative, as the wear of the link and block is very slight when the acting eccentric rod is on the centre of the block; the block has provisions on each side for suspension, the valve rod having portions formed to receive the block; the back part of the rod works in a dove-tailed guide of the ordinary kind.

It now becomes necessary to treat of the suspension or lifting rods for solid links; for this a few words will suffice. As the ascent and descent of the link whilst in motion are governed by the length and position of the rod, it is almost needless to state that the suspension rod should be connected in the centre of the connection of the eccentric rod. The link, when for going a-head, should be down. It may now be argued that the vibration of the link, when for going astern, must be excessive. Granted; but as the forward motion of the ship is of the most importance, it is not unfavourable to economy to adopt the connection alluded to. In some cases the solid link is guided at the top or bottom, but this is only required when an overhanging or outside connection of the eccentric rods is resorted to.

The next portion for consideration is the expansion valve and gear; the use of this valve is to allow the steam to be cut off at the early or given part of the stroke of the piston, and the expansion or elasticity of the steam completes the power required. Now it is certain that the use of high pressure steam for large cylinders and short strokes, produces excessive shocks at the commencement of the strokes, and thereby entails an increase of strength in the materials used, so that the proportions are larger than when for ordinary purposes. It is clear also that, when steam is admitted at an excessive pressure against the piston suddenly, it (the piston) receives an impetus equivalent to the power imposed, and in no case whatever could an engine of proportions for low pressure resist the strains imposed by the use of high pressure steam. The ordinary pressure adopted by marine engineers is from 20 to 30lbs. per square inch, more often the former than the latter. I am not aware, however, of any cause why 60 to 80lbs. should not be adopted, with a great increase of economy and power. Of course the present proportions of engines and boilers would have to be increased, if the same meterials were used, but steel boilers, shafts, and rods might be introduced with considerable advantage, embracing great strength with less weight.

Having alluded to the ordinary pressures at present used, it will be well now to advert to the expansion valves. These valves are of three kinds—throttle, slide, and tubular.

The motions imparted to the throttle valve are oscillating and revolving; the latter is now most generally adopted, but with this disadvantage, that the action is equal both for supply and cutting off.

The slide valves are of the ordinary and gridiron type; the latter may be said to be the better, on account of the stroke being so short in comparison to that of the former.

Tubular valves are tubes inserted in each other, with ports to correspond, a sliding or rotary motion accomplishing the desired effect. The motions imparted to these several valves are generally uniform, either by mitre gearing or eccentrics, consequently the action of the valves is not perfect. The proper motion for an expansion valve is to open gradually and close suddenly; to obtain this the old but correctly working cam must be resorted to; this useful arrangement is too often discarded to make place for newer but less correct productions. It may of course be urged that the cam is not applicable for high velocities, but undoubtedly its use might be attained by introducing stiff gear and perfect equilibrium double beat valves; by dividing this valve centrally a more correct action can be attained, in relation to that of the steam, on the valve whilst closed and open. The merits and demerits of the expansion valves here alluded to are almost equal. The ordinary throttle valve has less friction than any yet introduced, but it possesses the great evil of throttling the steam when closing; also when this valve is worked by levers, or has a vibratory motion, should the stroke be lessened, the full area cannot be attained. The last evil is dispensed with in the remaining example, as the ports or openings are much larger than required when the valve is at full stroke, and not too small when the least motion is given. The friction of the gridiron iron valve is perhaps in excess of the other examples, as in the case of the tubular valves the action of the steam is neutralised. The means adopted for altering the grades of expansion valves whilst in motion are various. A spiral motion is the one universally adopted, and there is not the least doubt it is correct.

I will now call attention to the following description of an expansive valve and gear which I have designed for high velocities:—A cylindrical casing has within it projections at given positions; two of these projections act as spaces between the ports of ordinary tubular valves. The valve now explained is tubular, but the area centrally is half of that of the ends, which are parallel for given lengths, due to the stroke of the valve. These parallel lengths also regulate the neutrality of the valve whilst in action. At the present moment the means adopted to impart the motion is a disc of metal with a circular slot; within this slot is a brass nut into which is screwed a pin. The connecting rod of the valve is attached to the pin in the ordinary manner. The means for altering the grades of expansion is by loosening the pin by its handle, and allowing the nut to slide in the slot to the required position. It is almost needless to add that the steam enters at the side of the casing, and escapes around and through the valve, keeping it in equilibrium.

The valves next in requisition are those for the ends of the cylinder, commonly known as relief valves. The usual kinds adopted are discs, with springs or weights to resist the given pressure of the steam. The action of these valves is, of course, due to the excess of pressure within the cylinder over that of the resistance caused by the springs or weights. It has been proved that in the case of excessive priming of the boilers the cylinders are suddenly flooded; in order to release the water, cocks are sometimes used, but in many instances the springs or weights are lifted by levers. Now, in the case of cocks, if not provided with valves beyond them they must be worked by hand at each return stroke of the engine, or the vacuum will be destroyed. The spring valves will close naturally, or by the spring on its release from the hand lever. High-pressure steam has been lately introduced, with great advantage, in the place of springs, but with an entirely differently-arranged valve and casing.

I have arranged a relief valve, so that the spring is not tampered with by levers or hand power, and an instantaneous opening can be effected without cocks, &c. The spring valve has an opening in it centrally to receive on its outer side a flat disc, termed the vacuum valve. On the inner side is a provision mitred to receive a solid disc valve, which, on being pressed inwards by a spindle and lever, allows a free exit for the steam and water; on a vacuum being caused the vacuum valve, which is guided on the spindle alluded to, closes the opening air-tight; by this it will be understood that the spring has not been in requisition, but on closing the inner disc the spring valve becomes one of the ordinary kind. Previously to starting the engines it is well known a vacuum should be caused in the condensers, also the cylinders and slide casings should be warmed, and the condensed water be allowed to escape through the relief valves and cocks.

The valves used for the purpose alluded to are termed the "blow-through valves." It may be here observed that, in some cases, the ordinary plug cock is preferred for this purpose. When valves are introduced, they are generally of the ordinary disc kind, but one firm adopts a common slide valve for the purpose, with the advantage of simplicity of levers, &c., and easy manipulation.

The piston-rods of marine engines are subject to excessive strain; consequently, the use of guides is imperative. For the single piston-rod engine, the universal system is a channel underneath the rod, the guide-block being generally of gun metal, and the upper portion attached to the piston-rod by bolts and nuts. For double piston-rod engines, the guides are of two kinds: the first arrangement is as the last, and the second, as for high-pressure engines, or double guides. To say which is the preferable mode of arrangement of guides will, perhaps, be deemed bold, but I may venture to state that I deem that for the single piston-rod the best of any yet introduced.

I cannot close this portion of the present paper without alluding to the admirable arrangement for tightening the gland of the piston-rod stuffing-boxes, introduced by the firm of Messrs. Maudslay, Sons, and Field. The screws are of the ordinary kind, but, in the place of nuts, worm wheels are used, worms being fitted to correspond; and motion can be given by a box-spanner while the engines are at work. This is one of the most important improvements tending to accelerate the progress of a ship during a voyage, say three or four months. Imagine the engines requiring stoppage during a gale in order to tighten the glands, and a fair estimation can be formed of the value of the improvement alluded to.

Having commented, though somewhat briefly, on the cylinder appendages, attention may now be given to the main frames and crank-shaft. The main frames may be said to undergo a continuous strain, and must, consequently, be of a certain strength in order to preserve the requisite rigidity. The cylinder is attached to the one end, and the condenser at the other, whilst the crank-shaft has to be supported in its bearings. Not many years ago a celebrated firm used to make the condenser and main frame in one casting; since that, we have had the well-known frame like the letter A on its side, also the hollow frame, with a raised projection for the crank-shaft, and a stay from the upper portion connected to the cylinder; this last may be said to be the most simple, and, at the same time, of less material than the A frame. As before stated, the strains on the frames are continuous, yet, when sudden shocks occur, from the racing of the engines or priming of the boilers, the tenacity of the cast iron is severely tested. As this is the case, wrought iron might be used with great advantage, both as to increase of strength and decrease of weight. The crank-shafts of marine engines are generally of wrought iron, in one mass, the cranks being double, and forged with the shafts. Three bearings are deemed imperative, so as to equally distribute the strains. Now, this is correct in theory and practice, and the writer will be deemed committing a grave error, no doubt, in mathematics, when he assumes that the forward frame and half-crank can be dispensed with, in order to reduce the weight and material. He is, of course, aware that the thrust and pull of the connecting-rod will be thrown on the centre crank and bearing, but, in order to counteract this, the length and diameter of the shaft at that part should be increased. He would also prefer, in this case, to extend the frame and connect the upper portion to the condenser, the cap being on the top instead of at the end, as now used. Screws might be employed to adjust the side brasses; the eccentrics could be within the cranks, or between them and the bearings.

Having alluded to the principal working details, I will now lay before you a description of the mode of condensation—past and present. It is well-known that the principle of condensation is to convert the steam into its original state. The contact of the cool fluid, in the shape of water, accomplishes this in the ordinary condenser, and cooling surfaces in the surface condenser.

In the days of the introduction of side lever engines, the arrangement of the condenser and air pump was faulty; in some cases the foot-valves were almost inaccessible. Not many years ago, being on board a steamship fitted with old side lever engines, which were then undergoing repair, I noticed a rope and block tackle over near the condenser. On inquiring of the engineer how he progressed, the answer was, "I am just going to sling one of the men with this tackle, by the heels, to inspect the foot-valves; and that," said he, "is no foolish job." On further examining the engines, I found that an upside-down attitude was required, and indeed the only one allowed for the inspection of the valves in question. Happily now, however, such an inconvenient arrangement is of rare occurrence. We also find the side lever engine is being superseded by that of the oscillating type.

The arrangement of the ordinary condenser and air pump for oscillating paddle-engines is generally as follows: the condenser is situated between and below the trunnions of the two cylinders; the air pumps are at an angle, with trunks and connecting rods of the ordinary kind; the foot-valves are at the bottom of the barrel of the pump, the piston has valves in it; and the discharge-valve, when not at the top of the pump-barrel, is at its side. Now, the principal defects in this arrangement are in the position of the valves and condenser. When the foot-valves are directly underneath the pump's piston, it is obvious that an almost entire disconnection must be made to inspect them. Also, in the case of the piston-valves requiring inspection, the pump-cover must be removed, and to attain this the gland packing has to be slackened, and the connecting rod disengaged. Now, to avoid these evils, doors might be introduced, but with these disadvantages—increased height or length of the air-pump passages, and a body of water always above and below the piston, which undoubtedly is what any right-thinking engineer would disapprove of, being clearly understood that an air-pump will produce a better vacuum when the piston thoroughly discharges the contents between the foot and delivery-valves at each stroke.

Having thus pointed out the existing evils of the ordinary arrangement, it will not be deemed out of place to introduce a remedy. The condenser at the side of, or below, the pump is in one of the worst positions that can be conceived; the idea of allowing the condensed steam to fall, only to be raised again, seems, on consideration, to be foreign to the ideas of our talented engineers. It is well known that, in ordinary arrangements, the condenser is always in the position alluded to; steam even of a low pressure is larger in volume, but not as dense and heavy as water; it is also more elastic, hence it will more readily ascend. This, then, being clearly understood, it is not unwise or impracticable to assume that, if the condenser were on the top of the air-pump, instead of at its side or bottom, a better vacuum would be maintained. I beg to offer a description of an arrangement of condenser and position of the valves, both for correct action and accessibility. It will be understood that the condenser in this case is over the air-pump; the suction-valves are inverted, consequently the weight of the water assists the action of the piston in causing a vacuum. The exhaust steam from the cylinders rushes up the exhaust pipe, and enters on the top of the condenser. The water in the air-pump is discharged through the delivery-valve at the ship's side. A door is secured opposite the delivery-valve and doors are provided on each side below the bottom of the condenser, for the double purpose of inspecting the suction-valves and the air-pump piston.

This arrangement of condenser and air-pump will occupy as little room as those of the ordinary kind, with the advantage of accessibility to all the working parts without disarrangement. It may be argued that the stuffing-box, being in a recess when used for guides, would be troublesome to keep tight or repack, but if oil be always kept in the recess, so as to entirely cover the gland, it would tend to lessen the liability of leakage; the nuts of the gland and bolts could be adjusted by a box-spanner, or the bolts prolonged to the top of the condenser. In cases where the depth of the ship would admit, the recess could be dispensed with; trunks are not proposed for this asrangement, as their diameters would be necessarily increased, owing to the length required to pass through the condenser, unless a recess were resorted to as now proposed.

The next portion of the subject now before us is the ordinary condenser for screw engines. The action of the air-pump in this case is usually horizontal, consequently the valves are at right angles to the pump. To describe each arrangement of condenser and air-pump that have come under the writer's notice would occupy too much time, consequently a brief mention of two or three examples on this occasion will be deemed sufficient. For direct-acting and trunk engines, with the cylinders secured together or side by side, the condensers were between, and, in some instances, in front or at the sides of the air-pump. The foot and discharge-valves were directly over each other, the former under the pump at each end, the condensed water or steam being drawn through the foot-valves, and forced through those above. In another instance the foot and delivery-valves were extended the entire length of the air-pump and passages, the position of the valves over and under being as before, and the condenser being between the air-pumps. For return connecting rod engines, the condenser and air-pumps are subject to great disadvantages. In order to obtain a passably good arrangement, and, at the same time, occupy a moderate space in proportion to those last mentioned, the condenser, &c., have to be shaped to suit the purpose required. It must be perfectly understood that when the piston rods are beyond the crank shaft (as in the example now in question) there is a certain amount of space required for the piston-rods and guides of the cross head, or guide block, whichever may be used. It is also clear that accessibility to all the valves without disarrangement should be attained. To illustrate these desiderata the following examples will be sufficient for the present purpose:—In one instance the condenser is partially between the cylinders, and extending beyond the crank shaft; the air-pumps are at the side of the condenser; the suction-valves extend the length of the air-pump; and the discharge-valves are between each pump, the pump and the valves being beyond the crank shaft.

The next example is as follows:—The condenser and its appendages are entirely beyond the crank shaft. The air-pumps are at the extremity or sides and near the bottom of the condensers. The foot and discharge valves extend the entire length, and are arranged over and under the pumps in the usual form. The guides for the piston rods are between the upper portion of the condenser and that of the discharge chamber.

Having disposed of the principal arrangements of air-pumps and condensers as formerly constructed, allusion will now be made to those of recent improvement and practice. As before stated, a better vacuum can be attained when the condenser is over the air-pump instead of at the side. For direct-acting engines there are two arrangements specially worthy of notice. 1st. The air-pumps are worked by the steam-pistons between the cranks as near the base lines of the engines as the periphery of the circles will admit, the condenser being one chamber, directly over the air-pumps. The suction valves are inverted in the bottom of the condenser, so as to effectually drain the same. The discharge chamber extends the entire length on each side and back end of the condenser, the valves being nearly in the same line as those for the suction, but reverse in action. The next example is the same as the last in principle, although different in arrangement. The air-pumps are situated as in the last example, but the condensers are separate, one to each engine, over and on each side of the air-pump. The suction valves are inverted in the bottom of each condenser to obtain the advantage before alluded to, the discharge chamber or valves being central or between each condenser, and directly over and between the air-pumps. It may now be argued that if the two examples last mentioned are perfect in action and arrangement, what is the cause of the diversity? The answer to this is, diversity of idea. Engineers, as a rule, are averse to the act of copying from each other. No sentence grates more harshly on the ear of a scientific man than the words, "Where did you copy this," or is more repugnant to his dignity.

Having referred to the improvements in the arrangement of condensers, &c., for direct-acting engines, attention will now be given to those adopted for double piston-rod engines. It must be borne in mind that for this class of engine the prolongation of the piston rods beyond the crank-shaft greatly deteriorates the arrangement of the air-pumps and condensers, in relation to the space occupied by those for single piston rod engines. In the examples now given, the air-pumps are worked by the steam piston, and as near the base line as possible. The condensers are separately arranged outside the guides of the piston rods of each engine; the suction-valves are inverted above the top of the air-pump, as in the last examples; the discharge chamber is between the air-pumps and the valves, on the same level as those for the suction. It will thus be understood that both suction and delivery are at the side, over and extending the length of each air-pump, instead of being directly over them, as in some cases.

The next example worthy of notice is arranged as follows:—The condensers and their appendages are beyond or outside the guides of each engine, the air-pumps deriving their motion as in the previous examples, and are as near the base line as possible, so situatad as to clear the guides. Partially over and beyond the side of each air-pump are the discharge valves, above which is the discharge chamber; over this, and at the sides of the same, is the condenser with the suction valves inverted.

I will now allude to the system of condensation known as surface condensation. Mr. Hall, in days of yore, introduced the tubular arrangement with great advantage. Engineers at that time were slow in appreciating the then presumed gain, and it is only lately that we have seen the surface condenser universally adopted by the powers that be. To condense steam properly is undoubtedly to reduce it to its natural or original state. Now, in the ordinary condenser we bring water into actual contact with the steam to condense it. Surface condensers are to be recommended particularly for one reason, viz., the production of distilled water for the feed of the boilers. The arrangement of the tubes for surface condensers entails practical difficulties as to the position most suitable, whether they be inserted transversely, perpendicularly, or longitudinally, of the hull of the ship, renewal of the tubes being often required (sometimes while at sea) from corrosion.

The means adopted to render the connection of the tubes in the plate air-tight are numerous. The usual mode now is—india-rubber rings recessed in the plates encircling each tube—compression being obtained by a nut for particular tubes, and by the vacuum in the condenser for those of horizontal positions;—this is simple and efficacious, and at the same time economical. It must here be remarked, however, that compression of the india-rubber by vacuum can only be attained when the steam is condensed by the external surface of the tubes or within the plates. The circulation of the water is either through or surrounding the tubes, and is produced by pumps with plunger-piston or centrifugal action. The position of the piston-pumps is horizontal, motion being derived either from the steam-piston or piston-rod. The centrifugal-pump requires a separate engine, or spur-gearing, &c., from the crank shaft to give the required velocity.

The values of the two arrangements now used for the condensation of steam are about equal. In the case of the water surrounding the tubes, the steam passes through the same, and in the case of the steam surrounding the tubes the position of the water is reversed.

It is obvious where internal condensation is effected a greater number of tubes are required, in relation to those of the external system—the inner surface of the tube being less than that of the outer. The advantage gained by the steam entering the tubes may be said to be—access for cleaning without disarrangement. Injection, or ordinary condensers, are more generally used than those of the surface kind, on account of economy in the outlay of capital at the commencement.

The injection-valves for ordinary condensers are generally of the solid or grid-iron type, the latter to reduce the stroke to open and close. The pipe for the dispersion of the water is usually a tube, with apertures, of an elongated or circular form. An improvement has lately been made in these pipes, by contracting the area for one-half the length, thus equalizing the diffusion of the water throughout.

The next valve necessary for the condenser is the snifting valve, which is a single disc of gun metal, with a slight spiral spring at its back, or upper part. A screwed spindle is universally used to prevent the valve from rising, after the water and air in the condenser has been blown out previously to starting the engines. It might be deemed neglectful if I were not to make allusion to the bilge injection-valve or cock, whichever may be used. This valve, as well known, is only required in cases of necessity, such as leakages or disarrangement of the bilge or donkey pumps. I would beg to suggest that the bilge water should not be allowed to enter the condenser, on account of the generally impure state of the bilges. A valve and box might be arranged at the end of the air-pump for this purpose.

The portions of the marine engine next for exemplification are the feed and bilge pumps. The position of these is so arranged that a free access can be obtained to the valves and surrounding parts without disarrangement. Some makers prefer to work the feed and bilge pumps in a line with each other, with one rod and plunger direct from the steam-piston. Other firms secure the pumps side by side to the discharge water-pipe of the condenser, each plunger being connected to the piston-rods crosshead; this latter improvement is more general than the former. In the case of hollow plunger or trunk air-pumps, those for the feed and bilge are on each side of the air-pump, and secured by nuts or keys. Before terminating this portion of the subject, it will be well to add that the valves for the air, feed, and bilge pumps are now universally discs of india-rubber, instead of the gun-metal spindle-valves.

It will have been observed that no allusion has yet been made to the arrangement of combined high and low pressure engines. For the purpose of comparison I will allude only to those arrangements in common use. The position of of the low-pressure cylinders is side by side, as for those of the ordinary kind; in some cases annular cylinders are used, viz., the high-pressure cylinder within that of the low pressure. Another arrangement is the high-pressure cylinder on the top of that for the low pressure. A third arrangement has the smaller cylinder at the back end of the larger. A fourth example consists of two high pressure cylinders in front of one for low pressure, the former acting as guides for the piston-rod. The means adopted for imparting the motion of the piston to the cranks are of the ordinary arrangements already described, with the exception of the necessary extra piston-rods and stuffing-boxes.

Having alluded to the different engines, and their details past and present, adapted for the single screw, I will now call attention to a notice of arrangement of engines as at present used for the twin or double-screw system. It must here be mentioned that the class of engines now under notice have precisely the same duty to perform as those before described, consequently, if I pass over the maior portion of the detail it is to avoid repetitiou.

The arrangement of the engines is usually separate for each screw. The type of engine generally adopted at present is direct-acting with surface or injection condensers. Single piston-rod engines seem to be more in favour than those of the double piston-rod return action type, I presume on account of the simplicity of the former. The position of the arrangement in plan is side by side—port and starboard—instead of directly opposite each other; that is owing to the space required for the arrangement adopted, and the small beam of the vessel; but in some cases engines are arranged opposite each other, with a great reduction of space compared to that of the side system. When the crank shaftings are connected the steering principle is destroyed, and the twin screw system, so far as regards propulsion, is very little better than the single system.

There is not the least doubt that as a mode of steerage the twin system is correct, and for shallow draughts it is advantageous. To suppose the plan to be universally correct for large vessels requires, however, more practical evidence than I at present possess; but of this I am confident, that for small or large vessels, whether for commercial or war purposes, the twin screws, when driven separately, are invaluable for steering. The advantages for war ships are principally the facility for manœuvring when under an engagement. Let it be presumed that the enemy has aimed at a twin screw steamer, by a contrary action of the screws her position can be shifted instantaneously, and the intended evil postponed, if not averted.

I have come to the end of my brief description of the marine engine, and will now allude to the weight of material, cost of marine engines, and the relation of nominal to actual horse-power, together with the consumption of fuel. The variation in the weight of marine engines is due to the design and arrangement as much as the material used. Double trunks may be said to be a fair example as to the average weight of marine screw engines. Return connecting rod engines are perhaps the heavier, in comparison to those of the single type, in relation to rods and guides. High and low pressure engines combined are the heaviest of any examples yet given. The materials comprising the different portions of the engines of the present day are of six kinds—first, cast iron, of which is formed the cylinders, pistons, valves, casings, main frames, guides, condensers, &c.; secondly, wrought-iron, comprising cranks and shaft, piston and valve rods, links, levers, weigh-shafts, bolts, nuts. &c.; thirdly, steel for springs, small pins, &c., fourthly, gun metal for bearings, guide blocks, bushes, glands, nuts, &c.; fifthly; copper, for pipes of all kinds required for steam and water; sixthly, india-rubber, for valves, packing, &c. For the present occasion, in reference to weight, I have selected twelve examples of marine screw engines, each varying in power and design. The examples of arrangement being in pairs, the result has been that 1·334 owt. per nominal horse-power may be taken as the average weight of material, exclusive of boilers, fittings, screw-propeller, and alley-shafting. It may here be observed that each maker of marine engines in the present day differs in design and arrangement, consequently the weight of trunk engines by different makers would be unequal. The same may be said for single piston rod engines, as well as for double piston rod return connecting rod engines.

I now come to that portion of this subject which is the crowning question of all, and too often the cause of much controversy in political and commercial circles, viz., what is the cost? My opinion is, that it is perhaps the most difficult query to answer that could be put, and the only reason for its introduction is to preserve myself from presumed neglect in not noticing this important matter. To ascertain correctly which is the cheapest class of engine at present in use, is a problem much too difficult for me to solve; but I will, however, tender such information as I deem reliable.

The price of a marine engine depends entirely on the class of workmanship. Should a roughly-finished engine and boiler be required, with more painted than polished surfaces, the cost will be reduced in comparison to that of the more highly-finished. The fittings also greatly regulate the outlay. Some companies pride themselves on this portion of display, others, again, look on it as an unnecessary expense; so, to draw a correct line of comparison would involve the amalgamation of the many ideas in order to give a fair evidence. I feel confident however, that marine engines, with boilers and fittings complete, can be produced of certain classes, for £70 per horse-power nominal, and the same can be produced to £50 per horse-power, each price of course being under certain conditions as to terms and workmanship.

Allusion must now be made to the power, &c., of marine engines. Nominal power is a term used particularly for commercial purposes. Each maker has his private rule, hence the difference in dimensions in engines of the same class and power. Actual horse-power is defined by the indicator diagram, speed of piston, &c.; the ratio between the nominal and actual power is in some cases low, in others high. The writer has known instances where, the nominal power being 1·0. the actual was 6·0; and in others, nominal 1·0, actual 2·123; the average ratio at present is nominal 1·0, actual 4·0 to 5·0. With reference to the consumption of fuel, there is a great difference in the evidence. Superheating and surface condensation are slowly making progress, and at the same time reducing the consumption of fuel in ratio to the amount of water evaporated or steam used. The average actual horse-power expended per cubic foot of water evaporated is, water being 1·0, actual horse-power 2·635 to 4·0, and doubtless in some cases more. The ratio of fuel consumed in pounds per hour, to the actual horse-power per hour expended may be taken as follows:—Engines of ordinary construction, power, 1·0; fuel, 5 to 6. For expansive working-engines, with superheating and surface condensation, thus:—Power, 1·0; fuel, 2·50.

I am deeply indebted to several eminent firms for their courtesy and practical information received and personally given. Messrs. John Penn and Son, of Greenwich, have kindly given me a tabular statement of much value to the profession and the Society. I am advised by this firm that a more extensive list of their trunk engines may be found in THE ARTIZAN journal for March, 1859, and November, 1861. The list now presented commences from the latter date; also that with their class of engines the consumption of fuel is about 4lbs. per actual horse-power per hour for expansive engines, with superheated steam and surface condensation. This firm has displayed a warm interest in the present paper, by kindly lending the photographs and splendid working models, which I have the pleasure of laying before you.

Messrs. Maudslay, Sons, and Field have kindly lent photographs of their late improvements in marine engines. From personal interviews, I am enabled to present the Society with valuable information, particularly as follows:—The amount of fuel consumed, per horse-power actual, for ordinary engines by this firm is 5lbs., in some cases less and in others more. For three cylinder expansive engines, with surface condensation and superheating, the consumption is reduced to 2·25 to 2·5lbs per horse power actual. These engines cut off at one-seventh of the stroke, producing an almost correct indicator diagram. In one example shown me, the nominal horse-power was 150; with a pressure of steam 25 per square inch, the indicator diagram produced a result of 875 actual horse-power, being in the ratio of 1 to 5·833, which may be said to be an exceptional result for screw engines. This firm has constructed, since 1851 to the present time, the following number of engines and boilers:—Of screw engines, 183; of paddle-wheels, 30. The highest nominal power of one pair of engines yet constructed by this firm is 1,350, and the lowest 10.

The Messrs. Rennie have kindly lent me models and photographs of the different classes of engines they are in the habit of constructing. I am informed by this firm that the consumption of fuel for ordinary engines is,—Actual horse-power, 1; fuel, 5. In the case of surface heating, surface condensation, and expansion—Actual horse-power, 1; fuel consumed, 2·5; showing a reduction of 50 per cent. on that of the ordinary kind, which is about equal to the other firms.

Valuable statistics have been supplied to me by Messrs. R. Napier and Sons, of Glasgow, giving particulars of the ships, engines, &c., constructed by them from 1851 to the present time. From these I have made a selection for publication. This firm has also kindly presented me with splendid photographs of their engines, &c., which are hung for inspection.

With reference to twin-screw propulsion, I am deeply indebted to the firm of Messrs. Dudgeon, of Blackwall, they having kindly furnished for this occasion practical statistics of the proportions of vessels and engines constructed by them since the year 1851 to the present time.

In conclusion, I must apologise for the length of my present paper; but I beg to observe that, had I extended my remarks to twice or thrice the present length, I should even then have failed in doing justice to this subject, which is undoubtedly one of national importance. To the credit of those concerned it can be truthfully said that, in comparison with other nations, the productions of our marine engineers maintain that high standard for excellency of design and workmanship which has ever characterised the natives of old England.

TWIN SCREW PROPULSION.

Tabular Statement of Ships, Marine Engines, &c., constructed by Messrs. Dudgeon, Blackwall, since 1851 to the present date (supplied by the Firm).

Beam of Vessel.	Length.	Depth.	Tonnage.	Immersion.	Nominal horse-power.	Diameter of cylinder.	Length of Stroke.	Kind of Condenser.	Diameter of Air Pump.	Diameter of Screw Propeller.	Pitch of Screw Propeller.	Distance between Centres of Propeller.
ft. in.	ft. in.	ft. in.	tons.	ft. in.		inches.	inches.		inches.	ft. in.	ft. in.	ft. in.
22 6	150 0	13 0	395	9 0	120	26	21	Injection	8½	7 0	14 6	8 9
23 0	165 0	13 6	425	9 0	120	26	21	”	8½	7 5	14 6	8 9
23 0	165 0	13 6	425	9 0	120	26	21	”	8½	7 5	14 6	8 9
23 0	165 0	13 6	425	9 0	120	26	21	”	8½	7 5	14 6	8 9
34 0	225 0	22 0	1,258	17 0	150	H. 24 L. 50	24	”	12	8 10	16 0	11 8
25 0	175 0	15 0	531	9 6	200	34	21	”	11	8 3	16 0	10 5
23 0	165 6	13 0	425	9 0	120	26	21	”	8½	7 0	14 6	8 9
23 0	165 6	13 0	425	9 0	120	26	21	”	8½	7 0	14 6	8 9
23 0	165 6	13 0	425	9 0	120	26	21	”	8½	7 0	14 6	8 9
23 0	165 6	13 0	425	9 0	120	26	21	”	8½	7 0	14 6	8 9
11 10	57 6	7 0	35	4 10	30	12	11	High pressure	None	3 8	7 4	4 6
23 6	200 0	13 4	546	9 6	200	34	21	Injection	11	8 0	16 0	9 5
15 0	85 0	6 6	91	2 9	30	12	11	High pressure	None	3 6	7 4	4 6
15 0	85 0	6 6	91	2 9	30	12	11	”	None	3 6	7 4	4 6
34 0	265 0	28 0	1,500	16 0	350	H. 31 L. 62	24	Surface	11	10 6	18 0	12 0
17 0	100 0	6 6	138	3 6	30	12	11	Injection	5¾	4 0	7 6	5 4
32 0	160 0	13 3	737	10 0	200	34	21	”	11	8 0	16 0	9 5
24 6	200 0	13 4	592	9 6	200	34	21	”	11	8 0	16 0	9 5
28 0	250 0	15 6	972	10 0	300	40	22½	”	13	9 2	17 3	10 9
28 0	250 0	15 6	972	10 0	300	40	22½	”	13	9 2	17 3	10 9
27 0	230 0	14 6	829	9 6	250	37	21	”	12	8 9	16 0	10 0
21 6	190 0	13 0	436	10 0	120	26	21	”	8½	7 0	14 6	8 9

Tabular Statement of Marine Engines constructed by Messrs. John Penn and Son, Greenwich (supplied by the Firm).

Name of Vessel.	Diameter of Cylinder.	Length of Stroke.	Revolutions per Minute.	Diameter of Screw	Pitch of Screw.	Diameter of Axis of Wheel.	Length of Floats.	Depth of Floats.	Nominal H. P.	Indicated H. P.	Speed of Ship.	Date of Trial.
Screw Engines.	inches.	ft. in.		ft. in.	ft. in.	ft. in.	ft. in.	ft. in.			knots.	
Minotaur	104¼	4 4	...	24 0	25 6	...	...	...	1350	...	...	—
Achilles	104¼	4 0	52½	24 0	25 6	...	...	...	1250	5746	14·25	December 28th, 1864.
Warrior	104¼	4 0	54¼	24 6	30 0	...	...	...	1250	5471	14·35	October 17th, 1861.
Black Prince	104¼	4 0	51¾	24 6	30 0	...	...	...	1250	5146	13·31	August 30th, 1862.
Resistance	70¾	3 6	68 to 69	18 0	21 0	...	...	...	600	2424	11·84	September 23rd, 1862.
Paddle-wheel Engines.												
Exploratore	72	5 0	40	...	...	19 0	10 0	4 6	350	2556	17·27	May 6th, 1862.
Taliah	72	5 0	39	...	...	19 0	10 0	4 6	350	2540	17·74	December 28th, 1863.
Izzeddin	66	5 0	41½	...	...	17 6	10 0	3 10	300	2373	16·5	September 19th, 1864.
Victoria	58	4 6	42	...	...	17 6	7 10	3 6	220	1640	16·83	September 3rd, 1861.
Prince Imperial	52½	4 0	48 to 49	...	...	14 11	8 0	3 2	180	1480	16·3	September 28th, 1864.

The following is a list of engines constructed by Messrs. Maudslay, Sons, and Field, for H.M. Navy since 1851 to the present date, kindly furnished by Joshua Field, Esq.:—

Engines, &c., for 75 Screw Vessels	Total	37,570
” 26 Paddle Vessels	”	6,340
” 69 Screw Gunboats	”	4,260
Total		48,170

THE FOLLOWING TABLE GIVES PARTICULARS OF SOME OF THE PRINCIPAL MARINE ENGINES, RECENTLY CONSTRUCTED BY MESSRS. R. NAPIER AND SONS, GLASGOW.

NAMES OF VESSELS.	Paddle or Screw.	Material.	Tonnage O. B. M.	Kind of Engine.	No. of cylinders	Diam. of cylinders.	Length of Stroke.		Nominal H. P.	Kind of Boilers.	Kind of Propeller.
						inches.	ft.	in.			
Coromandel	Screw	Iron	...	Plunger, direct	2	50	2	6	250	Tubular	Common.
Gunboat for H.E.I. Co.	„	...	...	Horizontal, high pressure	2	18	1	6	80	„	„
Emperor Alexander	„	„	...	Plunger, direct	2	60	3	0	350	...	„
Islesman	„	„	197 $\frac{81}{94}$	Horizontal	2	28 $\frac{1}{8}$	3	0	80	„	„
Victoria	Paddle	„	144 $\frac{76}{94}$	Oscillating	2	27 $\frac{1}{16}$	3	0	44	„	Radial.
Fifeshire	„	„	...	Inclined	2	36 $\frac{1}{8}$	3	6	82	Lamb's flue	Eccentric
Chevy Chase	„	„	963 $\frac{3}{94}$	„	2	72 $\frac{1}{8}$	8	0	416	Tubular	„
Royal William	Screw	Wood	...	Plunger, direct	2	65 $\frac{1}{8}$	3	0	500	„	Griffiths
Cormorant	„	„	...	„	2	45 $\frac{1}{8}$	2	0	200	„	„
Scotia	Paddle	Iron	4,050 $\frac{26}{94}$	Side lever	2	100	12	0	1,000	„	Radial
Orestes	Screw	Wood	...	Pluuger, direct	2	60 $\frac{1}{2}$	3	0	400	„	Griffiths.
Clan Alpine	Paddle	Iron	1,507 $\frac{30}{94}$	Inclined	2	64	8	0	400	„	Eccentric.
Wolf	„	„	870	„	2	61	6	0	275	„	„
Rolfe Krake	Screw	„	1,091 $\frac{13}{94}$	Horizontal direct	2	48	2	0	235	„	Griffiths.
Osman Ghazy	„	„	4,221 $\frac{51}{94}$	„	2	92	4	0	900	„	„
Abdul Aziz	„	„	4,221 $\frac{51}{94}$	„	2	92	4	0	900	„	„
Orkman	„	„	4,221 $\frac{51}{94}$	„	2	92	4	0	900	„	„

Total number constructed by this firm from 1851 to 1864 inclusive—Screw engines, 87; Paddle engines, 39.

MANCHESTER ASSOCIATION FOR THE PREVENTION OF STEAM BOILER EXPLOSIONS.

At the ordinary monthly meeting of this association, held on March 7th, the chief engineer presented his report on the recent transactions of the association, which included a statement for the months of November and December last, of such matters as were of an engineering character. It has been usual to postpone the December report until the committee met in January, in order that the visits of inspection for the year might be completed, and also time allowed for getting out the accounts thereof. In this case, however, from pressure of other matters, this engineering statement was unavoidably delayed beyond that period, but is now issued to the members; while it is intended to lay before the next monthly meeting of the Executive Committee a statement of such engineering matters of interest as shall have transpired in the working of the association up to that time, and since the commencement of the present year. The following is an abstract:—

"From October 22nd, 1864, to the close of the year there were examined 536 engines and 809 boilers. Of the latter, 88 have been examined thoroughly, 31 internally, and 690 externally. In the boilers examined, 500 defects have been met with, 5 of them being dangerous.

"No. 9 explosion occurred to a boiler not under the inspection of this association. Two scientific engineers were appointed by the Government to investigate the cause of the explosion; it appears that the boiler was employed on a steam barge or lighter, and was a small vertical one, being internally fired, and cylindrical, both in the external shell and internal fire-box, the crown of the latter being domed, and the flames passing off—not through a number of small tubes, as in a vertical multitubular boiler, but—through a single central taper flue, direct to the chimney.

"The height of the boiler was 8ft., and the external diameter 4ft. 6in., while the height of the internal fire-box was about 5ft., and its diameter at the bottom 4ft., and at the springing of the crown 3ft. 6in. The length of the central taper flue was about 3ft., and its diameter about 9in. at the bottom and 14in. at the top. The thickness of the plates was $\frac{5}{16}$ths of an inch in the cylindrical portion of the external shell, and half an inch in the flat end plate at the top of the boiler. The plates of the cylindrical portion of the internal fire-box varied from half an inch to $\frac{3}{8}$in. in thickness, while that of the fire-box dome was $\frac{5}{16}$, and of the vertical flue $\frac{7}{16}$. The sides of the internal fire-box were tied to the external shell by twenty 1$\frac{1}{4}$in. stays, screwed throughout, while in addition there were two water tubes 10in. in diameter, within the fire-box, running directly across from side to side at a slight inclination with the horizontal, and at right angles one with the other. These water tubes not only tended to improve the circulation of the water inside the boiler, but also to increase the heating surface, as well as to enable the internal fire-box to resist the external pressure, tending to collapse it. The boiler is reported to have been well made throughout; there were no angle irons, but all the plates were flanged; the rivets well filled the holes; the plates were well drawn together, and the material and workmanship appeared to be altogether satisfactory.

"On its explosion, the external shell is reported to have been rent into several fragments, the rents not confining themselves to the seams of rivets, but running in many places through the solid metal. The steam barge was lying at the time near to a landing quay, at which it had only arrived a few minutes previously, and pieces of the boiler and steam pipes were carried over some of the houses bordering on the quay, and in one case over a three storied building, the parts falling into an adjoining street. Notwithstanding the small size of the boiler, the force of the concussion was very severe, a good many windows were broken, and the frames blown in.

"With regard to the cause of the explosion, it is stated in the official report, already referred to, that the appearance of the fire-box entirely forbade the supposition that the explosion had resulted from shortness of water; also, that although the safety-valve was rough and inferior, yet the writers were not in a position, from its examination, positively to state that it had been jammed fast; but, nevertheless, considering the safe construction of the boiler, and the manner in which it had rent, as well as the destruction to the surrounding property, they were unable to attribute the explosion to any other cause than to an excessive pressure of steam within the boiler, although the circumstances of the case did not permit their determining the precise occasion of that pressure.

"The particulars, already given, appear to justify the preceding conclusion, that the boiler exploded from undue pressure; and it will be seen that the existence of such a pressure is not improbable, when it is considered how rapidly steam may be raised in a boiler containing so little water as this one did, and when the engine is at rest, as it was on the present occasion. Also, the circumstances at the moment of explosion were just those which might naturally have led to the neglect of the safety valve, thus:—The steam barge had sprung a leak, in consequence of injuries received in a collision, and, being unable to answer her helm, had run into another lighter, when she became reduced to a sinking condition. Under these circumstances her bow was run upon a bank, when her stern went down, and the boiler very shortly after exploded. These accidents to the barge may not, improbably, have led to the derangement of the safety valve, the lever of which was loaded with a weight, and thus of a class the most likely to suffer by the shocks of collision, especially since it was, as previously stated, roughly constructed.

"In conclusion, there can be no doubt that this boiler would have worked safely at its regular pressure of 70lbs. on the square inch, if equipped with suitable fittings, and attended with ordinary care; while this opportunity may be taken of calling attention to the importance of having every boiler fitted with a duplicate safety valve, as well as a reliable steam pressure gauge.

"No. 16a Explosion happened to a boiler not under the inspection of this Association, on May 30th. The boiler was of the plain cylindrical egg-ended, externally fired class, and it worked at a colliery. It was fed with water drawn from the pit, which was of a very corrosive tendency, and the plates were considerably reduced in thickness thereby, at a point where the feed on its inlet impinged.

"On its explosion, one end of the boiler is reported to have been blown to a distance of about 100 yards from its original seating, while the main portion flew in an opposite direction. The explosion is attributed to shortness of water.

"No. 19 Explosion occurred to a boiler not under the inspection of this Association, and which appears to have been internally fired, and of the ordinary "Cornish" construction, having a single furnace flue. It was one of a series of two, set side by side, and connected together.

"On its explosion the boiler was thrown upwards from its seating, as well as the one alongside of it dislodged, while in addition the steam pipe was carried away, and the roof as well as the walls of the boiler house destroyed.

"The boiler rent at the bottom of the shell, at a part where the plates resting on the seating were so reduced by external corrosion as to be scarcely thicker than a sheet of paper, so that the explosion is attributable simply to the dilapidated condition into which the boiler was allowed to fall.

"No. 24 Explosion occurred to the boiler of a locomotive colliery engine not under the inspection of this Association.

"The explosions of locomotive boilers employed on passenger lines of railway are usually investigated by an engineer appointed by the Board of Trade, and reported on to Parliament, so that a thorough investigation is secured, and the information disseminated. No such investigation, however, took place in the present instance, while this being among those cases in which a personal examination from this Association was prevented, from the causes explained above, I have been able to obtain but few particulars.

"The boiler is reported to have been between eight and nine years old, 11ft. 2in. long, and 4ft. in diameter in the cylindrical portion of the shell. It was fitted with two safety valves and a steam gauge, the ordinary working pressure being 140lbs. per square inch. The shell was affected internally by corrosion, being indented in places to the depth of $\frac{1}{8}$ of an inch. It does not appear that there had been any deficiency of water, the fire-box remaining uninjured.

"At the coroner's inquest the engine driver as well as the fireman gave in evidence that they considered that everything about the boiler had been quite right. The engineer to the colliery company, under whose superintendence twenty-two new tubes had been put in about two months previous to the explosion, stated that he considered the boiler one of the best they had; while, with regard to the thinning of plates from wear, he knew of no means of testing it in such a boiler, until a rent actually occurred. The locomotive superintendent of an adjoining line of railway considered the boiler to have been a very strong one, indeed stronger than the average, and could not account for the explosion. Another colliery engineer believed the boiler to have been perfectly safe, and that it would have stood a test of 200lbs. or upwards, which was higher than the pressure at which it appears to have burst. The coroner, in summing up, stated it appeared that everything about the boiler had been in perfect order, and that the iron was good, in fact, a little better than usual. There had been no negligence either in working or repairing the boiler, and there was no blame to be attached to any one, but quite the reverse. Upon this evidence the jury brought in a verdict of Accidental death.

"No. 25 explosion occurred to a boiler which was not under the inspection of this association.

"It was the centre one of a series of three, set side by side, and working together at a mine, and was of the ordinary "Cornish" construction, having a single furnace tube running throughout from one end to the other. This furnace tube was 34ft. long, 3ft. 9in. in diameter, and made of plates $\frac{7}{16}$ of an inch in thickness. The boiler was fitted with a single safety valve, loaded to a pressure of 30lb. per square inch, while there was a steam gauge connected to the main steam pipe, which was thus in communication with each of the three boilers, as long as all of the junction valves were open, but not otherwise.

"The boiler had been lying idle for some weeks, undergoing repairs to the shell, and the explosion occurred as steam was being got up for the first time after their completion, and before the safety-valve had been seen to blow off, or the communication to the other boilers had been established by opening the junction valve.

"The boiler failed in the furnace tube, which collapsed from one end to the other. The boiler, however, was not at all disturbed from its seat, nor were the steam pipes broken, and the other two boilers, the one on the one side, as well as that on the other, continued to drive the engine as if nothing had happened. Judging from other explosions, this would not have been the case had the boiler been externally fired, but the whole series would have been dislodged.

"The explosion was attributed, at the inquest, to deficiency of water, although it was known that there had been an ample supply shortly before, and which, it was stated, would have lasted, not only up to time of the explosion, but several hours beyond. Under these circumstance, to maintain the theory of shortness of water, it was supposed that a leak had started in the shell. That this leak, however, was only imaginary will be seen from the fact that it has not since been discovered, and that the boiler has been set to work again without any repairs being done to the shell.

"The true cause of the explosion it is thought will be found in the large size of the furnace tube, viz., 3ft. 9in., and in the fact of its not being strengthened either with flanged seams or encircling hoops, &c. It is true that such a flue might work safely for a time with steam at a pressure of 30lb. per square inch, if it were well made and truly circular. But with ordinary workmanship the latter seldom proves to be the case, and these internal flues are frequently found, upon actual measurement, to err from one to two inches from the true form, which very seriously impairs their strength. Again, furnace tubes get gradually weaker from wear and tear, and any slight departure from the circular form is liable to increase, so that it is only at a hazard that an ordinary plain tube of such dimensions as the one under consideration can be worked for any length of time. It may be added that the flue was speckled with corroded indentations about a quarter of an inch in diameter, and nearly an eighth of an inch deep, which, however, would not be sufficient alone to account for the collapse.

"No. 26 explosion, seven persons being killed and seven others injured, occurred to a boiler not under the inspection of this association, and was, as in the case of No. 9 explosion, officially investigated, and reported upon by an engineer appointed by the Government. I have been promised a copy of this report, which however I have not yet received.

"In the meantime it may be stated that the boiler was internally fired, and of the double furnace "Breeches" class. The shell was 30ft. long and 8ft. 3in. in diameter. The furnaces were 12ft. long and 3ft. 6in. in diameter, while the flue was 18ft. long and 5ft. 6in. in diameter. The thickness of the plates was $\frac{7}{16}$ of an inch in the shell, and $\frac{3}{8}$ of an inch in the furnaces and flue, while the working pressure was from 40lb. to 50lb. per square inch.

"The boiler failed at the left hand furnace, which rent at the crown, the rush of steam and water which ensued, carrying away the furnace mouthpiece, as well as scattering the *débris* with considerable force, and it was from this, added to the scalding effects of the steam and water, that the personal injuries above named resulted.

"The explosion has been attributed to shortness of water, and a final opinion upon the correctness of this conclusion must be deferred until full particulars are received.

"On the present occasion I have to report four explosions, from which three persons have been killed, and ten others injured. Not one of these explosions occurred to boilers under the charge of this Association.

Tabular Statement of Explosions from October 22nd, 1864, to December 31st, 1864, inclusive.

Progressive No. for 1864.	Date.	General Description of Boiler.	Persons Killed.	Persons Injured.	Total.
29	Oct. 25	Ordinary single flue, or Cornish, Internally-fired	1	5	6
30	Nov. 18	Waggon	1	1	2
31	Dec. 21	Ordinary single flue, or Cornish, Internally-fired	0	4	4
32	" 24	Locomotive	1	0	1
		Total	3	10	13

"No. 29 explosion—the fireman being killed and five others injured—happened at a flax mill, to a boiler not under the inspection of this Association.

"The boiler was internally fired, and of single flue "Cornish" construction, having flat ends, strengthened with gusset stays. It was about fifteen years old, and 20ft. 3in. long, having a diameter of 5ft. 3in. in the shell, and 3ft. in the furnace tube. The thickness of the plates, both in the cylindrical part of the shell and flat ends, as well as in the front portion of the furnace tube, was $\frac{3}{8}$ of an inch, while in the remainder—that is the back part of the flue—it was $\frac{5}{16}$, the ordinary working pressure being 55lb. on the square inch.

"The boiler failed at the internal flue tube, which collapsed, and completely flattened, while the back end plate was torn entirely away, leaving the gussets and outer ring of angle iron attached to the shell.

"The boiler was dislodged from its seat, and the boiler-house destroyed, while fragments of pipes, &c., as well as bricks, were scattered in every direction, and thrown to a considerable distance.

"At the inquest it was stated that owing to some defect in the engine, which prevented its working satisfactorily, the fireman had recently added to the load upon the safety valve, by laying a portion of a fire-bar upon the lever, which appears to have brought the pressure up to about 68lb. per square inch. Scientific evidence was adduced to the effect that the boiler ought never to have been worked at a higher pressure than 40lb. on the square inch, and the learned counsel, engaged to defend the owner, made the most of this evidence to show that the explosion arose entirely from over pressure of steam, for which the fireman was responsible, and the jury brought in a verdict to the effect that the fireman had met his death by a steam boiler explosion, which his own negligence had caused.

"No. 30 explosion—one person killed and another seriously injured—occurred at a silk mill, to a boiler not under the inspection of this Association.

"The boiler was one of a series of two, which, though set side by side, were of a very different class the one in question, which was the left hand one, being of 'Waggon' construction, and externally fired, the other being of modified 'Cornish' construction, and internally fired. The waggon boiler, which exploded, was upwards of thirty years old. It was 12ft. long, 7ft. high, and 5ft. 6in. in diameter at the waggon head. The shell was strengthened at the sides in the waist with six stays, and at the flat ends with a single longitudinal one, all these stays being about 2in. square. The thickness of the plates was ⅜ of an inch in the bottom, the sides, and the ends of the shell, and ¼ of an inch in the crown or waggon head. The boiler was fitted with a single lever safety valve, 3½in. in diameter, which was ordinarily loaded to a pressure of about 10lb. per square inch, and it had originally an independent open column mercurial steam pressure gauge, but this becoming deranged, it had only the limited use of a dial gauge in common with the other boiler, that is to say, when its junction valve was open, but not otherwise.

"The explosion occurred when steam was being got up in the boiler for the first time, after it had been lying idle for nearly a year. There was no weight upon the lever of the safety valve but merely a lump of lead placed directly on the valve, which, since it weighed about 25lb., gave a pressure not exceeding 3lb. per square inch. What the exact pressure within the boiler was, however, could not be ascertained.

"As to the cause of the explosion, I carefully examined the edges of all the plates at the rents, to ascertain if any thinning by corrosion had taken place, but did not find that such had been the case. On the contrary, although the boiler was upwards of 30 years old, as previously stated, it was in good condition, the stays sound and well secured. Also no signs were perceived of the boiler having been allowed to run short of water, while the load on the safety valve, being less than 3lb. per square inch, was clearly insufficient to account for the explosion. On examining the valve, however, it proved to be entirely out of order. It was made of brass, while the spindle was of iron, and this had become so seriously rusted as to prevent its free action. It was only with difficulty, and by driving the valve out of its seat with a hammer, that it could be released, while it appeared upon inquiry that it had not been taken out and cleaned before setting to work, although the boiler had been standing idle so long, neither had the valve been seen to blow on the day of the explosion.

"Under these circumstances there is no difficulty in coming to the conclusion that the explosion did not result from the infirmity of the boiler, or from shortness of water, but simply from excessive pressure of steam, caused by the imperfect action of the safety valve, in consequence of its inferior construction in the first place, and its neglected condition in the second.

"No. 31 explosion occurred to a boiler not under the inspection of this association, and by it four persons were injured, but fortunately no one was killed.

"I was prevented from making a personal investigation of this explosion, but have been favoured with particulars by an engineer, who visited the scene of the catastrophe a few days after the explosion happened, from which it appears that the boiler was of the ordinary 'Cornish' class, being internally fired, and having a single furnace tube. Its length was 36ft., and its diameter in the shell 6ft. 4in., and the furnace tube 3ft. 8½in.; while the thickness of the plates was $\frac{5}{16}$ full in the shell, and ⅜ in the furnace tube. There were two safety valves, loaded to a pressure of 15lb. per square inch.

"The boiler on its explosion was rent into five or six pieces, consisting of portions of the external shell, as well as a short length of the internal flue tube.

"The explosion appeared to have been due to the thinning of the plates from external corrosion at the seating, where, in consequence of leakage from a roughly bolted patch, the plates were so corroded, for a length of 3ft. longitudinally, as to be nearly eaten through in places, and hence the primary rent from which the explosion sprung.

"Competent inspection would have prevented this explosion, which was due simply to external corrosion, consequent on neglect."

At the monthly meeting held on Tuesday, March 28th, the chief engineer presented his report.

"During the last three months, *i.e.*, from January 1st to March 24th, 559 engines have been examined, and 803 boilers, 39 of the latter being examined specially, and 6 of them tested with hydraulic pressure. Of the boiler examinations, 621 have been external, 32 internal, and 150 thorough or entire. In the boilers examined 326 defects have been discovered, 12 of them being dangerous.

"Three of the cases of injury to furnace crowns are of interest, while the injury in each instance arose from overheating at night-time, in consequence of shortness of water when the fires were banked up.

"The first of these occurred to a plain two-flued 'Lancashire' boiler, which was one of a series of four, and the water was lost through the blow-out valve at the bottom of the boiler.

"The second case of injury to furnace crowns through overheating occurred to a boiler of double furnace, oval flue, water tube construction, set in a series of three, two of them being at work at the time, and all of them connected together, both by the steam and feed pipes. The water in this instance appears to have been syphoned out, through the feed pipe, from one boiler into the other working alongside, the latter being found in the morning to be completely overcharged, while the furnace crowns of the injured ones were laid bare.

"The third case of injury to a furnace crown through overheating, occurred in a plain, single-flued 'Cornish' boiler, the water being lost, as in the previous instance, through the feed back-pressure valve, which was found, on subsequent examination, to have been kept off its seat by some dirt which had got between the two. The feed water, as in the previous instance, was introduced below the level of the furnace crown, so that this is the second case that has recently occurred where considerable inconvenience and expense would have been prevented by the adoption of the simple plan already referred to—viz., that of introducing the feed water above the level of the furnace crown instead of below it.

"Each of the injured furnace crowns, in the three cases just alluded to, was fitted with a fusible plug fixed near to the fire-bridge, and which proved useless in every instance. In the first case, the plugs were of that description in which a movable plate, very similar to a safety-valve, and perforated with a number of small holes filled with alloy, is dropped into a ground seat. The alloy appeared to have just commenced to melt, but owing to the local action of the smouldering fires, which burnt up nearer to the fire-doors than to the bridge, the fusible plug failed to act. In the second case, the fusible plugs were of that description in which a loose leaden washer, about the size of a penny piece, is held in place by an annular cap screwed over it. These also proved useless.

"On the present occasion I have to report the occurrence of eleven steam boiler explosions, by which six persons have been killed and twenty-four others injured. Not one of the boilers, however, was under the inspection of this association.

"In addition to these, an explosion has occurred to a household boiler, by which one person was very seriously injured.

"The boiler in question was employed for the purpose of warming the water in a cistern on a floor above it, and was fixed immediately behind the firegrate of a kitchen range, by which it was heated. On its explosion the kitchen range was blown out of its place, and thrown forward into the room along with a fragment of the boiler, while another piece was blown through the wall at the back, leaving a large opening into the adjoining yard, the windows in the apartment being smashed, and the door frames broken.

"The boiler appears to have been arranged according to the usual plan, being connected to the cistern overhead with two pipes, down one of which the cold water flowed by its superior gravity; while through the other the hotter and lighter water rose, thus establishing a circulation. As long as the fire is in action in these boilers, the circulation continues, provided that the cistern overhead be supplied with water, the pipeway be clear, and the entire communication uninterrupted; while, as long as this is the case, the boiler is perfectly safe, since the open pipes form natural safety-valves, and no accumulation of pressure can take place within the boiler. On the occurrence of frost, however, these pipes are apt the become choked with ice, and the circulation in consequence to be stopped, when, on the application of fire to the boiler any steam that may be generated within it is bottled up, and explosion becomes inevitable if the fire be at all brisk, and retained for any length of time.

"To prevent the recurrence of these explosions, all such boilers should be fitted with a small ordinary metal safety-valve, which would not be affected by changes of temperature, and were this done the water would escape at these valves and relieve the pressure when the pipes were choked with ice.

Tabular Statement of Explosions from January 1st, 1865, to March 24th, 1865, inclusive.

Progressive No. for 1865	Date.	General Description of Boiler.	Persons Killed.	Persons Injured.	Total.
1	Jan. 6.	Locomotive	0	0	0
2	Jan. 6.	Plain Cylindrical: Externally-fired	0	2	2
3	Jan. 9.	Portable Agricultural Multitubular: Internally-fired	0	0	0
4	Jan. 14.	Locomotive	3	6	9
5	Feb. 6.	Ironworks, Horizontal Furnace: Externally-fired	0	0	0
6	Feb. 9.	Ironworks, Vertical Furnace Boiler: Externally-fired	0	2	2
7	Feb. 12.	Locomotive	0	0	0
8	Feb. 20.	Ordinary Single-flue or Cornish: Internally-fired	0	0	0
9	Mar. 14.	Ironworks	1	5	6
10	Mar. 20.	Locomotive	1	1	2
11	Mar. 23.	Ironworks, Horizontal Furnace Boiler	1	8	9
		Total	6	24	30

"No. 3 explosion is an illustration of the importance of equipping boilers with suitable mountings, and occurred to a portable agricultural boiler, of the locomotive multitubular type. It was one that was let out for hire upon different farms for driving thrashing machines, and steam was being got up in it for this purpose, as it was standing alongside the barn, when the explosion happened, on the occurrence of which the man-hole cover was blown completely across a large field, the hind axle of the carriage, on which it travelled, was broken in the middle, the boiler was thrown over on its side, and the engine attached to it torn away and considerably damaged.

"The owner of the boiler attributed the explosion to the lessee's having worked it at too high a pressure, of which he considered that the flight of the manhole cover was sufficient evidence.

"No. 6 explosion was of a very peculiar character, inasmuch as a piece of plate, having a superficial area of about five square feet, was torn out of the side of the boiler, right through the solid metal, and shot away by the force of the steam, while the boiler remained in its place unmoved, and in other respects intact. By the flight of this piece of plate, as well as by that of a portion of the brickwork by which the boiler was surrounded, the roofing of part of the works at which the explosion occurred was carried away, while, in addition, two men were seriously injured, but fortunately no one killed.

"The explosion occurred at an ironworks, to a boiler which was not under the inspection of this Association, and was one of six, which though situated at different parts of the works, were yet connected together, both by the steam and feed pipes. It was of the externally-fired, upright furnace class, so commonly employed at ironworks, and was constructed to receive the waste heat from three puddling furnaces. One of these had, however, been exchanged for a fire-grate of large dimensions, so that the boiler was heated by the flames passing off from two puddling furnaces, and from one fire-grate. The height of the boiler was 24ft., while its diameter was 7ft. 9in. in the external shell, 4ft. in the central descending flue, and 2ft. in the three internal branch tubes, which radiated from it, the plates being $\frac{7}{16}$ of an inch in thickness, and the usual working pressure of steam about 35lb. per square inch.

"The shape of the piece of plate that was blown out of the side of the boiler may be described as that of an irregular parallelogram, measuring about 3ft. 6in. vertically, and 1ft. 10in. horizontally, at the widest part. It was intersected about mid-height horizontally by a ring seam of rivets, which encircled the boiler, and at this line the ejected plate tore asunder into two pieces of somewhat equal size, while the other rents round its circumference were through the solid metal. The hole made in the side of the boiler was situated, as nearly as may be, on a level with the inlets of the central descending flue, and a little to the right hand of the one fed from the fire-grate, which had been substituted for the puddling furnace, so that it will be seen that the rupture took place near to, but somewhat below, low water mark.

"The cause of this remarkable rent did not appear, as far as I was able to detect, to have been the brittleness of the plates, since they withstood repeated and severe blows from a heavy hammer, neither does the local character of the injury allow of its being attributed to overpressure of steam, but there seems little reason to doubt that the rent was caused by the plates being overheated, since it appeared upon examination that the side of the boiler had bulged 4in. outward, in the first place, and then rent down the centre of this bulge in a vertical direction, folding back on one side very much like the leaf of a book, or a door on its hinges, the edges of the plates at the primary rent—which was shown to be such by the direction of the flight of the parts—being drawn out, as they only could have been when the metal was hot, while the fracture at the hinge was that of colder metal.

"This overheating has been attributed to shortness of water, but the man in attendance states that the float indicated an ample supply—there being a depth of 3ft. 6in. over the crown of the central descending flue tube—and that the feed was not only going into the boiler when the explosion occurred, but had been doing so for some time previously; while it may be added that there was a feed back-pressure valve fixed to the boiler to prevent the water's returning through the feed pipe, and that the float is reported to have been in working order.

INSTITUTION OF ENGINEERS IN SCOTLAND.

ON CERTAIN RECENT IMPROVEMENTS IN THE MANUFACTURE OF CAST-IRON PIPES.

By Mr. George Lauder, C.E.

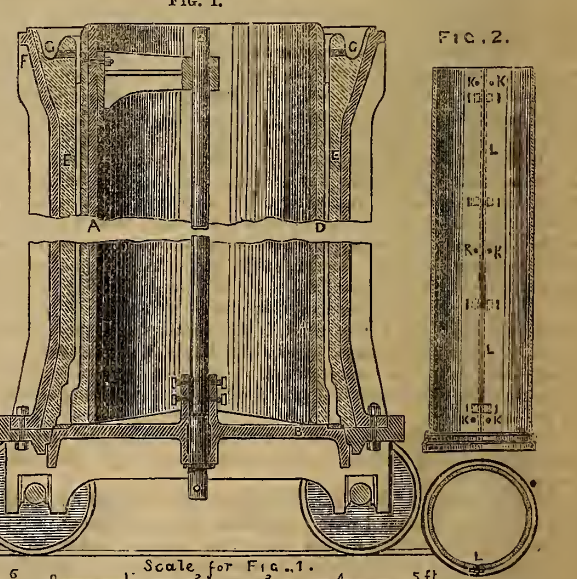
The introduction of elaborate machinery some years ago to facilitate the moulding of cast-iron pipes has rendered pipe-making a separate branch of the iron trade. Pipes are now produced at a price and with a rapidity which leaves hand labour hopelessly behind. Since the introduction of machinery there has sprung up a number of minor improvements, which, although not challenging the attention of those not immediately connected with the manufacture of pipes, may not prove uninteresting to the members of the Institution.

The essential qualities in pipe casting are—1st. Solidity of the metal composing the pipe; 2nd. That the metal be of equal thickness all round, and the pipe cylindrical and straight; 3rd. That the surface—inside especially—be smooth and fair, so that friction may be diminished to the smallest possible amount, and no inequalities be presented to form a nucleus for the deposit of solid matter; 4th. To have as perfect a system of jointing as possible.

The method of casting pipes on end in dry sand moulds, socket down, has for some years past been made an essential in most specifications for large pipes. The advantage to be gained from this mode is, to have all the scoria and other impurities in the metal floated to the top and allowed to lodge in a piece of the pipe which is afterwards cut off, the pipe being made 12in. to 16in. longer for this purpose. By this mode of manufacture the socket is left solid, in fact it is the most solid part of the pipe.

Fig. 1 shows a section of the mould for a 40in. pipe being cast in this way, with an improved core-bar. A A is the core-bar barrel, attached to a bottom plate B B, having its circumference C C turned to fit into a similar turned part in the plate on which the moulding-box F F is fixed. D D is sand forming the core, E E the sand forming the mould.

Fig. 1.



It is usual in casting pipes, socket down, to make the core in two parts, one to form the barrel of the pipe, the other the socket. The socket part being first put into its position in the mould, the barrel part is lowered into its position over it. There is no means of getting at this joint to make sure that it is good before the pipe is cast, so that any inaccuracy in the setting remains undetected until it is too late to rectify it.

With the core-bar here shown the core is made entirely in one piece. It is put in position in the mould, by being drawn up through it from a pit beneath, and accuracy in setting is provided for by means of the turned bottom-plate B B on which the bar is fixed, the turned part C C fitting into a recess, also turned out in the carriage on which the moulding-box is fixed. The mould and core being made concentric with these guiding surfaces, the casting cannot fail to be symmetrical. The mould is made concentric with this guiding surface by means of fitting the socket-pattern with a similar piece to B B, which is put in position and rammed before the moulding of the pipe is proceeded with.

The core shown in the drawing is made of sand, similar to the mould E E, rammed round a collapsable bar. Sand cores have long been in use for small pipes, say 3in. diameter. But it is due to Messrs. D. Y. Stewart and Co. of Glasgow, to mention that they were the first to introduce sand cores in the manufacture of large pipes. The pipes made by their improved method have reached a perfection hitherto unknown in the trade. The process of manufacture is as follows:—

A core-box (fig. 2) is made from a cylinder of cast-iron, the interior of which is of the same form as the interior of the pipe and bored out quite smooth—a slot is cut as shown at L L passing nearly through the metal. The cylinder is then sprung open. The holes K K are for the insertion of shears, which by means of a screw open the box. The snugs I I are cast on, for the purpose of clamping the box together at the split part, so that it may be held firmly while being rammed up. In proceeding to make a core, the core-bar is extended to its largest diameter, and secured at that point, the box is then lowered over it and firmly clamped. Guiding pieces are fixed on the box to fit the turned part of the bottom plate B B, of the bar. The annular space between the box and the bar is then rammed full of sand, the box sprung and lifted off, leaving the core solid and firm. It is passed into the stove to be dried, after which it is coated with black-wash, and is then ready to be placed in the mould, as before described. The core thus formed is rammed on a carriage, which it never leaves until it is lifted off to be put in the mould.

By this process, it will be observed, this core cannot fail to be cylindrical, and from the mode of drying on end, will preserve this form. Variations in the size of the core are also rendered next to impossible, as all the workman has to attend to is, that the box be properly clamped before it is rammed. We thus have a system which removes from the hands of the workman all the essential parts of the process which require his attention, and obtain thereby an accuracy which otherwise cannot be reached.

The absence of inequalities on the inside surface of those pipes strikes the most casual observer. There is not such a thing as a ring or a wave to be seen, these being frequently a matter of much annoyance in loam core pipes, caused by the cracking of the loam in drying. It might be supposed the core-box above described would get injured by the repeated springing. Such is not the case, however; a 3ft. box at present in use has made over 2,500 cores and is as good as at first.

Some difficulty was experienced in the first trials, by the metal washing away the sand at the shoulder of the socket, falling as it does through a space of 13ft. This has been overcome so far by a simple device, which might be applied in other cases with advantage. A gutter, C C, is formed round the top of the mould in the sand, a number of small holes all round form a passage from the bottom of this gutter to the mould. This serves to check the flow of the metal, and preserves the exposed part of the core. It further serves to keep back scoria, &c., which floats on the top, while the pure metal flows from the bottom and fills the mould.

As to the straightness of these pipes, the writer cannot recall a single instance of a bent pipe among a lot of several thousands which have passed through his hands within the last few months. It is no exaggeration to say, that pipes by this method can be taken from the mould almost as fair as from the turning-lathe—of course allowing for the roughness of the skin. Besides the above advantages, the equality of weights of these pipes is not to be overlooked. Taking at random 50 pipes, 3ft. diameter, the extreme variation of weight is from 49 cwt. 2 qrs. 14 lbs. to 47 cwt. 2 qrs. 14lbs.—a difference of only 2 per cent. from the average, while the general average lies within 1·166 per cent. The causes of variation lie in the softness or hardness of the ramming, the difference of temperature between the core-bar and the moulding-box at the time of casting, or a difference in specific gravity of the metal. These causes can all be practically avoided with a very small amount of care. It is no uncommon thing for a number of these pipes to pass the weighs without the weights being altered to a greater extent than within the limits of 14lbs.

As to the expense of working these cores, Messrs. Stewart inform me that the cost is fully more than that of loam cores; but, from the few bad pipes turned out, and no loss occurring from extra weights, the balance is on the right side. The most of the expense arises from the ramming, which is all done by hand, no feasible plan having yet presented itself by which steam power can be advantageously employed. The sand forming the core is used over again, similar to the sand used for the mould, a small quantity of new sand sufficient to form the socket, which is the most exposed part, being added.

The method of jointing is the same as described by Mr. Downie in his paper on pipe joints last session.

The Liverpool Corporation Water-Works' extra main not being yet in full operation, I am unable to give precise information as to the success of turned and bored joints on this large scale. There have been about six miles of pipes made of this size with this joint. From the results of experiments instituted by Mr. Duncan, the engineer of the works, before the joint was finally determined on, there is every reason to expect it will be entirely successful.

Two 12ft. lengths of 2ft. pipe were bolted together by long bolts passing from end to end—a pressure of about 400ft. of water was put on them, the joints being quite tight. The centre supports were then lowered 2in., the joint remaining tight; the supports were then withdrawn altogether, and the "sag" in the centre amounted to from 5in. to 6in., as near as we could judge, before a leak of any consequence occurred. In another experiment, made with 3ft. pipes, the joint was drawn 2in. before there was a leak. These joints were put together with asphalte softened with pitch oil to about the consistency of putty, with two turns of rope yarn thread round the spigot end—both socket and spigot being warmed, and the asphalte hot, when put on. This joint is an approximation to that proposed by Mr. Downie, which has only a belt on the spigot end of the thickness of the pipe, and no taper, while the socket strip is broad and slightly tapered.

Professor Rankine said he had seen the whole of the process, both of making the moulds and casting the pipes upright, according to the mode described by Mr. Lauder, and he could fully corroborate all the advantages which were stated to belong to it. One special advantage accruing from pipes being cast with the socket end down was that the flaws and air bubbles were always at the top, so that by cutting off the upper part the pipe was left perfect. There were also other advantages connected with the various details, and indeed the whole process was exceedingly well contrived, and answered the purpose very well. The joint described was made according to the specification of the particular water-works for which it was intended; and he declined to express any opinion regarding it.

Mr. Alexander Smith could speak from experience of the work done by the machine described. His firm had got cylinders of 8ft. diameter cast by it to form piers for the bridge across the Clyde on the line of the Caledonian Railway at the Float, and for accuracy of size they were unsurpassed. In fact, the machine seemed altogether well adapted for making good work. He admired very much the plan adopted of slackening the core immediately after the metal was set, and thereby allowing the pipe to shrink without the slightest strain being put upon it.

Mr. Lauder said the chief novelty was the sand core, they having all formerly been made of loam. The cylinders which Mr. Smith referred to had been made on this system with a sand instead of a loam core, as formerly.

In answer to Mr. Lawrie, Mr. Lauder said there was great difficulty in making long sand cores by machinery, from the necessity for having lengthy rammers. To apply steam power for this purpose would not answer, as the space for sand between the core-bar and the core-box would not admit of making the rammers of such strength as to stand the work, and there were other difficulties in the way of applying power.

Mr. Downie remarked, that the application of *sand cores* to such large pipes was very interesting; the largest sizes yet used were 3ft. or 3ft. 4in., but it seemed quite applicable to almost any size; if the question of expense did not interfere, and on this point Mr. Lauder had told them they did not compare favourably with *loam cores*. One great difficulty was to get this kind of core to stand the rough usage consequent on shifting the cores from the ramming pits to the drying stoves while they were yet *green*. After they were *dried* there was very little risk. In reply to a remark of Mr. Lawrie's about increasing the thickness of sand, he said that in addition to the extra expense for materials and drying this would incur, the very first pinch of the carriage would cause it all to drop and fall down, if it were made so thick as Mr. Lawrie suggested to give strength sufficient to the rammers for the application of power, and to do away with the manual labour. In fact, there would be, in such case, great chance of their dropping or falling to pieces immediately on the removal of the core-box. The proper thickness of sand was only got at by a long series of trials of various thicknesses; and he believed Messrs Stewart and Co. had found $1\frac{1}{4}$in. or so to be about right. There was another practical difficulty in the application of sand cores, and that was the great tendency of the sand to *scab*, or scale off, at the back of the socket, by the molten metal striking with great force on the projecting part of the core in falling from the *runner* overhead. This was got over by making a very large number of small "gates," thus subdividing the stream and lessening the shock. Still, with every care in using fresh sand, sprigs, sheet tin, and other applications, to resist the molten metal, there was sometimes trouble from this cause, while with loam cores, properly made, no such difficulty existed. Then there were the inequalities due to differences of temperature in either the core-bars or core-box, as well as those resulting from ramming by hand. For instance, in parts where it was *soft rammed* there would be lumps or irregularities inside the pipes, and the weight would be thereby slightly increased; but if they were kept within the limit Mr. Lauder assigned, it was indeed very satisfactory. In loam cores, although there was no trouble from this sort of *straining*, yet there were often cracks in the loam, which produced *veins* in the castings, and it was certainly very desirable to get pipes smooth inside, even at some extra cost in the manufacture. But unfortunately for the founder, he got no better price for his wares, and the prices were generally so low as afforded little margin for much refinement. As regards Mr. Smith's bridge cylinders, they were not made by the moulding machine, but by hand labour from a collapsing pattern, and expanding core-box; and as to his remark about the advantages of *slacking the core* immediately after the metal was set, this advantage was common to *all* collapsing core-bars since the first of that class of bars was designed and applied successfully some eighteen years ago.

The President remarked that steam engine cylinders were cast in pits, and run from the bottom, so as to prevent the defects referred to by Mr. Downie, and he would like to know what objections of a practical kind there were to that plan being adopted with regard to pipes?

Mr. Downie replied that pipes were not cast in sand pits like steam cylinders, but the moulds in iron casings all stood in the open. In short, the system was totally different in casting pipes from that usually practised in making steam cylinders. The system described by Mr. Lauder was a great improvement in many respects.

Mr. Lauder remarked that the objection made by Mr. Downie regarding the inequality in the pipes by the expansion of the core-box when heated was got over by keeping it at the same temperature the whole day. In the morning it was heated with shavings, and so the temperature was kept equal. It had been found that when the core-box was warm it worked far better than when cold, for in the latter state the sand was apt to stick to it.

Mr. Downie said that one striking feature of this core was its protecting the core-bar from rapid irregularities of temperature, which were well known to be injurious to all collapsing core-bars. In the case of a sand core $1\frac{1}{4}$in. thick, the bad conducting properties of the sand were in its favour, and therefore less destructive to the working parts as compared with the usual loam core made without hay bands, because in all collapsing core-bars a core could only be got to hang with loam from the thickness of ⅜in. to ⅝in., and the consequence was the parts of the bar expand and get out of order, and warp and twist frequently with continuous use. There was no doubt a great irregularity of temperature produced by rapid casting, and he did not admit that the heat produced by shavings in the morning could equal the heat of casting during the day; in any case, heating the *core-box* did not get over the difficulty with the *core-bars* and casings. As regards the turned and bored joint, it was similar to that described in last year's Transactions; and it was very satisfactory to him that the remarks made in the paper then read on the subject of turned and bored joints were fully corroborated by subsequent experience, and confirmed by the paper now read by Mr. Lauder.

Note by Mr. G. Lauder since the paper was read.—In looking over the proof sheet of the discussion on my paper, I see Mr. Downie appears to have said that "sprigs, sheet-tin, and other applications" are used to preserve the socket part of the core. This is not the case—nothing of the kind having been found requisite, since the gutter, mentioned in my paper, was resorted to. Further, with regard to the heating of the core-box—in working, no difficulty is experienced from this, as the small variation in the weights of the pipes shows.

ROYAL INSTITUTION OF GREAT BRITAIN.

ON THE EOZOON AND THE LAURENTIAN ROCKS OF CANADA.

By Professor A. C. Ramsay, F.R.S.

Mr. Ramsay commenced by giving a brief account of the physical structure of part of the interior of North America, which consists of great plains and tablelands lying between the ranges of the Laurentian mountains (which run from Labrador far westward along the north shores of the St. Lawrence and Ottawa), the mountains of Gaspé and the Appalachian chain, and the gradual slopes of the Rocky mountains in the far west. The geological survey of Canada embraces great tracts of the Laurentian mountains and of the mountains of Gaspé, and all the flat country that lies south of the St. Lawrence, the Ottawa, and Lake Huron, and in these territories a vast region has been surveyed in a manner that may fairly be said not to have been surpassed on any part of the North American continent. This survey was begun in the year 1842, and before its commencement the Silurian strata of the United States having been generally correlated to those of Europe, the precise relations of the strata of Canada to both soon began to be established. Before that period very little was known by geologists about the Laurentian rocks, except that they consisted of gneiss, granite, syenite, and so-called igneous masses, and the geological age of the series was undetermined. Indeed, the gneiss of the mountains north of the St. Lawrence, and of the Appalachian chain, of Gaspé, Newfoundland, and other districts were all more or less confounded together, and supposed, *as gneiss*, to be probably of the same or nearly of the same age.

But in 1845 it was first proved by Sir William Logan that the Laurentian gneiss lies unconformably under the Potsdam sandstone, a rock well known to be the equivalent of the Lingula flags of Britain, or the "Primordial zone" of Barrande, then and for long after supposed to contain in its lingulæ and trilobites the earliest created forms of organic life. This, taken in connection with the discoveries of other American geologists, clearly proved the Laurentian gneiss to be of much earlier date than the greater part of the gneiss of the Green Mountains (a part of the Appalachian chain) and of Gaspé, &c., for they were shown to be the metamorphised representatives of various members of the Silurian series, most of them younger than the Potsdam sandstone.

This was followed by the discovery of the Huronian rocks, which were proved also to be older than the Potsdam sandstone, but younger than the Laurentian gneiss; and not only so, but it is also shown that the Huronian rocks, themselves metamorphic, were deposited after the metamorphism of the Laurentian strata; for they contain pebbles and boulders of the latter in such a condition, that it is plain the metamorphism of the masses from which they were derived took place long before the commencement of the Huronian epoch.

In 1863 a stratigraphical discovery still more remarkable was made; for it was proved that the Laurentian rocks themselves consist of two series of altered strata, the uppermost of which lies in the highest degree unconformably on the lower series; and it was again found that the Potsdam sandstone, quite unaltered, lies thoroughly, unconformably on the upper Laurentian gneiss.

Besides total unconformity, there is a marked and constant distinction in the nature of the gneiss of the two series, the lower being Orthoclase-gneiss, containing potash-felspar, while the upper has been called Anorthosite-gneiss, containing lime and soda-felspars, much of which is true Labradorite; and these differences being constant, there is no difficulty in distinguishing the two series.

Both series are exceedingly contorted, and have undergone an amount of metamorphism that may almost be called extreme, unless we adopt the view that granite and its allies are the result of an amount of metamorphic action so excessive that the rocks have passed beyond the stage in which foliation still remains.

The Lower Laurentian being at present the oldest known stratified series, its base is unknown; although as it contains in some cases water-worn stratified pebbles, it is clear that its original unmetamorphised materials were derived from the waste of consolidated stratified formations of far older date. Neither are its topmost strata known, for all the other strata with which it is in contact lie unconformably upon it. Its known thickness is, notwithstanding, very great, as the following measured section of a portion of the strata will indicate. It is given in descending order:—

1	Orthoclase gneiss	3,400 feet.
	Crystalline limestone	20 "
	Orthoclase gneiss	1,580 "
2	Crystalline limestone of Grenville, with a thin band of gneiss and *Eozoon Canadense*	750 "
	Orthoclase gneiss with quartzite and garnets	3,500 "
3	Crystalline limestone, with two bands of gneiss, with garnets and hornblende	2,500 "
	Orthoclase gneiss	4,000 "
4	Crystalline limestone of Trembling lake	1,500 "
	Orthoclase gneiss of Trembling mountain	5,000 "
		22,250 "

It was in 1858 that fossils were found in the band of limestone No. 2; and at first they were considered by Sir W. Logan to belong, probably, to the genus of corals known as *Stromatopora*: but renewed examinations, first by Dr. Dawson, Principal of M'Gill College, Montreal, and afterwards by Dr. Carpenter, establish that in reality the fossils are *Foraminifera*, not detached like those of more modern type, but that they lived and grew in a peculiar mode over wide areas in the sea bottom, in a manner somewhat analogous to the mode of growth of a bank of corals. The chambers (as shown in the diagrams used) are unsymmetrical, and while growing spread irregularly, and they are enclosed above and below by a layer having a finely tubular structure similar to that of the shell of the nummulite and other allied forms. Between these layers the sarcode-body was enclosed, and between the irregular chambers there frequently lies an interskeleton penetrated by numerous branching tubes, and by an occasional larger tube, called by Dr. Carpenter the Stolon. The chambers that contained the sarcode-body and the tubes now consist of serpentine, and the interskeleton of carbonate of lime; and on an acid being applied the silicious casts of the tubes are found so arranged that Dr. Dawson and Dr. Carpenter had no doubt as to the organic nature of the specimens, which were examined by them with the microscope most carefully. Better authority it is impossible to have.

Having visited the district with Sir W. Logan, I think I may safely say that the chief part of all the bands of limestone is so crystalline (from metamorphic action) that it is hopeless to expect to find fossils in them; but that part of the band No. 2, in which they have heretofore been observed, attains a thickness of about 200ft., and doubtless Eozoon or other traces of organic remains may yet be found elsewhere. It is by a lucky accident, so to speak, in metamorphic action, that they have been preserved where we now find them; and, said the speaker, "I for one firmly believe not only that all these Laurentian deposits were of marine origin, but also that the original matter of limestones of such vast thickness, and that once spread so widely over the old sea bottom, must have been chiefly formed by the growth and decay of organic bodies."

Mr. Ramsay then showed the importance of these discoveries in relation to geological time.

First, he spoke of metamorphism having, according to the best hypothesis, been produced by heated alkaline waters in rocks deeply buried beneath vast accumulations of strata, since removed by denudation.

Before the commencement of the Silurian epoch such metamorphic actions had already taken place three times; first, in the lower Laurentian rocks; secondly in the upper Laurentian rocks; and thirdly, in the Huronian series, and each set of strata had evidently been subjected to prodigious waste and denudation, before the commencement of the formation that now succeeds it in the American series.

But secondly, geological time is not to be measured merely by the formations now existing, for the unconformities indicate gaps, or periods of time, stratigraphically unrepresented, which were probably far longer in duration than the time occupied in the deposition of the formations that remain.*

Again, an instructive moral may be drawn from a consideration of the subject with regard to the style of reasoning that has often been too prevalent with respect to the discovery of the oldest zones of life of various kinds. For example, for many years no one doubted that the Lower Tertiary or Eocene beds contained the oldest relics of mammalian life, and a great outcry of disbelief was raised when they were discovered in the secondary rocks in the Stonesfield slate of the lower Oolite. Since then the *Microlestes* has been found in the New Red series, and there for the time it rests. The same kind of astonishment prevailed, as reptile bones were successively discovered down through the Lias into the Trias, and from these into the Palæozoic formations of Permian, Carboniferous, and Old Red Sandstone age. And when we consider the history of the mollusca, as recorded by distinguished geologists, the same hankering after finality has constantly cropped out. The "primary formations," it was said, contained no fossils, for they were formed before the creation of life began; till late in last century Hutton dispelled the illusion by proving the presence of fossil shells in so-called "primary clay slates." For some time the Llandeilo flag of Sir Roderick Murchison were regarded as the oldest fossiliferous rocks, till on the discovery of the still older lingula flags and their equivalents in Bohemia, they were fondly named the *primordial zone*. "Here at last is a resting place; we can hope for nothing older than the lingulæ and trilobites of this great original 'primordial zone;' but soon Mr. Salter found annelids, and as he thinks trilobites on an horizon lower still, and the beginning was again thrown farther back into time; and no one dared to dream of traces of life yet older, being found in gneiss, for if they even ever existed there, which is improbable, they must have been all obliterated by metamorphic action. Suddenly Sir. W. Logan makes a great leap, thousands of fathoms deeper than any formation previously known to contain the relics of life, and from the limestones there extracts the Eozoon, from rocks so immeasurably older than the oldest Silurian and Cambrian strata, that no power of imagination can feebly realise, even in a geological sense, the great gaps that

* See the Presidential Anniversary Addresses to the Geological Society, for the years 1863 and 1864, by Professor A. C. Ramsay.

lie hetween them; and though we may feebly attempt to estimate the latest lapses of geological time, we can no more hope to fathom these Laurentian depths than we can hope to measure the distance of the most unresolvable of the unresolved ucbnlæ, merely because we are able to estimate our distance from the sun."

CORRESPONDENCE.

We cannot hold ourselves responsible for the opinions of our Correspondents.

LAKE'S DIFFERENTIAL ENGINE.

To the Editor of THE ARTIZAN.

Sir,—In the last nnmher of THE ARTIZAN there is a letter from Mr. Campin claiming for Lake's differential engine an economy superior to that of the Cornish variety, and therefore by inference far superior to that of the ordinary high pressnre engine. I think, however, that a simple calculation will show that it possesses no such advantage. The quantity of steam used in the engine quoted as an example by Mr. Campin is stated as ·28 cubic feet for each revolution, the absolute pressure being 75lbs. per square inch. In order that this quantity of steam should be used in an ordinary high pressure engine having the same stroke as the sample engine (12in.), and working at the same rate of expansion, viz., 5 to 1, the piston should have an area of 100·8 square inches, and the work done in each stroke would then be as follows :—

Before steam is cut off	$75 \times 100{\cdot}8 \times {\cdot}2 = 1512$	foot pounds.
During expansion	$45 \times 100{\cdot}8 \times {\cdot}8 = 3628{\cdot}8$	„
	$5140{\cdot}8$	„
Deduct for resistance of atmosphere	$15 \times 100{\cdot}8 \times {\cdot}1 = 1512$	„
Total power developed in each stroke	$3628{\cdot}8$	„

or 7257·6 foot pounds for each revolution, against 6,000 foot pounds obtained from the differential engine by the same expenditure of steam.

As, however, the quantity of steam that would be used by the engine mentioned by Mr. Campin would not be *exactly* ·28 cub. ft., it may be better to compare it with the ordinary engine in another way. The trunk of Mr. Campin's engine is supposed to be equal in its contents to a cylinder 12in. long, and having a sectional area of 50 sq. in., and the quantity of steam used at each revolution is equal to four-fifths of the contents of this trunk. The same quantity of steam would evidently be used by an ordinary high pressnre engine having a cylinder of 40 sq. in. sectional area, and 2ft. 6in. stroke, the steam being expanded five times, as in Mr. Campin's example. The work done by an engine of these proportions, working with steam of an absolute pressure of 75lbs. per square inch would, in each stroke, be as follows :—

Before steam is cut off	$75 \times 40 \times \frac{1}{2} = 1{,}500$	foot pounds.
During expansion	$45 \times 40 \times 2 = 3{,}600$	„
	$5{,}100$	„
Deduct for resistance of atmosphere...	$15 \times 40 \times 2\frac{1}{2} = 1{,}500$	„
Total power developed in each stroke	$3{,}600$	„

or 7,200 foot pounds for each revolution against the 6,000 foot pounds obtained from the differential engine. The horse-power of the high pressure engine, when working at 35 revolutions per minute would be $\frac{7200 \times 35}{33000} = 7{\cdot}63$ horse-power.

Taking the steam used as ·28 cubic feet at each revolution, the quantity used per honr would, as Mr. Campin states, be 588 cubic feet; and this divided by 7·63 would give 77 cubic feet per horse-power per hour, against 92 cubic feet for the differential engine.

The weight of 77 cubic feet of steam having an absolute pressure of 75lbs. per square inch is equal to $77 \times {\cdot}163 = 12{\cdot}551$lbs., and if the evaporative power of the fuel employed be taken at $7\frac{1}{2}$lbs. of water to 1lb. of fuel, as in Mr. Campin's letter, the consumption will be 1·67lbs. per horse-power per hour against 2lbs. for Lake's engine.

The amount of fuel thus estimated is, as is well known, very far helow that actually necessary in practice; and there are many reasons why this should be the case. In the above calculations no allowances have been made for the loss of power caused by the friction of the steam in the pipes and steam passages, by radiation or by defective exhaustion, each of which influences would by itself materially affect the results obtained. For such a comparison between the two classes of engine as has been made in this letter, the allowances just alluded to are hardly of much importance, as they would be reqnired for both engines. The radiating surfaces of the cylinders and trunk would, however, be greater in the differential engine than in an ordinary high pressnre engine of equal power.

I have already trespassed so much upon your space that I must not at present more than allude to the simplicity of construction claimed for Lake's engines. The sketch accompanying Mr. Campin's letter scarcely supplies sufficient data upon which to form an opinion, but from the information thus given I certainly cannot think that the differential engine possesses any advantage in this respect.

I am, Sir, yours truly,

Stratford, March 23rd, 1865. W. H. MAW.

To the Editor of THE ARTIZAN.

SIR,—In reply to Mr. Maw's letter on the above subject (dated March 23rd), allow me to call attention to his ignoring the fact that in Lake's engine there are no steam passages wherein steam can be wasted, as in ordinary engines; hence he is wrong in stating that the allowances on this head would require to be made alike in his example and mine. As regards the simplicity of construction, the sketch to which Mr. Maw alludes shows all the moving parts save the fly-wheel, shaft, governors, and eduction valve, which is a simple conical valve. The exhaustion in Lake's engine is necessarily more perfect than in the ordinary, as the exhaust valve remains *full open* during the entire stroke. If we take Mr. Maw's figures *theoretically*, they may be called accurate; but it is evident that they represent a practical impossibility; and I think it would be more satisfactory if he would calculate the loss in steam passages, defective exhaust friction in *glands, slide valves, eccentrics* (existing in the common *engine*, but not in Lake's), and give the results; I think they will balance the 14 or 15 per cent. saving he claims in the ordinary engine over Lake's.

I am, Sir, yours, &c.

FRANCIS CAMPIN.

REVIEWS AND NOTICES OF NEW BOOKS.

Handbook of the Steam Engine, containing all the Rules required for the Right Construction and Management of Engines of every class, with the easy Arithmetical Solution of those Rules. By JOHN BOURNE, C.E., author of "A Treatise on the Steam Engine;" "A Treatise on the Screw Propeller;" "A Catechism of the Steam Engine," &c. London: Longman's. 1865.

Mr. Bourne's design in undertaking the present book was, that it should form a key to the catechism of the steam engine; but, he adds in his preface, it has, "during its composition, been somewhat extended in its scope and objects, so as also to supply any points of information in which it appeared to me the catechism was deficient, or whereby the utility of this Handbook as a companion volume would be increased."

From the lateness of the period at which the book reached us, we cannot, this month, do more than give a glance at its contents. Chapter 1 is devoted to the arithmetic of the steam engine; chapter 2 to the mechanical principles of the steam engine; chapter 3 to the theory of the steam engine; chapter 4 the proportions of steam engines; chapter 5, proportions of steam hoilers; chapter 6, power and performance of engines; chapter 7, steam navigation.

To the last chapter, viz., steam navigation, Mr. Bourne has devoted about eighty pages, and has interspersed the chapter with numerous woodcuts; and altogether it is one which will be read with considerable interest by the engineering student. In chapter 6 Mr. Bourne has devoted some space to the subject of the Giffard Injector.

There is also an interesting series of papers upon the construction and use of the indicator, in which Richards's patent instrument is described; and its advantages, as compared with those previously in use, are pointed out. Some excellent remarks on the making or taking of diagrams, and the interpretation of indicator diagrams are also given.

Mr. Bourne's remarks upon heating surfaces of modern hoilers, and on the relative surface areas in boilers and condensers are valuable.

Altogether Mr. Bourne's Handbook of the Steam Engine is an admirable work, and a valuable addition to the engineer's library.

A Record of the Progress of Modern Engineering, 1864, *Comprising Civil Mechanical, Marine, Hydraulic, Railway, Bridge, and other Engineering Works. With Essays and Reviews.* Edited by W. HUMBER, A.I.C.E., M.I.M.E. London: Lockwood and Co. 1865.

The present volume, heing the second of the series, is superior to its predecessor in the selection of subjects, in the textual description, and in the illustrations as to general views, as well as details. There are forty-eight pages of textual matter devoted to the general description, and specifications, and details of the engineering works illustrated by the thirty-six large and well-executed plates, forming, together with the analytical index, a very excellent record of public works in progress, or completed, in 1864. There is (pp. 6 to 9) a short chapter "Upon the Coating of Iron-structures to prevent Oxidation," which is deserving of the careful perusal of the engineer and architect; the subject is a most important one, and it has received at Mr. Humher's hands the most careful study since 1851; it is very ably treated in the present volume. The short biographical sketch of the late Robert Stephenson, Esq., C.E., is accompanied hy a very good photograph of the late R. Stephenson, Esq., C.E., by Caldesi & Co.

Meteorology and the Laws of Storms. Being a New Theory of the Causes of Winds, and an Investigation of the Nature of Storms, concluding with Practical Rules for their Avoidance. By GEO. A. DE PENNING, C.E. Calcutta: Bengal Printing Company. 1864.

A work well worthy of careful study. The author has treated his subject in a scientific and practical manner that entitles his theory to attention.

Obituary.

We regret to learn from Java, that Mr. W. Cores de Vries, the great benefactor of the Netherlands Indian Archipelago, expired at Wiesbaden, on the 29th November last, whither he had retired, but too late, for the restoration of his health.

The limited space at our command in the present number prevents us detailing the many services rendered to his country, by Mr. de Vries; by whose efforts the company formed in 1851 for the conveyance of the mails and transport of troops to the most remote of the Netherland Colonies, was established, as also were the Dry Docks in Java, and the Floating Docks at Sourabaya and Batavia.

NOTICES TO CORRESPONDENTS.

Rovere (Naples).—We believe that an Italian edition has beeu published of Karmarsch's "Mechanische Technologie." You will find in that work full information upon the subject of your inquiry. The original work, iu Germau, was published by Gebruder Hahn, Hanover.

F. F. (Paris).—Your letter received at our succursale iu Glasgow has been forwarded on to us here; and as you have furnished us with your address, we shall have pleasure in sending you through the post the information which we are collecting for your guidance.

"Inventor."—1. We have referred your letter, to the Director of "The Artizan Patent Office," from whom you will have received the particulars asked for; 2. No; the commission do not advise a reduction of the existing fees on patents; they are of opinion that the existiug fees and the present mode of paying them should be retained.

A. N. (Russia).—We have received your letter and sketches enclosed. If you will write stating more distinctly what you wish, and give us your address (which your letter does not contaiu) we will thereupon advise you as to the most desirable course to be taken. We refrain from expressing our opinion until wc hear from you stating more definitely upon what points you seek our opinon and information.

R. B.—1. We should recommend neat's-foot oil. 2. There is no published work that we know of upon the subject. You may, however, find some information as to values, &c., in some of the commercial newspapers and bulletius, or circulars, such as the "Commercial Daily List," London, the "Liverpool Mercantile Gazette," and the "Liverpool Journal of Commerce." There is also published, we believe, in Liverpool the "Oil Trade Circular" (or Review), which latter, perhaps, would serve you more particularly.

E. P. (Greifswald).—We have written you at length upou the several subjects mentioned in your letter, and await receipt of your reply.

Mechanic (Sau Francisco).—Your lengthy commuuication iutended by you to have been addressed to our Glasgow office, having been insufficiently directed, was not delivered there until after some delay. We have your letter now before us, as we are going to press, but too late for insertion or notice, as to the points raised, iu our present issue.

PRICES CURRENT OF THE LONDON METAL MARKET.

	April 1.			April 8.			April 15.			April 22.		
	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
COPPER.												
Best, selected, per ton	90	0	0	90	0	0	93	0	0	93	0	0
Tough cake, do.	88	0	0	88	0	0	90	0	0	90	0	0
Copper wire, per lb.	0	1	0	0	1	0	0	1	0	0	1	0
„ tubes, do.	0	1	1	0	1	1	0	1	1	0	1	1
Sheathing, per ton	95	0	0	94	10	0	95	0	0	95	0	0
Bottoms, do.	100	0	0	100	0	0	100	0	0	100	0	0
IRON.												
Bars, Welsh, in London, per ton	7	2	6	7	2	6	7	7	6	7	7	6
Nail rods, do.	8	10	0	8	10	0	8	10	0	8	10	0
„ Stafford in London, do.	8	10	0	8	10	0	8	15	0	8	15	0
Bars, do.	9	0	0	9	0	0	8	15	0	8	15	0
Hoops, do.	9	12	6	9	12	6	9	15	0	9	15	0
Sheets, single, do.	10	7	6	10	7	6	10	7	6	10	7	6
Pig, No. 1, in Wales, do.	4	10	0	4	10	0	4	10	0	4	10	0
„ in Clyde, do.	2	12	6	2	13	3	2	13	3	2	15	6
LEAD.												
English pig, ord. soft, per ton	20	5	0	20	5	0	20	5	0	20	0	0
„ sheet, do.	21	0	0	21	0	0	20	10	0	20	10	0
„ red lead, do.	22	0	0	22	0	0	22	0	0	22	0	0
„ white, do.	26	0	0	26	0	0	26	0	0	26	0	0
Spanish, do.	19	10	0	19	10	0	19	0	0	19	0	0
BRASS.												
Sheets, per lb.	0	0	9½	0	0	9½	0	0	9½	0	0	9½
Wire, do.	0	0	9	0	0	9	0	0	9	0	0	9
Tubes, do.	0	0	9¾	0	0	9¾	0	0	9¾	0	0	9¾
FOREIGN STEEL.												
Swedish, in kegs (rolled)	15	10	0	15	10	0	15	10	0	15	10	0
„ (hammered)	16	0	0	16	0	0	16	0	0	16	0	0
English, Spring	18	0	0	18	0	0	18	0	0	18	0	0
Bessemer's Engineers' Tool	44	0	0	44	0	0	44	0	0	44	0	0
TIN PLATES.												
IC Charcoal, 1st qua., per box	1	7	0	1	7	0	1	7	0	1	8	0
IX „ „ „	1	13	0	1	13	0	1	13	0	1	14	0
IC „ 2nd qua., „	1	5	0	1	5	0	1	5	0	1	6	0
IC Coke, per box	1	1	6	1	1	6	1	1	6	1	2	6
IX „ „	1	7	6	1	7	6	1	7	6	1	8	6

Institution of Naval Architects.—Mr. Alexander M'Laiue, of Belfast, shipbuilder and Board of Trade Surveyor, whose "End-on" system of naval construction has received the careful consideration of the Admiralty authorities, perhaps in consequence of the facilities it is said to present for mounting the very heaviest guns possible to manufacture in the ships designed by Mr. E. J. Reed, the Chief Constructor of the Navy, has, we understand, been lately promoted from being an associate to be a member of the Institution of Naval Architects.

NORMAND'S PATENT SAWING MACHINES.

Referring to our announcement in last month's issue, we regret we are unavoidably prevented giving the Plate and descriptive particulars which we have prepared of Messrs. Normand's patent machine for the curvilinear sawing of ship-frame timbers, &c., until our next issue.

RECENT LEGAL DECISIONS

AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

Under this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical hearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least —less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

Liability for Injury to Land.—The action, Tipping *v.* the St. Helens Smelting Company, was for compensation for injury to land caused by the ahove-mentioned company. The plaintiff had purchased several hundreds of acres of land, witb a mansion house. The company had erected some copper works at a short distance from the plaintiff's property before he purchased it: and the injury was caused by the vapours from those works. Mr. Justice Mellor, in summiug up at the trial at Liverpool (when a verdict was found for the plaintiff) directed the jury that every man was hound to use his own property in such manner as not to injure the property of his neighbour, unless by lapse of time he had acquired a perspective right to do so; that the law did not regard trifling inconveniences, but that everytbing must be looked at from a reasonable point of view; and that, therefore, in an action for a nuisance to property by noxious vapours arising on the land of anotber, the injury to be actionable must be such as visibly to diminish the value of the property, and the comfort and enjoyment of it; that in determining that question tbe time, locality, and all tbe circumstances should be taken into consideration; and that in countries where great works had been erected and carried on, which were the means of developing the material wealth of the country, persons must uot staud on extreme rights, and hring actions in respect of every matter of annoyance, as, if it were so, business could not be carried on in those places. The question lately argued in the Court of Excbequer Chambers was whether this direction was right in point of law; and the Court held that it was, and sustained the verdict.

The European and American Submarine Telegraphic Company (Limited) v. Elliot and Others.—This was a demurrer to the bill for want of equity. The bill contained allegations to the effect that in March, 1857, the defendant, William Wylde, and the late John Lewis Ricardo, who died in August, 1862, obtained from the Portuguese Government a concession for twenty years of an exclusive right to hiing telegraphic cables under the sea to, and land them on tbe coasts of, and take them over the Azores, with rigbt to transfer the concession to a company; that in the early part of 1857 one of the plaintiffs, Serjeant Glover, was engaged in forming the European and American Submarine Telegraphic Company (Limited), for the purpose of purchasing the above concession and laying down submarine telegraphic cables from England to Portugal, and thence by the Azores to America; that in May, 1857, tbe defendants Pinniger and Tupper, on behalf of Wylde and Ricardo, agreed to sell the above concession to Mr. Serjeant Glover for the purposes of the above company, "in tbe event of his handing to them £10,000 in cash and £5,000 in shares of tbe contemplated company;" that such company was duly registered on the 27th of April, 1858; that in July, 1860, the defendant William Rowett procured a concession from tbe French Government for the exclusive right of laying on French territory submarine telegraphs betweeu France, Spain, Portugal, and America; and tbat, immediately after such last-named concession, tbe defendant William Rowett, who had the means of bringing great influence to bear on the Portuguese Government, had used his strongest efforts to prevent the ratification of the concession of March, 1857; that tbe French influence at the Court of Lisbon had been used for the purpose of defeating such last-named concession, and procuring a new concessiou of the exclusive right to use the Azores to be made to tbe defendaut William Rowett and his associates; that early in 1864 the defendants Admiral George Elliot, Admiral Drummond, Captain Sir J. C. Dalrymple Hay, Admiral Sir G. Sartorius, and William Rowett, with otbers, formed a company which was about to be incorporated by the name of the Ocean Telegraph Company (Limited), with a capital of £720,000 for establishing snbmarine telegraphic communication between Europe and America from France, at Brest and Cape Finisterre, to the Azores, and thence to America; that Serjeant Glover, upon hecoming aware of the formatiou of the Ocean Telegraph Company, gave notice to its promoters of his intention to protect his interests under the coucession of March, 1857; that such notice led to negociations which terminated in an agreement dated 19th of December, 1864, made between Serjeant Glover and persons authorised to act on behalf of the defendants, whereby the Ocean Telegraph Compauy agreed on the concession of March, 1857, heing perfected by tbe Portuguese Government to purchase the same for £80,000, and Serjeant Glover and William Rowett were to use their best endeavours to perfect such concession; that Rowett opposed the ratification of Glover's concession; that the defendants were endeavouring to obtain from the Portuguese Government a concession similar to that of March, 1857; that Wylde was co-operating with them for that purpose, and that the defendants Elliot, Drummond, Hay, and Sartorius were exerting the influence they possessed by virtue of tbeir official position in her Majesty's Government, or as officers in her Majesty's service, to influence the Portuguese Government to grant a new concession of the rigbt to use the Azores and the Portuguese territory for the purpose of electric telegraph cables for tbe benefit of the Ocean Telegraph Company; that Serjeant Glover had always been, and was now ready and willing, to join in the ratification of the concession of March, 1857, but the plaintiffs were apprebensive that tbe influence of the defendants with the Portuguese Government would induce it to cancel that concession and to grant a new concession to the defendants. The plaintiffs therefore prayed for an injunction to restrain the defeudants from procuring the grant or ratification of any concession by the Portuguese Government of any right to use the Azores for the purpose of any electric telegraph except an application in conformity with the agreement of December, 1864, that tbe defendants might be decreed specifically to perform the agreement of May, 1857, and that it might be declared that they were, in case they should obtain any such concession as aforesaid from the Portuguese Government, liable to pay to the plaintiffs, aud that they might be ordered to pay to tbem, accordingly, the sum of £80,000, in accordance with the agreement of December, 1864. The defendants Elliot, Drummond, Hay, Sartorious, and Rowett demurred to the bill for want of equity. The Vice-Chancellor said the agreements of May, 1857, and December, 1864, were too vague in their terms to be the subject of relief in this court. There was nothing in the agreement of December, 1864, which could enable any one to say what sort of an application was to be made to the Portuguese Government for perfecting its sanction to the concession. The demurrer must therefore be allowed.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

Industrial Exhibitions.—An Act of Parliament has just received the Royal Assent for the protection of inventions and designs at industrial exhibitions. The Board of Trade may certify "Industrial Exhibitions," and the exhibition of inventions and designs at such places is not to prejudice patent rights or registration.

Tunnel-Driving Machine.—An interesting experiment, connected with excavations of hard substances in railways and quarries, is being tried at the seat of Mr. W. B. Beaumont, of Upper Wood Hall, Wakefield, near to the South Yorkshire line of railway. It is a machine patented by Captain Beaumont, for driving tunnels in stone by machinery. The system pursued is briefly as follows:—A series of cutters or jumpers, are arranged around the periphery of a strong iron wheel or bore head, which latter is also armed at its centre with a single tool. The system is set in motion by steam or compressed air, acting through the medium of a piston and cylinder, with its necessary accessories of valves, &c., giving a series of heavy blows, while at the same time the bore-head rotates slowly on its axis, thus cutting a continuous chase or groove, which isolates a cheese-shaped mass of rock; the centre tool, or jumper, has meanwhile cut a central hole capable of containing a sufficient amount of powder to shatter the rock thus left free to receive the full force of the explosion. The diameter of the tunnel now being cut is 5ft. 2in., and the tools or jumpers being the outside of everything, the machine can readily follow the bore-head carrying them. During the week, in one day, the machine had completed 9ft. 6in., the last 23½in. being cut in 1 hour 40 minutes, and the time taken by one man in breaking up the mass (after the charge had been fired) and passing it through the bore-head was 1½ hour. It is needless to remark that this is irrespective of the time taken in manipulating the machine and jumpers, which as at present arranged constitutes by far the longest part of the whole operation. Messrs. Bryan, Donkin, and Co., the manufacturers, already see many ways of increasing the mobility and handiness of the machine, which appears, imperfect though it is, to have already exceeded in point of speed the anticipations of its projectors.

Safety Engine.—George B. Brayton is exhibiting a safety engine in Boston, U.S., that he has been twelve years in perfecting. It has no large reservoir of water and steam, the explosive force being confined to minute cells and small tubes; it has a new kind of heating surface; and an engine of 10 horse-power occupies less than 6ft. square room. It costs but 15c. an hour for fuel, and does away with the extra insurance on buildings containing steam power.

Constitution of Steel.—The Royal Academy of Sciences of Belgium has awarded the gold medal proposed to be given by the author of the best work on the Constitution of Steel to Capt. Caron, so well known for his researches on this subject. M. Stas, the principal of the persons appointed to examine the essays, in commenting on Capt. Caron's work, expresses his own entire concurrence in his opinion, that iron in passing into the condition of steel does not take up any nitrogen in addition to that which it originally contained. Steel, he says, is essentially composed of iron and carbon, and owes its qualities or its defects to two different causes—the state of the carbon in the metal, or the nature of the foreign bodies which debase it. Whenever steel is good, its carbon can, under the influence of tempering, combine with the metal, and gives us a hard, brittle metal, which further tempering renders supple and elastic. When steel becomes bad after undergoing several heatings it is due to its carbon having been burnt or separated from the iron, and tempering will not regenerate the combination. This separation is due to the presence of foreign bodies, more especially silicum. These bodies also give to the metal defects varying with their nature and the impurities they contain. M. Stas further adds that Capt. Caron's essay is "undoubtedly the *résumé* of long and glorious labours, put forth with a simplicity which greatly enhance their merits."

Water-Lifts for Raising Weights.—A young engineer of Paris, M. Léon Edoux, has lately contrived a machino for raising weights vertically. Tho system, first essayed and put into practical use during the erection of a largo mansion in the Rue Lafayette, consists in making use of water as a counterpoise to tho materials required to bo lifted to different heights above tho ground. Tho apparatus consists of a double framework or towor of timber, formed of six uprights, and braced together by cross ties at distances. These uprights serve to guide the ascent and descent of two wrought-iron boxes or platforms of equal weight, and capablo of holding two cubic mètres or two tons of water each. A chain, connecting tho two boxes, passes over two fixed pulleys at the top of the framework, so that when ono ascends the othor descends, and tho bottom of each box is furnished with a valve which can either bo opened by hand or some contrivance on its touching tho ground. To understand tho working of the apparatus, suppose one of tho platforms on the ground and the other at tho top of the tower or framework; tho bottom ono filled with tho materials required to be lifted. Wator is admitted by means of a supply laid on from the water-mains into the upper vessel until not only tho weight but tho resistance from tho friction of tho chain is counterbalanced; as soon as this is tho case tho platform containing tho water descends and tho materials in tho othor are raised to tho required height. A break, to regulate tho motion, renders this apparatus complete. As regards safety and certainty of performance, this lifting-engine is superior to all others for house building, and far cheaper also. Tho cost of installing the lift is about equal to that for raising weights by manual labour, and considerably less than that worked by Lenoir's gas engine. This system is by no means a new ono, and Baron Séguier states that Sir I. K. Brunel showed him, twenty years ago, at the Chatham Dockyard works, the application on a large scale, of the equilibration by water to the raising of immense loads of wood to considerable heights during the construction of a bridge. At the great tunnel under the Alps, the counterbalancing by water is applied to the working of an inclined railway at the Modane (Savoy) end, where the entrance to the tunnel is 347·8ft. above the high road. Besides a road of moderate incline, and, in consequence, of some length, an inclined plane has been constructed, with a gradient of 1 in 2·23, part of the width (21ft. 4in.) being occupied by 464 steps, cut in solid rock, for pedestrians, and part by a railway forming a self-acting incline. This is worked by a rope, to either end of which is attached a waggon capable of holding two tons of water in a suitable tank, besides the materials required to be drawn up, passing over a drum at the top. The materials or implements required to be drawn up being placed in the waggon below, as much water is allowed to escape from the tank as will cause the weight of the upper tank to predominate, when the motion immediately commences, the heavier descending and the lighter ascending, while the velocity is controlled by a powerful break.

Sewage of Towns.—The last report of the Sewage of Towns Commission has just appeared. As the result of labours, extending over eight years, the commissioners have confidence in the following conclusions:—1. The right way to dispose of town sewage is to apply it continuously to land, and it is only by such application that the pollution of rivers can be avoided. 2. The financial results of a continuous application of sewage to land differ under different local circumstances; first, because in some places irrigation can be effected by gravity, while in other places more or less pumping must be employed; secondly, because heavy soils (which in given localities may alone be available for the purpose) are less fit than light soils for continuous irrigation by sewage. 3. Where local circumstances are favourable, and undue expenditure is avoided, towns may derive profit, more or less considerable, from applying their sewage in agriculture. Under opposite circumstances, there may not be a balance of profit; but even in such cases, a rate in aid, required to cover any loss, need not be of large amount. Finally, the commissioners said that, in their judgment, the following two principles are established for legislative application:—First, that wherever rivers are polluted by a discharge of town sewage into them, the towns may be required to desist from causing that public nuisance. Second, that where town populations are injured or endangered in health by a retention of cesspool matter, the towns may be required to provide a system of sewers. And should the law, as it stands, be found insufficient to enable towns to take land for sewage application, it would, in their opinion, be expedient that the legislature should give them powers for that purpose. The report is signed by the Earl of Essex and the other members of the commission, and dated March, 1865.

Engineering in Paris.—The proprietors of metal foundries have large orders on hand, and, among others, several metal bridges for the railway round Paris. Railway carriages are being still built for the Viceroy of Egypt, who has likewise commanded a new horizontal steam-engine of 150 horse-power. The Italian railway companies have ordered a variety of machinery, and one extensive manufacturer in Paris has at present an order for the construction of twelve vertical engines of from 3 to 10 horse-power for Algeria. Another is constructing several machines of the same description, of 5 horse-power, for Holland. Forcing pumps and other machinery for draining are likewise in hand.

Cannel Coal.—About a century ago the celebrated Duke of Bridgewater was the proprietor of a large estate situated at a place called Worsley, seven miles from Manchester. This estate contained numberless valuable coal seams, easily to be got at, but nevertheless comparatively worthless, in consequence of the great expense and difficulty of transporting the coal to market. The Duke, being a singularly enterprising individual, determined, if possible, to remedy this defect, and by one of those happy coincidences which so frequently reward a praiseworthy effect, he found, in the self-instructed genius James Brindley, the very man to contrive the means for securing the desired end. Suffice it to say, that Brindley constructed an excellent profit-paying canal between Liverpool, Manchester, Worsley, and the Great Wigan district. This canal appears to have been finished about the year 1766, and store-houses were built at various points in its course, where the Duke's coal was deposited, for the purpose of supplying the immediate neighbourhood. At this time the word "kennel," or "kannel" was generally employed in Lancashire and Cheshire to designate an artificial watercourse; and even Brindley himself, in some of his letters, speaks of the new undertaking as "the Duke's kennel." It is not, therefore, surprising that the Duke's coal should have received the name of "kennel coal," being, so to say, kennel borne; and this name would be peculiarly applicable at Liverpool, where sea-borne coal from Whitehaven, in Cumberland, had long been in use, and was, moreover, an article differing in many of its qualities from the Duke's coal. That this is the true origin of the name now applied to this kind of coal is farther established by the fact that the eminent geologist, Werner, who visited the coal districts of England not long after the above period, has adopted the very word, and in speaking of the Wigan coal calls it "kennelkohle." This work has indeed been lately written "cannel" in this country, and some ingenious persons, finding themselves quite at a loss to discover the source of such a name, have come to the conclusion that it is derived from the word "candle," and to support this they have asserted that slips of this kind of coal will burn like a candle; an assertion which we need hardly say is altogether fabulous.

Another new Process of Engraving.—A layer of finely pulverised chalk is compressed and smoothed by hydraulic power on a metal plate. The artist draws on this with an ink which makes the lines hard. A soft brush or a piece of velvet rubbed over the plate leaves the inky portion in relief. The whole plate is then saturated with a chemical solution, which turns the chalk into stone, somewhat analogous to Ransome's principle seemingly. From this impressions may be taken, or stereotypes or electrotypes obtained. The cost of these "graphotypes" is said to be something like one-tenth the cost of wood-blocks.

Improved Travelling Crane.—Mr. T. B. Burnett, of Mount Vernon, New York, has invented an improved travelling crane, very simple in construction, and of great value, from the facility with which goods can be removed by it from one place to another, without dropping or depositing tho load. Tho gearing by which the weights are raised is similar to that on ordinary cranes, and tho hoisting chain is led up over a boom, which jointed at tho bottom, so that it can be raised or lowered. Tho rigging is composed of heavy iron bars, and there is a counter-balance box behind the crane. When the crane has been loaded, and is ready to bo transferred from tho point where it is at work, the labourers apply themselves to handles which act on gearing below the platform on tho front axle. By means of a small pinion meshing into this gear, they are enabled to remove any weight that can be raised by tho crane to any point on tho track.

New Fuel.—A new form of fuel, composed of peat and coke, has been patented by Mr. William Smith, of Dublin. Tho compound is intended to be used in the smelting of iron, and it is thought that its employment will result in tho production of iron equal in value to that now manufactured in Sweden. Tho preparation is as follows: The coke (or charcoal) is reduced to powder and mixed with wet peat. The mixture is then passed through moulds, and tho blocks thus formed are submitted to pressure and dried. Tho inventor states that peat charcoal thus prepared will stand the blast and burden of a blast furnace, and may bo used with as much advantage as perfectly pure charcoal.

The London Coal Trade.—The monthly statement of tho quantity of coal and coke entered at the Coal Exchange for tho month of March has just been issued by

Mr. J. R. Scott, the clerk and registrar. The sea-borne supply for the past month amounted on the aggregate to 692 ships, bringing 285,706 tons, against the corresponding month of 1864, of 798 ships and 288,334 tons, being a decline of 3,618 tons and 106 ships. The supply for March per sea was in the following proportions:—Newcastle, 128,548 tons, in 237 ships; Seaham, 6,387 tons, in 25 ships; Sunderland, 83,532 tons, in 199 ships; Middlesborough, 6,579 tons, in 19 ships; Hartlepool, 42,411 tons, in 146 ships; Blyth, 918 tons, in 3 ships; Scotch coal, 2,212 tons, in 9 ships; Wales, 10,031 tons, in 25 ships; Yorkshire, 1,917 tons, in 17 ships, 1,733 tons of small, in 5 ships, and 1,438 tons of cinders, in 7 ships. The total tonnage for the three months of the present year from this source has been 919,605 tons, in 2,313 ships, against 865,154 tons, in 2,336 ships, being an increase of 54,451 tons, and a decrease of 23 ships. The railway coal traffic for the month of March has been 231,817 tons 2 cwt., against 187,780 tons 15 cwt. for March, 1864, being an increase of 44,036 tons 7 cwt. The London and North-Western Railway are entered as forwarding 86,698 tons 7 cwt.; the Great Northern, 81,383 tons; Great Western, 25,377 tons; Midland, 11,776 tons; Great Eastern, 19,124 tons 13 cwt.; South-Western, 3,318 tons 19 cwt.; London, Chatham, and Dover, 2,705 tons 5 cwt.; London, Tilbury, and Southend, 178 tons; and South-Eastern, 335 tons 12 cwt.; and Grand Junction Canal, 920 tons. From the 1st of January to the 31st of March of the present year the railways above mentioned carried 702,011 tons 7 cwt., while for the corresponding months of 1864 the tonnage was 599,135 tons 17 cwt., showing an advance of 102,875 tons 10 cwt. Of this immeuse tonnage (as compared with any preceding year), 16,724 tons brought by railway passed *in transitu* through the metropolis; 26,952 tons of seaborne were sent to British possessions and foreign parts; 13,482 tons of railway-coal were sent beyond the district, and 6,031 tons of railway coal sent beyond limits by canal or inland navigation; 2,947 tons of railway-borne coal went to the British possessions or to other places beyond London limits, and 2,012 tons of sea-borne coal came into port, and was exported in the same ships. The supply from all sources for March was 517,523 tons 2 cwt., against 476,104 tons 15 cwt. for March, 1864. The tonnage for the present year amounts altogether to 1,621,616 tons 7 cwt., which is 167,326 tons 10 cwt. in excess of that entered for the first three months of 1864, when it was 1,464,289 tons 17 cwt.

Anglo-Egyptian Navigation Company.—The International Financial Society have issued a prospectus of the Anglo-Egyptian Navigation Company, with a capital of £500,000, in shares of £20, to take over the line of steamers between Liverpool and Egypt at present owned by Chapple, Dutton, and Co., of Liverpool, and F. Chapple and Co., of London, and to extend the business, so as to bring it into connection with London, Marseilles, and other additional ports. One half of the purchase-money is to be taken in paid-up shares, and Messrs. Chapple, who are to act as agents and managers for seven years for a fixed commission, are to guarantee a minimum dividend of 10 per cent. per annum for the first five years.

A Road Over the Cordilleras.—M. Carpentier, a French gentleman residing in Chili, has laid before the Argentina a project for constructing a carriage road over the Cordilleras by the pass of Tino. He is willing to undertake the execution of this work, the expense of which is estimated at two hundred thousand dollars, for his own account, engaging to complete is within three years, if allowed to raise a moderate toll on the passing traffic for twenty years from its completion. The Argentine Government have accepted the offer, and confirmed it by a decree, so that the undertaking will commence forthwith. At present the Tino pass is only passable in winter on foot, and in summer solely on horseback or on mules. When the road is finished passengers will go from Valparaiso to St. Jago by the railroad in five hours, and thence the following morning by the extension line to San Fernando, when they will be conveyed by a diligence to the foot of the Cordilleras, which will be crossed the next day by the new road, arriving at Mendoza in seventy-two hours. From the latter town—the scene of the awful earthquake last year—there is a regular communication established with Rosario by means of post diligences, so that the whole journey from Valparaiso to the Atlantic will be performed in less than twelve days.

Thin Sheet Iron.—Assuming that the 2,000th of an inch is about as thin as iron can be rolled in sheets of more than a few square inches surface, the Hope Company has tried the experiment of producing a large plate of that substance, and have succeeded in turning out a very beautiful specimen 2ft. 2in. in length, and 8½in. wide, the surface contents being, cousequently, no less than 221 sq. in.; and it is stated that the managers are sanguine that they will succeed in rolling similar sheets 60in. long. The iron appears to be of excellent quality, and with the exception of one or two extremely fine holes, which are observable upon placing a strong light behind it, the sheet is perfect. The weight is somewhat under 178 grains, which is at the rate of 1·25 sq. in. to the grain. Compared with the thinnest tissue paper that can be purchased, the iron is so thin that it would require five sheets of the metal to amount to the same thickness as three sheets of the tissue paper. Whether further efforts will be made in the same direction, of course we do not know; but we think it must be admitted that whether in the production of thin iron or of thick, for it must be remembered that it was the 13½in. armour plates of John Brown, of Sheffield, that led the Sligo Works to roll their thin sheet, the English manufacturers are thoroughly able to produce any quality that may be demanded of them.

The Mont Cenis Tunnel.—The *Official Gazette* of Turin publishes the latest returns of the progress made in piercing the tunnel of Mont Cenis. During the first quarter of the present year an advance of 337 metres has been made, counting both sides together. Last year, during the corresponding period, the progress made was only 235 metres. The whole length pierced on both sides on the 31st of December, 1864, was 4,086 metres, so that it is at present 4,423 metres, or a little more than a third of the whole.

A New Torpedo.—An engineer of Stockholm is stated to have just invented a torpedo boat for blowing up iron-plated vessels. This machine is made to float beneath the surface of the water, and is provided at the bow with a mine, which is to explode when it strikes the ship which is to be set on fire. One of the principal bankers of the city is engaged in constituting a company in shares to provide the inventor with the means of constructing a certain number of these machines.

NAVAL ENGINEERING.

Anti-fouling Composition.—The *Orontes* screw iron troopship and the *Hector*, screw iron frigate, have both been docked at Portsmouth to examine, and report upon, and replenish the preservative and anti-fouling compositions with which their hulls below the water-line were coated when they were last placed in dock. The bottom of the *Orontes* was found to be free of any important accumulation of weeds, but, under the counter of her stern, and in the run of her lines, to her screw aperture, she is thickly encrusted with barnacles, and the bottom is dotted all over with patches of rust, the rivet heads in many places showing evident signs of being affected by the copper contained in the "anti-fouling" composition. As a "preservative" to the ship's bottom, the composition appears to have utterly failed. As an "anti-fouling" preparation, the result is rather more favourable, but this slight advantage appears to have been more than counterbalanced by the failure in "protective" qualities to the iron of the ship's bottom. The compositions used on the *Orontes* were the Admiralty's, or Hay's improved. The compositions were payed on the *Orontes*' bottom when she was in dock in August last.

The Spanish Navy.—According to the bill read in the Spanish Congress on the 6th ult., by the Minister of Marine, the Spanish naval forces are fixed as follows:—Two sailing vessels of 172 guns; a frigate of 42 guns; 3 corvettes, carrying 76 guns; 2 brigantines, carrying 32 guns; 2 first-class sloops, 4 guns; 11 second-class ditto, 11 guns; 70 schooners; 3 launches and 3 transports of 1,823 tons burthen. The ironclads will consist of 3 frigates, of 104 guns and 3,000 horse-power; 4 screw steam frigates, of 186 guns and 2,360 horse-power; 12 schooners, carrying 29 guns, of 1,400 horse-power; 3 transports, of 2,600 tons and 370 horse-power; 8 paddle steamers, of 40 guns and 1,760 horse-power; and a transport of 960 tons and 500 horse-power. These vessels will be manned with sailors, and provided with 2,826 marines. Lastly, there will be 597 men to guard the arsenals.

The Gun-cotton Committee have been trying further experiments with this highly explosive material, and there seems to be every hope of its being used instead of powder, as a bursting charge for shells, and also as a mine in the torpedoes and other similar vessels, which are expected to be largely employed in any future naval war.

Alteration of Ships.—An Admiralty return shows that the cost of the alterations and repairs executed on the *Royal Sovereign* and *Prince Consort* since their return from their cruise last autumn has been £3,854 for the former ship and £7,107 for the latter. The estimate of the cost of altering the *Royal Alfred* from the ordinary broadside to her present arrangement, in the manner approved by the Admiralty in December, is £11,912.

The Trial of the "Salamis" paddle despatch-vessel, 835 tons, 250 horse-power, recently took place over the measured mile in Stokes Bay, near Portsmouth, under unusually favourable conditions of wind and weather. The wind had a force of from 1 to 2 only from W.N.W., and the water was quite smooth. The trial of the *Salamis* was attended with unusual interest, from the fact of her being the trial vessel selected by the Admiralty to compare results with the *Helicon*, a sister vessel in tonnage and with engines from the same patterns, but with her fore body constructed on Mr. Reed's elongated U plan, a form of construction that has also been adopted in the French Imperial marine by M. Dupuy De Lowe in the *Solferino*, *Magenta*, and other vessels. The *Salamis* and *Helicon* are two out of four vessels of a new class recently introduced into her Majesty's navy as fast paddle despatch-boats, the other two being the *Enchantress* (Admiralty yacht) and the *Psyche*. The two latter vessels carry the old regulation figure-head and gear, with bowsprit, &c., projecting beyond their stems; but the *Salamis* and *Helicon* have nothing outside their stems, and carry their stays from foremast and foretopmast down to their stem-heads. The *Salamis* drew 10ft. 4in. of water forward and 10ft. 5in. aft, with 180 tons of coals on board, and complete in all respects for six months' sea service, with the exception of a few casks of provisions. The results of the trial were as follows:—With full boiler power.—First run—revolution of engines, 31·75; time 4 min. 19 sec.; speed of ship, 13·900; steam, 26; vacuum, 25. Second run—revolutions of engines, 31·75; time, 4 min. 31 sec.; speed, 13·284; steam, 26·5; vacuum, 24·5. Third run—revolutions of engines, 32; time, 4 min. 13 sec.; speed, 14·220; steam, 26·5; vacuum, 24·5. Fourth run—revolutions of engines, 32; time, 4 min. 37½ sec.; speed, 12·996; steam, 26·5; vacuum, 24·5. Fifth run—revolutions of engines, 32; time, 4 min. 5 sec.; speed, 14·694; steam, 26·5; vacuum, 24·5. Sixth run—revolutions of engines, 32; time, 4 min. 52 sec.; speed, 12·329; steam, 26·5; vacuum, 24·5. The mean speed of the ship with full boiler-power was 13·699 knots. With half-boiler power a speed of 11·433 knots was obtained as a mean of two runs, the revolution of the engines being 26·5 and 27; the pressure 26, and vacuum 25. In making circles with full power and turning to port 27 sec. were expended in getting up the helm and bringing the rudder to an angle of 25, with three turns of the wheel and four men to man it, the half circle being made in 2 min. 39 sec., and completed to the full circle in 5 min. 6 sec. In turning to starboard, the time occupied in getting up the helm was 32 sec., the angle of the rudder being 24·5, with three turns of the wheel, and the half circle made in 2 min. 40 sec., and the full circle in 5 min. 13 sec. In both instances the revolutions of the engines before putting up the helm were 32 deg., and lowered to 30 deg. afterwards. With half-boiler power the circles were made in less time than with full power, as will be seen by the appended figures:—Turning to port.—Half circle made in 2 min. 5. sec.; full ditto, 4 min. 15 sec.; angle of rudder, 29½ deg.; ditto to starboard, half circle made in 2 min. 4 sec; full ditto, 4 min. 5 sec.; angle of rudder, 30 deg. The temperatures during the trial were—On deck, 58 deg. to 60 deg.; engine-room, 62 deg. to 65 deg.; forward stokehole, 70 deg. to 68 deg.; after ditto, 73 deg. to 75 deg. The engines and boilers worked most satisfactorily, and the diagrams on the indicator cards were above the average. The engines are constructed on the ordinary oscillating principle, the cylinders having a diameter of 61in., and a 4ft. 6in. length of stroke. The paddlewheels have an outer diameter of 20ft. 6in., and 17ft. from the centre of motion. They are fitted with the feathering floats. Messrs. Ravenhill and Salkeld are the makers of the ship's machinery. The indicated horse-power developed by the ship's engines was 1,385, or nearly six times their nominal power.

Naval Appointments.—The following appointments have taken place since our last—J. Sanders, Chief Engineer to the *Cumberland*, for the *Minotaur*; J. Hopwood, First-class Assist.-Engineer to the *Cumberland*, for the *Minotaur*; T. Vickery, J. M'Millan, and A. Dewar, promoted to First-class Engineers; E. J. O. Lanham, Acting Second-class Assist.-Engineer to the *Asia*; R. J. Hay, Chief Engineer to the *Narcissus*; J. Knight, Engineer to the *Narcissus*; G. Pratt, Acting First-class Assist.-Engineer to the *Narcissus*; C. Thomsou, Second-class Assist.-Engineer to the *Narcissus*; G. Kent, Chief Engineer to the *Mutine*; T. G. Purmett, First-class Assist.-Engineer to the *Mutine*; B. Carr, in the *Blenheim*, promoted to Engineer; G. W. Robins, in the *Gibraltar*, promoted to Acting Engineer; H. Meredith, Acting First-class Assist.-Engineer to the *Mutine*; G. Fordham, Second-class Assist.-Engineer to the *Fisgard*; G. Williamson (b), Assist-Engineer to the *Narcissus*, *vice* Pratt; J. E. Warner and W. Thomson, Assist.-Engineers to the *Excellent*, for the *Royal Sovereign*; W. E. Presgrave, of the *Duncan*, R. H. Trubshaw, of the *Achilles*, and R. C. Oldknow, of the *Cossack*, to be Engineers to the Fleet; G. Simpson, of the *Coquette*, to be Acting Engineer of the Fleet; R. Oliver, Assist.-Engineer to the *Dromedary* J. Sanders, Chief Engineer, to the *Asia*, for the *Minotaur*; J. Hopwood, Assist.-Engineer to the *Asia*, for the *Minotaur*; R. Widdecombe, Assist.-Engineer to the *Indus*, for the *Scorpion*; G. Roe, Engineer, to the *Frederick William*; F. G. Julian, Engineer to the *Indus*, as Supernumerary; W. P. Guyer, Engineer to the Donegal, for the Tenders; J. Wood, Assist.-Engineer for the *Indus*, for hospital treatment; J. Mather, Engineer to the *Fisgard*, as Supernumerary; and H. Pitt, Engineer to the *Asia*, as Supernumerary.

STEAM SHIPPING.

French Coasters.—Accounts from Havre state that machinery of 300 horse-power is being prepared for three screw steamers. The hulls of these steamers are to be built under the inspection of shipwrights from Bordeaux. The necessity for replacing the heavy sailing vessels now employed in the coasting trade by well-built steamships is universally admitted. It has been further proved that screw steamships possess a decided advantage over paddlewheel steamers. The paddlewheel steamer, even when the wind is favourable, loses a part of her speed when one of her wheels is raised out of the water by the falling over of the vessel on the other side. The Bordeaux shipbuilders have adopted the English plan, and expect to derive great advantage from it.

Steam Shipbuilding on the Clyde.—Messrs. Reid, of Port Glasgow, have on hand a screw of 630 tons for a Liverpool house, to be employed in carrying minerals between Norway and Newcastle. Messrs. Kirkpatrick, M'Intyre, and Co., of Port Glasgow, have launched a saloon river steamer, intended for the passenger trade of the Clyde. She is to be fitted by Messrs. W. Smith and Co., of the Clyde Foundry, Greenock, with diagonal oscillating engines of 140 horse-power nominal. She has been named the *Alexandra*. The *Undaunted*, a paddle of 468 tons, builders' measurement, intended for towing purposes on the Hooghly, has been launched by Mr. A. Denny, of Dumbarton. She is to be fitted with oscillating engines of 250 horse-power, by Messrs. A. Denny and Co. Messrs. A. and J. Inglis, of Point-house, have launched a screw of 605 tons, builders' measurement, for the Glasgow and Londonderry Steam-packet Company. Her dimensions are—Length of keel and forerake, 197ft.; breadth moulded, 25ft.; depth, 13ft. 8in. She will be fitted by the builders with a pair of geared engines of 130 horse-power nominal. This steamer received the name of the *Thistle*. Messrs. T. Wingate and Co., of Whiteinch, have launched a paddle named the *Whiteinch*. She is 700 tons burdens, has engines of 200 horse-power, and is intended for the colonial trade of the United and Universal Steam Navigation Company (limited). Messrs. Randolph, Elder, and Co., of Fairfield, have launched a 1,000 ton composite steamer, named the *Konigin Sophia*, the second of four which they are building for the Netherlands Inland Steam Navigation Company. Messrs. Caird and Co., of Greenock have launched a paddle for Messrs. Burns's Glasgow and Belfast line. The steamer, which was named the *Buffalo*, is of the following dimensions:—Length of keel and forerake, 240ft.; breadth of beam, 26ft.; extreme breadth of ship, 29ft.; depth of hold, 14ft. Her burden is 807 tons, builders' measurement. She will be fitted with oscillating engines of 250 horse-power, and will be supplied with Messrs. Caird's patent expansion gear. The *Buffalo* is the largest vessel yet built for Messrs. Burns's Belfast and Glasgow line. A sister ship to be named the *Llama*, is in a forward state in the same yard. Messrs. Caird have also another large steamer of 2,000 tons register in course of construction for Messrs. Burns. This steamer is to be named the *Palmyra*, and is intended for the Mediterranean trade.

LAUNCHES.

Launch of the Agincourt.—The *Agincourt*, a monster armour-plated ram of 6,680 tons burden and 1,350 horse-power, was floated on the 27th March, from the shipbuilding yard of Messrs. Laird Brothers, Birkenhead. It is rather more than three years since the works of the *Agincourt* were commenced, and the first plate of the keel was lowered into the dock to its final place on the blocks in June, 1862. The total weight of the ship, armour-plating, and machinery, is more than 8,000 tons. During the course of her construction as many as 1,000 men have been employed upon this one ship, varying according to the different stages of the work. The dimensions of the ship are:—Length over all, 410ft.; length between perpendiculars, 400ft.; breadth extreme, 59ft. 3½in.; tonnage, 6,680 tons; draft of water abaft, 26ft.; ditto forward, 25ft.; height of port sills above water, 10ft.; number of ports on each side, 26; of which two on each side are suited for 12-ton 300-pounder guns, and the remainder for 100-pounder Somerset naval guns, or 110-pounder Armstrongs. The armour-plating is 5½in. of iron-bolted on to 10in. of teak extending from 5ft. below the water-line to the gunwale, or a total height of about 21ft. The armour-plates are rolled and were made partly at the Mersey Steel and Iron Company's Works, and the remainder by Messrs. Brown and Co., Sheffield. For about 30ft. at the extreme ends of the vessel the thickness is slightly reduced so as to give buoyancy to the vessel, the thickness at the stem being 3in., and under the counter about 2½in. The stem is formed in the ram shape, and is a solid forging of enormous strength. This and the stern frame, which weighs upwards of 40 tons, were made by the Mersey Steel and Iron Company. The hull of the vessel is of iron, of very great strength, and divided into numerous watertight compartments by both longitudinal and athwartship bulkheads, and there is also a watertight inner skin, forming a double bottom to give security against danger of the vessel sinking in case of the bottom being injured by striking on rocks. The upper deck is plated with iron ⅝in. thick underneath the wooden deck to resist shell firing. The engines are of 1,350 horse-power nominal, and were made by Messrs. Maudslay, Sons, and Field.

Messrs. Bowdler, Chaffer, and Co., of Seacombe, Cheshire, have launched a screw steamer, built for the Kirkless Steam Navigation Company (Limited), intended for the coasting trade, and of the following dimensions:—Length, 150ft.; breadth, 24ft.; depth of hold, 15ft.; tonnage, 415 o.m. She is to be fitted with engines of 60 horse-power by Messrs. J. Jones and Co., of Liverpool.

A Swedish Monitor.—The launch has been safely effected in Stockholm of the *John Erikson*, the first Swedish Monitor. She measures 205ft. long by 46ft. wide. The side plating is 5in. thick, and around the turret it is 12in., as is also that which protects the rudder. The vessel will be provided with six engines.

TELEGRAPHIC ENGINEERING.

The International Telegraph Conference, in their sitting of the 1st of March last, had authorised a commission, consisting of special delegates from the different states in Europe, to draw out a project of Convention. This project having just been terminated the Conference was again recently resumed at the residence of the Minister of Foreign Affairs, under the presidency of his Excellency M. Drouyn de Lhuys. Besides the representatives of the sixteen foreign states present at the first meeting, delegates from three other countries—Hanover, Saxony, and the Grand Duchy of Baden—also assisted at the proceedings. Viscount de Vougy, director-general of the French telegraphic lines and president of the special commission, was requested to read the project of Convention, which was done, and unanimously approved by the assembly. In token of their approval, the plenipotentaries of the different Governments have placed their initials to this paper until the definite documents for their signatures have been duly prepared. The desired understanding has, therefore, been fully attained. During the course of the many laborious sittings dedicated to this negotiation, every member of the Conference appears to have been actuated by the most liberal views and a sincere spirit of conciliation, and the result of their labour is in its *ensemble* extremely satisfactory both to the interests and requirements of the different states which took part in the question.

The Atlantic Telegraph Cable.—The work connected with the equipment and preparation of the *Great Eastern* steamship for laying down the Atlantic telegraph cable between this country and America during the approaching summer is being carried on in the most expeditious manner at the vessel's moorings, Saltpan-reach, between Chatham and Sheerness. Already considerably more than 1,000 miles of the cable have been placed on board, the total length deposited in the tanks constructed between the decks more than half the quantity intended to be shipped. The total length of cable required to stretch from the starting point in Ireland to the spot where it is intended to land on for the reception of the cable up to the 22nd ult. being 1,220 statute miles, rather the American side is exactly 2,253 miles; but, according to present arrangements, it is intended to place at least 2,400 miles on board, the few additional hundred miles' length being allowed for "slack," the action of currents, and other such like contingencies. The smallest of the three monster tanks in which the cable is deposited when received on board the *Great Eastern*—that in the forward part of the ship—is now full, the total length stowed away within it being exactly six hundred and thirty-three miles. The largest of the tanks—that in the after part of the vessel—is intended to receive between 800 and 900 miles of the cable, and already a total quantity of 520 miles has been deposited in it, the filling of this tank being temporarily suspended to admit of the third, or midship tank, which is constructed to hold about 820 miles, being proceeded with. The returns on the 22nd ult. gave a length of 62 miles as deposited in the last of the three tanks. During the time the cable is on board it is kept submerged, the tanks, for this purpose, being always filled with water. Electricians are constantly employed on board in a portion of the *Great Eastern* appropriated for their accommodation, and by means of the most delicate and sensitive instruments every portion of the cable is subjected to the most careful and rigid tests, as it is received from the hulks and deposited in the tanks, in order that the most trifling defect may be discovered. Up to the present time, however, not the slightest break or flaw in the whole of the 1,200 miles' length of cable has been detected, notwithstanding that during every minute of the day a constant current of electricity is passing through the coils, and there is little doubt, therefore, that, so far as its electric capabilities are concerned, the cable will leave this country in the highest possible state of perfection, and with the improved instruments intended to be used capable of transmitting messages between this country and America at the rate of twelve words per minute, or more than double the number which could be forced through the old Atlantic telegraph cable. The rate at which the cable has been shipped on board has varied from 20 to 30 miles per day, and it is calculated that, providing no delay takes place at the works of Messrs. Glass, Elliott, and Co., of Morden-wharf, Greenwich, where the cable is manufactured at the rate of 100 miles per week, the entire quantity will be shipped by the first week in June, and the *Great Eastern* ready to take her departure towards the latter end of the same month, so as to fall in with the best possible weather to be met with in the Atlantic. The weight of the new Atlantic cable is nearly double that of the one originally laid, the weight of the entire insulation of the cable submerged in 1858 being 261lb. per nautical mile, while that of the new cable is 400lb. per nautical mile. The weight of the new cable in air is 35 cwt. 3 qrs. per nautical mile, and in water 14 cwt. per knot, or equal to 11 times its weight in water per knot; or, in other words, it will bear its own weight in 11 miles depth of water. The original Atlantic telegraphic cable weighed but 20 cwt. per mile in the air, and rather more than 13 cwt. per nautical mile in water, which would be equal to 4·85 times its weight in water per knot. In the cable now in course of shipment the breaking strength is 7 tons 15 cwt., while the breaking strength of the first laid cable was only 3¼ tons, and the contract strain equal to 4·85 its weight per knot in water. The contract strain of the new cable is equal to 11 times its weight per mile in water, or more than double the strength of the cable first laid between this country and America.

RAILWAYS.

Peat for Locomotives.—An experiment has been made with peat in a locomotive on the Central Railroad, U.S. The engine drew a car, containing the superintendent and a number of gentlemen, twenty miles in forty-five minutes, without an attempt at making speed. The peat made a beautiful fire, throwing out immense heat, and burning with a steady flame. The steam was kept up at an even gauge of from 90lbs. to 100lbs. during the trial trip. The usual amount of coal consumed by coal-burning engines is a ton to every twenty miles, but in this instance only half a ton was used, giving evidence of its value as a substitute for anthracite.

English and American Railways.—Nothing more forcibly illustrates the superior condition and solid structure of the English railways than the speed of some of the mail trains. The night mail from the Euston-square Station, London, to Perth, in Scotland, performs the journey—451 miles—in 11½ hours, or at the rate of 40 miles an hour, including stoppages. The mail between New York and Washington—229 miles—goes through in from 11 to 12 hours, being about half the speed of the English mails. It is evident, says the *Scientific American*, that neither speed nor safety can be expected upon our railroads until they are rebuilt in a solid and enduring manner; many of the accidents occurring being the result of their bad condition.

The Traffic on the Metropolitan Railway.—The statistics of the traffic on the Metropolitan Railway present some very extraordinary results when compared with the other lines of railway. Few persons, probably, have any adequate idea of the amount of passenger traffic and mileage receipts on this line, and there is certainly nothing in the working of any railway in the United Kingdom which can compare with them. The line is 3¾ miles in length, carries more passengers than the Great Eastern with its 665 miles, more than the London and South-Western with 513 miles, and more than the Midland, with more than 641 miles open. On this 3¾ miles twice as many passengers were carried last year as on the Great Northern, with 353 miles open, as many as were carried on the London and Brighton, 243 miles in length; on the South-Eastern, with 286 miles; and on the North-Eastern, which has a length of 1,095 miles in work. The receipts per mile for passengers only on the Metropolitan line for the week ending 5th March were £678. The receipts for passengers and goods during the same week were—on the Great Eastern, £44; Great Northern, £82; Great Western, £49; London and North-Western, £76; London and South-Western, £43; Midland, £69; and South-Eastern, £58. The mileage receipts of the Metropolitan were, therefore, 15 times as large as that of the Great Eastern and the London and South Western; nearly 10 times as great as the receipts of the Midland; about 9 times greater than those of the London and North-Western; and 8 times as large as the Great Northern mileage receipts. The receipts from passengers alone on the Metropolitan were higher by more than 50 per cent. than the united mileage receipts of the seven great railways which have their termini in London. These facts may serve to furnish some idea of the enormous amount of traffic which the metropolis can supply for a system of metropolitan railways.

Communication between Passengers and Guards.—An apparatus patented by Messrs. Dilkes and Turner, of Leicester, for establishing communications between passengers and guards of railway trains in cases of emergency, has been undergoing a series of experiments on the Midland line. The apparatus consists of a piece of rope supplied to each carriage, passing through wheels fixed beneath each compartment. To each end of the rope is attached a spring hook for coupling, so that a train might be extended to any length or *vice versa*. A small pulley is placed in each compartments, which is connected with the wheel beneath, through which the rope passes. Upon the turning of the handle of the pulley a bell is rung in the guard's van, and also one near the driver; an indicator simultaneously springs out from the side of the compartment where the signal is given and locks itself securely. It cannot be thrust back by the passengers, so that no person can tamper with the apparatus without being detected. If a carriage were to run off the line, or the coupling break, the bells would be rung at once, without the intervention of the passengers. In addition to this, the apparatus furnishes an independent means of communication between the guard and driver, and cannot possibly get out of order. The cost of the apparatus is estimated at about £1 per carriage.

Railway Compensation.—The following resolutions have been unanimously passed by the vestry of St. Martin's-in-the-Fields:—"That the present state of the law affecting questions between railway and other public companies and the owners and occupiers of property to be taken compulsorily by such companies is in a very unsatisfactory state, and has been, and is still, productive of much undeserved loss and injury to such owners and occupiers, and has occasioned utter ruin to many individuals, who have been dispossed of their holdings, and deprived of their trade, without any compensation whatever. That the ambiguous language of the Lands Clauses Consolidation Act, 1845, and the Railway Clauses Consolidation Act, 1845, referred to in recent conflicting judgments of the courts of law, and expressed in the opinions of the Judges, has shown it to be imperatively necessary that some declaratory act of the Legislature should set the disputed questions at rest, and that some provision should be made for compensation for all injuries, whether to property or trade, caused by the acts of public companies. That owing to the enormous masses of trade property removed, and about to be removed, by the introduction of railways into the heart of the metropolis, contrary to the recorded opinions of committees of both Houses of Parliament, the matter calls for immediate remedy and it is therefore advisable that vigorous steps be taken by the inhabitants of the metropolis to induce her Majesty's Government to bring in a Bill to protect those who, as occupiers, are at present deprived of the fruits of a long life of laborious industry in the establishment of a trade, without compensation or relief of any kind. That these resolutions be forwarded to the whole of the vestries and district boards in the metropolis, soliciting their co-operation in a petition to Parliament.

The Great Northern Traffic.—The Great Northern Railway Company are about to make extensive alterations at their coal yard in Doncaster. The growing importance of the coal trade, and the convergence of several independent lines in and near that town, have induced the directors to decide that the present coal yard shall be appropriated for a goods station, and they have entered into negotiations with the corporation for the purchase of thirty acres of land for the new coal depot.

Railways in Algeria.—The Algerian network is composed of two great lines—one from Algiers to Oran, following the valley of the Chelif, and the other from Philippeville to Constantine. The Paris, Lyons, and Mediterranean Railway Company—which, not content with lines in France, has actually cast an eye upon French Africa—proposes to prosecute the works this year with great activity. A sum of £240,000 has been subscribed upon its budget for the commencement of the work, £120,000 of which is derived from the subventions accorded by the State. The £240,000 will be employed on the line from Algiers to Oran, on which 30⅝ miles are already in operation. On the Philippeville and Constantine line the earthworks are commenced between Philippeville and the village of St. Charles.

RAILWAY ACCIDENTS.

Accident on the South-Western Railway.—On the 10th ult., about 4 o'clock in the afternoon, an accident occurred at the Barnes junction of the London and South-Western Railway. It appears that a train, consisting of an engine and five carriages, belonging to the North London Railway Company, left the new Kensington terminus of the branch line at 3.30 p.m. The up North London trains, in order to reach Kew, have to pass from the up Richmond line at a point nearly midway between the Mortlake and Barnes stations, over a rather sharp curve, to the down loop line rails. The 3.30 train reached the junction about five minutes to 4 o'clock in due course, but the engine had no sooner passed the point than it gave a jump and left the rails at the curve, dragging with it, in a sort of zigzag course, two of the foremost carriages of the train. The engine, after quitting the rails, tore up the permanent way with its wheels, and finally came to a dead stop, having embedded itself so deeply in the ballast, that the driving and other wheels could scarcely be seen. The passengers received no injury.

Collision on the London and North-Western Railway.—A collision took place at the junction at the south end of Crewe station early on the morning of the 21st ult., between the 9 p.m. mail from London to Scotland and a luggage engine which had been allowed to foul the down line. The mail engine, tender, and three carriages were thrown off the rails and more or less damaged, and the tender of the goods engine was detached by the force of the blow and knocked off the road. Although considerable damage was done to the company's stock, no person was injured. It is supposed the mishap was caused through some misunderstanding on the part of the pointsman.

Accident on the South Devon Railway.—An accident happened on the night of the 5th ult., on the South Devon Railway, which was attended with fatal results. The 8.5 p.m. goods train from Plymouth proceeded all safe as far as Totnes, but on clearing out of the Totnes station, and arriving about 200 yards beyond it, just over the West-bridge over the River Dart, the engine, from some unexplained cause, ran off the rails into the marsh on the side of the line, carrying with it 24 out of the 25 trucks which composed the train, the end guard's van being the only carriage that remained on the rails. The line was entirely blocked up, and it was not until the wheels of the engine were completely embedded in the marshy soil that its progress was arrested. The permanent way also was in many places much damaged. The engine-driver and fireman were by the accident thrown off the engine to the ground, and received such injuries that the fireman was instantly killed, and the engine-driver fatally injured.

Railway Collision at Weston-super-Mare.—An accident occurred on the 18th ult., at the Weston-super-Mare junction of the Bristol and Exeter Railway. The night express train which leaves Bristol at 8 p.m. was detained for a short time at Weston, to repair an accident to the piston of the engine, and, while waiting at the junction, was run into by the ordinary short train from Bristol to Weston, though the danger signals were up, and could be seen for more than a mile. The last carriage of the express was thrown on the top of the engine of the short train, and shivered to pieces, the platform being covered with the *debris*. No lives were lost, but several persons were injured.

Railway Accident near Killiecrankie.—An accident of a rather singular character recently took place to the goods train which leaves Perth at 1 a.m. As the train was passing between Pitlochrie and Killecrankie at a high rate of speed, an immense block of stone, upwards of three tons in weight, became detached from the rock in one of the deep cuttings and fell thundering into the train, oversetting four of the waggons and throwing them down the embankment, two on each side, with all their contents. When the driver stopped the train it was discovered that a number of the waggons behind had been cut off by the occurrence from the remainder of the train. No one was injured, though this is probably more than could have been said had the rock descended while a passenger train was passing.

DOCKS, HARBOURS, BRIDGES.

The Proposed High-Level Bridge which is to carry the South Wales and Great Western Direct Railway across the River Severn, near to Chepstow, is, according to the design of Messrs. Fowler and Fulton, the engineers, to be two miles and a quarter in length, and is to have sufficient headway to permit masts of ships of 122ft. in length to pass under when the surface of the river is at the main tide level, so as in no way to impede the navigation. The principal opening, which is to cross the low-water channel, is to be 600ft. span, being the total width of the Thames at Southwark Bridge, or 150ft. wider than the opening of the Menai Bridge. Messrs. Fowler and Fulton estimate the probable cost of this bridge at £980,000, for which sum Messrs. Cochrane, Grove, and Co., bridge contractors, have undertaken to complete the work.

Fall of a New Pier.—A new pier in course of construction at New Brighton, Cheshire, recently gave way, and upwards of forty people were precipitated on to the shore. Fortunately the tide was out, and beyond the shock caused by the fall, no person was severely injured.

Railway Bridges over Streets.—The London, Chatham, and Dover Railway Company have been charged at the home circuit assizes, with a nuisance, by contravening their Act in the mode of building their Newington bridges, thereby endangering the public safety. The company pleaded not guilty to the indictment. The local vestry were the prosecutors, in the name of the Queen. It was argued on their part that the bridges complained of were not water-tight, and from want of deadening arrangements the noise of trains passing startled horses, so that accidents had happened and lives were lost. In other and similar bridges these defects had been obviated with the greatest ease, and the defendants were bound to do all in their power to prevent their bridges being a public nuisance. They were not asked to destroy the bridges, but simply to alter or improve them a little. The Lord Chief Baron, at the close of the prosecutors' case, suggested that the matter should be referred to some competent person to examine the bridges, and decide what should be done; and this was finally agreed to, the defendants to pay the cost of the suit, if found in the wrong.

The Intended Albert Bridge from Chelsea to Battersea.—This bridge is designed by Mr. Rowland Mason Ordish, of the firm of Ordish and Le Feuvre, engineers to the Amsterdam and Dublin Exhibitions, and does not appear to resemble in its construction the ordinary and generally-known structures of its class. Its chief distinction, however, seems only to be that it is secured from oscillation or movement, it being virtually rigid in those parts which are movable in the suspension bridges already in use. The want of stability formed, as is, perhaps, well known, one of the great difficulties, apparently, to overcome with regard to this class of structure. The Albert Bridge is intended to be so constructed that it will support moving and stationary loads with a safety equalling that of any of the bridges at present used for the purposes of railway traffic over the Thames; while it is stated to be more adapted for this purpose where wider spans have to be bridged over, so that it is capable of being used where other structures could not be erected with facility for purposes of railway accommodation. The Albert Bridge will be erected over the Thames, uniting Oakley-street, Chelsea, to the Albert-road, Battersea Park, and has already been commenced at the Albert-road abutment. This bridge appears to possess many new features as compared with existing bridges. For instance, whereas in Chelsea and Hammersmith Bridges a girder runs at either side along the entire length of the roadway, dividing the carriageway from the footways, and separating the width of the bridge into three comparatively narrow channels, in the Albert Bridge both these are done away with. In most of the suspension bridges at present erected, also, the roadway, where it passes through the uprights forming the towers, becomes contracted, and afterwards enlarges to its original width again. This, also, is obviated in the Albert Bridge. A bridge similar in construction is likely soon to be commenced over the Moldau at Prague, by the well-known Austrian contractors Messrs. Klein Brothers.

MINES, METALLURGY, &c.

Imports of Copper.—The imports of copper ore show a slight advance in the two months ending February 28, having amounted to 10,613 tons, as compared with 10,359 tons in the corresponding period of 1864, and 8,796 tons in the corresponding period of 1863. The imports from Spain declined in the two months to 64 tons, as compared with 1,075 tons in the corresponding period of 1864; but the imports from Cuba increased to 3,040 tons, as compared with 1,188 tons, and those from Chili to 4,999 tons, as compared with 4,216 tons. The imports of copper regulus amounted in the first two months of 1865 to 2,212 tons, as compared with 2,209 tons, in the corresponding period of 1864, and 4,312 tons in the corresponding period of 1863. The great falling off in 1865, as compared with 1863, referred to Chili. The imports of unwrought and partly wrought copper in the two months ending February 28 were 45,020 tons, against 49,900 tons in 1864, and 20,480 tons in 1863 (corresponding periods). The imports under this latter head declined this year, as compared with 1864, as regards Chili, but the deliveries from Australia increased.

Silver Ore.—The value of the imports of silver in the first two months of this year was computed at £56,307, as compared with £39,070 in 1864, and £26,640 in 1863 (corresponding periods). There has thus been a decided increase of late. It will be seen, however, that in the ten years ending 1863 the value of these imports made no progress. Thus, in 1854 it was £521,330; in 1855, £564,580; in 1856, £354,970; in 1857, £299,511; in 1858, £209,154; in 1859, £342,637; in 1860, £382,806; in 1861, £289,373; in 1862, £331,564; and in 1863, £272,826.

Rolling the First Plate at Hartlepool Rolling Mill.—Up to the present time only a portion of these works have been got into operation. Sixteen puddling furnaces have been at work, a monster steam hammer, and the apparatus requisite for the rolling and shearing or cutting of puddled bars; but recently the large plate-mill, consisting of ponderous and powerful machinery, driven by an engine of 80 horse-power, was also efficiently set in motion, and for the first time shipbuilders' plates were manufactured at Hartlepool. The steam-engines now at works at the works include two large engines from the Kirstall Forge Company, of 26in. and 32in. cylinders respectively; the fly-wheel connected with the mill being of 25ft. diameter, and upwards of 35 tons weight. This mill, and a smaller one also just completed, are capable of producing it is estimated, 2,000 tons per week; and the company are now in a position to supply plates of every description and size.

Manufacture of Zinc.—The improved process of manufacturing zinc, patented by Mr. James Webster, of Birmingham, consists in bringing the zinc ore, or oxide of zinc, in a finely divided state, into the presence of molten iron, or other substance which melts at a temperature superior to the volatilising point of zinc. He adapts to a cupola a vessel containing the pulverised zinc ore, or other compound of zinc, which, together with nitrate of soda, also pulverised, is carried down a channel, and supplied in a regular manner to a close chamber, into which the molten iron is run from the cupola. This regulated supply of the zinc ore may be effected by means of a rotating screw, which will force the pulverised ore forward into the molten metal, where it will become volatilised by the high temperature to which it will be subjected in the close vessel. From this close vessel the vapours are conducted through a pipe to a vessel containing water, where the zinc vapours are condensed, and the metal precipitated. The close vessel, where the zinc ore is brought into the presence of the molten metal, will, after a time, become charged with slag, which must from time to time be drawn off. The nitrate of soda is simply to keep the slag thin; any other suitable substance may be used. As the action of the zinc on the molten iron is exceedingly beneficial, and refines and purifies the metal, and improves its quality, it may be found convenient and commercially advantageous to use the commonest description of pig iron, in order to improve its quality.

The Great Iron Mountain.—The discovery of the vast mountain of iron on the Batchewannung Bay, on the Canadian shore of Lake Superior, says a Detroit paper, has very naturally excited great interest, not only in this country but in Europe. We are in receipt of a letter from the Vice-President of the Glasgow Geological Society, in which further details are solicited. There is great excitement on the subject among Eastern capitalists, and a powerful company has been already formed in Boston. The books were opened a few days since, and stock to the amount of 94,000 dollars was sold at once. The company will be known as the Ames Iron Manufacturing Company, of Lake Superior, Canada, being thus named in compliment to Hon. Oakes Ames, so long identified with the manufacture of the well-known shovels which bear his name. Joshua B. Toby, proprietor of the Tremont Ironworks, at Wareham, Mass., is the treasurer. Arrangements have been fully completed to commence operations this spring. A railroad will be built at once from the harbour to the mines, a distance of seven or eight miles, and it is expected that the road will be in running order by August 1, when the company will commence the shipment of ore. The harbour is one of the best on the lake, and the road will have an easy grade, as we before stated, on the authority of Col. Duffield, one of the most accomplished engineers in the United States. We further learn that two more companies are to be formed for operating on the same tract. There will be a fine field for all of them, and as many more, as the ore is inexhaustible. Not the least important, perhaps, of the results of this remarkable discovery, is the impetus which it will give to Canadian enterprise, insuring the ultimate development of the resources of the interesting region skirting the northern shore of Lake Superior. It has long been the settled conviction of scientific men that this region possessed immense wealth in various kinds of materials. The subject is one of deep interest on both sides of the line.

ROYALTIES ON MINES.—A return issued from the Office of Woods and Forests shows that the revenue of the Crown as royalty on the produce of mines and quarries amounted, in the financial year 1862-63, to £16,453 for England, £6,529 for Wales, £32 for Scotland, and £10 for Ireland. The sum of £9,770 was received as royalty on coal got in England, £3,364 on iron, and £2,820 on stone. Wales presents the novel item of £2,005 for royalty on gold and silver.

LEAD IN AMERICA.—The demand of lead for consumption was very steady during the past year. The importations amount to 27,900 tons—an advance of 7,000 over the average of the three previous years. The receipts of galena during the same time were 1,300 tons—less than the average of the three previous years. During last year Government consumed about one-half of the entire delivery of lead, the consumption for ordinary purposes showing a large falling off. The price of lead during the last nine months was below the cost of importation, and it did not advance at any time during the last year in proportion to gold. It opened on January 1 at 10½c., advanced to 16½c. in July, declined in September to 13¾c., and since October it has fluctuated between 14½c. and 15½c. in currency.

COPPER.—The annual consumption of copper is 13,000 tons, of which about one-half is derived from the Lake Superior Mines. The balance is derived in ores from California, Chili, Cuba, &c. On Jan. 1, 1864, copper was quoted in Boston and New York at 39c. It advanced with the rise of gold to 56c. in July, declined to 47c. in September, and has since fluctuated, with the fluctuations of gold, between 48c. and 50c.

GREAT MINING COMPANY.—A letter from Sydney states that a project has been mooted in that city for starting a gigantic undertaking under the name of "The Australian Mineral Lands Company." It is proposed also to extend its operations to Tasmania and New Zealand. Whilst duly regarding the probability that vast gold fields are yet to be discovered in the northern territories of South Australia, Queensland, and Western Australia, the attention of the proposed company will be chiefly directed to the development of other mineral wealth. Assuming that there are immense quantities of copper, silver, iron, lead, and other metals known to exist, and that the deposits can be worked with enormous profit, it is intended to apply to the several Governments having control of those mineral lands for leases to work them. Notwithstanding the reports of scientific men and the evidence of casual discoveries of the existence of vast mineral deposits in New South Wales, as yet only eight copper mines have been worked in that colony. The Australian Mineral Lands Company will not confine their operations to a re-exploration of known long-neglected sources of wealth. In the northern territory of South Australia "a wide unbounded prospect lies before them." The liberal spirit manifested by the Legislature of South Australia induces the projectors to form "great expectations" from mining enterprises in that region. An ample number of shares, however great the demand may be in Sydney, will be reserved for intending co-partners in the other colonies and in the United Kingdom.

SUBSTITUTE FOR BLASTING POWDER.—At Stockholm several experiments have been made with nitro-glycerine, in order to test its application as a substitute for blasting powder in mining operations. They were considered very successful, the new compound being found to be superior in its effects to the ancient method, and the price considerably less. Among other trials, a hole bored near the summit of a rock to a depth of 23ft. was charged with 5½ lbs. of nitro-glycerine. Five minutes after the fuze had been lighted a dull report was heard, and enormous blocks were detached from the rock. Several other mines were fired with blasting powder, but their effects were inferior to those of the nitro-glycerine.

GAS SUPPLY.

READING GAS.—Several hundred pounds' worth of Reading gas stock has just been sold by auction, the 5 per cent. stock at par; the 7 per cent. at £12 10*s.* per cent. premium; and the 8 per cent. at £30 to £35 per cent. premium.

THE TYNEMOUTH GAS COMPANY have declared a dividend of 7½ per cent. upon original shares, with a bonus of 3*s.* per share, and have resolved to divide among themselves, in shares, an increase of their capital to £30,000 by the issue of 4,000 half shares of £2 10*s.* each, on which, so far as called up, a dividend of 5 per cent. is to be paid. The works, including a new coal depôt, new gasometer for 210,000ft. of gas, new purifiers, &c., have been completed at a cost of £7,005 and paid for. The mains have been extended to Preston.

THE MIDHURST GAS COMPANY have resolved on a reduction in price from 8*s.* 4*d.* to 7*s.* 6*d.* per thousand feet.

EARLS COLNE.—A contract for the formation of gas works for Earls Colne has been signed with Messrs. Holmes and Co. engineers and gas contractors, of Huddersfield, to erect the entire of the works for the Earls Colne Gas Company (Limited) for £1,015.

THE SUPPLY OF GAS IN THE CITY.—A report for the past year by Dr. Letheby as to the illuminating power and chemical quality of the gas supplied to the City of London has recently been issued. Dr. Letheby, it should be stated, is not only Medical Officer of Health, but Gas Analyst for the City of London, and the report in question refers to a period of 12 months ending on Saturday week. The illuminating power, he says, has been tested on 2,809 occasions, and each of those testings was the average result of ten observations. The gas has been burnt according to the provisions of the Act of Parliament—namely, from an Argand burner of 15 holes with a 7-inch chimney, and at the rate of five cubic feet per hour. The burner which is now used differs from the old burner of 1860, in the circumstance of its having an internal aperture of 0·44 of an inch instead of 0·57. This checks the supply of air to the gas, and, by preventing over-oxydation, raises the illuminating power about 12 per cent. The burner is strictly in accordance with the provisions of the Act of Parliament, and it has been used for the last 12 months. The results of the 2,809 testings of the gas were that the range of the illuminating power had been from 11·66 standard sperm candles to 16·64—the average for the year being 13·70 candles. That of the Chartered Company had ranged from 9·35 candles to 16·07, the average being 13·14; and that of the Great Central had ranged from 10·77 to 16·20, the average being 13·42. Of 939 testings of the City Company's gas during the year there had been but two occasions when it was below the Parliamentary standard of illuminating power, 26 had occurred during the last quarter, and of these 23 had occurred between the 21st of January and the 18th of February. He was, therefore, led to think either that there had been lately some great neglect in the process of manufacture, or that there had been some experimental investigation going on at the works during the month in question. On comparing the illuminating power of the gas supplied to the city during the past year with that of former years, there had been a considerable falling off in the quality of both the Great Central and the Chartered gas. While the illuminating power of the Great Central gas was equal to 14·47 candles, as estimated by the new burner, in the 10 years preceding 1862, it had been equal to only 13·42 candles in the year which had just expired; and with respect to the Chartered gas the falling off had been from 13·70 candles to 13.14. The chemical quality of the gas had been very dissimilar in the case of the three companies. That of the City Company had been of late almost uniformly good, for it had been perfectly free from ammonia and sulphuretted hydrogen, and had rarely contained more than 20 grains of sulphur in 100 cubic feet. The Great Central Gas had also been free from sulphuretted hydrogen and ammonia, but it had nearly always been over-charged with sulphur; and with respect to the Chartered gas, it had lately been generally under the *maximum* quantity of sulphur, but it had always contained an excess of ammonia. In the course of the year 840 examinations had been made of the gas for sulphur—that is, 280 examinations for each company; and the range had been from 14·4 grains per 100 cubic feet to 35. The average amount in the City Company's gas had been 19·4 grains, in the Chartered 20·1, and in the Great Central 21·9; and of the 280 examinations of the gas of each company, the City Company's gas had on 93 occasions contained more sulphur than was sanctioned by Parliament, the Chartered on 139 occasions, and the Great Central on 226; but it was proper to observe that during the last quarter the City Company's gas had been only twice above the amount, and in the preceding quarter only four times. So also with the Chartered the numbers had fallen from 61 in the quarter to 19; but the gas of the Great Central Company continues to have an excess of sulphur. The pressure of the gas during the year had generally been from about 8-10ths of an inch to 2½ or 3 inches; the average of each company being 1½ inch.

APPLIED CHEMISTRY.

ACTION OF SODIUM ON CARBONIC ETHER, BY MONS. H. GAL.—Carbonic ether is formed by the reaction of sodium on oxalic ether, and it is usually said that the action of the metal must be continued as long as gas is disengaged. But if this is done no carbonic ether will be obtained, for the sodium acts on the ether, and if the reaction be stopped at the proper time, a considerable quantity of a liquid boiling at 79° is obtained. Sodium acts on this liquid also with disengagement of hydrogen; it is soluble in water, and analysis attributes to it the formula of alcohol. The formation of this compound is inexplicable by any equation the author can imagine.

ON THE ELECTROLYTIC PRECIPITATION OF COPPER AND NICKEL AS A METHOD OF ANALYSIS, BY WOLCOTT GIBBS, M.D.—The precipitation of copper by zinc, in a platinum vessel, with the precautions recommended by Fresenius, leaves nothing to be desired, so far as accuracy, ease, and rapidity of execution are concerned. The method labours, however, under a single disadvantage—the introduction of zinc renders it difficult, or at least inconvenient, to determine with accuracy other elements which may be present with the copper. It has occurred to me that this difficulty might be overcome, the principle of the method being still retained, by precipitating the copper by electrolysis with a separate rheomotor. The following numerical results, which are due to Mr. E. V. M'Candless, will satisfactorily show the advantages of the method for the particular cases in which it is desirable to employ it. The copper was in each case in the form of sulphate; the deposition took place in a small platinum capsule, which was made to form the negative electrode of a Bunsen's battery of one or two cells, in rather feeble action. The positive electrode consisted of a stout platinum wire, plunged into the surface of the solution of copper at its centre. The following table gives the results obtained in the analysis of pure sulphate of copper:—

Number.	Salt taken.	Copper found.	Percentage.
1	1·2375	0·3145	25·41
2	0·4235	0·1075	25·38
3	1.0640	0·2705	25·42
4	1·3580	0·3440	25·33
5	0·5665	0·1450	25·59
6	0·4735	0·1205	25·48

In seven determinations of copper in the alloy of copper and nickel employed by the Government for small coins the following results were obtained:—

Number.	Weight of alloy.	Copper.	Percentage.
1	0·4160	0·3640	87·50
2	0·5180	0·5410	87·54
3	0·4600	0·4090	88·91
4	0·5120	0·4481	87·51
5	0·4220	0·3693	87·51
6	0 2525	0·2225	88·11
7	0·3705	0·3255	87·85

The percentage of copper required by the formula $Cu\,O, S\,O_3 + 5\,H\,O$ is 25·42, while the Government standard alloy of nickel and copper contains 87·50 per cent. of copper. The time required for precipitation varied from one to three hours, the separation of the last traces of copper being in each case determined by testing a drop of the liquid upon a porcelain plate with sulphuretted hydrogen water. The copper after precipitation was washed with distilled water, dried in a vacuo over sulphuric acid, and weighed with the platinum vessel. The only precaution necessary is to regulate the strength of the current so that the copper may be precipitated as a compact and bright metallic coating, and to dry as quickly as possible. When the copper is thrown down in a spongy condition, it not only oxidises rapidly, but it is impossible to wash out the last traces of foreign matter contained in the solution. This is well shown by No. 3 and No. 4 of the second series, in both of which cases the copper was precipitated too rapidly. The solution from which the copper has been deposited contains the other elements present in the original substance. It may be easily poured off without loss, and the washings added. It appears at least probable that nickel may be determined by electrolysis in the same manner as copper, the solution employed being the ammoniacal sulphate with excess of free ammonia. Mr. M'Candless obtained in two determinations in a commercial sample 91·36 and 91·60 per cent. of nickel. In both cases the nickel was thrown down completely as a bright, coherent, metallic coating upon the platinum.

METALLIC COATING, SO AS TO PRODUCE A WHITE SURFACE.—This is effected in a very simple way by Mr. Weil. He makes an alkaline solution of this metal which he intends to deposit, and adds to it tartaric acid, glycerine, or some other organic matter. Iron, steel, &c., may with such a fluid be coated with copper, zinc, nickel, &c., and beautiful bright surfaces be obtained. It is usually sufficient to place the object to be coated in the alkaline solution; but, if required, a weak galvanic current may be generated, by bringing it into contact with a piece of zinc.

NEW METALLIC ALLOYS.—Messrs. T. Dunlevie and J. Jones have patented a metallic alloy, to be employed for the bearings of shafts or frictional surfaces in machinery, "rolling stock," &c. The improvements consist in the combination and use of spelter and block tin, to which is added a small quantity of copper and a small amount of antimony, and the mode of combining the above in the melting pot is as follows:—First, take 4oz. of copper, melting or fusing it in any ordinary crucible. When fused, add 16oz. of block tin and 1oz. of antimony; and when both are melted together, pour the compound out into a mould. Then melt in a separate vessel 128oz. of spelter, together with 96oz. of block tin, and when both are fused, add the above ingot of copper, tin, and antimony, and fuse altogether; when properly fused in these proportions, or thereabouts, the alloy is complete. The chief features of this alloy are its great durability, and its low temperature when under the heating influence of friction. The component parts being 16lbs. of block tin, 18lbs. of spelter, 8oz. of copper, and 2oz. of antimony; take the 8oz. of copper, and add thereto 2oz. of antimony, and fuse them together; then add double the quantity of block tin, and when mixed pour out into an ingot mould; then melt the 18lbs. of spelter, and add thereto, the remaining portion of the block tin, and when those are fused, and well mixed, and the ingot previously made thereto. For lining bearings, journals, &c., the bearing is to be tinned, in the ordinary method, with block tin and sal-ammoniac. The improved lining alloy is then gradually fused, and the bearing heated, until it will fuse a solid strip of the alloy. A heated shaft, or mandril, is then enclosed in the bearing and mould, and the alloy poured in between the bearing and the shaft, remaining until it hardens; the bearing is then taken from the mould lined with the alloy.

LIST OF APPLICATIONS FOR LETTERS PATENT.

WE HAVE ADOPTED A NEW ARRANGEMENT OF THE PROVISIONAL PROTECTIONS APPLIED FOR BY INVENTORS AT THE GREAT SEAL PATENT OFFICE. IF ANY DIFFICULTY SHOULD ARISE WITH REFERENCE TO THE NAMES, ADDRESSES, OR TITLES GIVEN IN THE LIST, THE REQUISITE INFORMATION WILL BE FURNISHED, FREE OF EXPENSE, FROM THE OFFICE, BY ADDRESSING A LETTER, PREPAID, TO THE EDITOR OF "THE ARTIZAN."

DATED MARCH 24th, 1865.

828 W. Simons & A. Brown—Dredgers
829 C. Bevan—Cabin furniture for ships and other vessels
830 A. Baillot—Sewing machines
831 T. Farmer & F. Lewis—Ornamenting japanned goods
832 W. Loeder—Rails for railways
833 R. Lublinski—Umbrella and parasol top fasteners
834 J. B Brown—Vessels for storing petroleum and hydrocarbons
835 J. Green—Cutting or chasing the threads of screws or worms
836 W. E Newton—Ink
837 J. A. Swauzy—Machine for washing, wringing, and mangling
838 D. Arnold—Gun locks
839 J. C. Stovin—Communicating signals between passengers in a railway train
840 V. Baker—Obtaining motive power
841 G. F. Marchisio—Obtaining light
842 J. H. Johnson—Treatment of rice

DATED MARCH 25th, 1865.

843 E. Wolverson—Manufacture of ornamental metallic chains
844 H. C. Hurry—Railway points
845 J. Milton—Looms for weaving
846 W. Miller—Presses for cotton and wool
847 A. I. L. Gordon—Communication between passengers and guard of a railway train
848 E. H. Smith—Sewing machines
849 R. W. Barnes—Ascertaining the states of subterranean work
850 J. Dodd—Mules for spinning
851 W. Richardson—Cotton gins
852 J. H. Johnson—Spittoons
853 W. Betts—Protective labels for bottles, jars, and other similar vessels
854 D. E. Blacke—Utilising the heat of steam
855 W. Clark—Lighting and heating

DATED MARCH 27th, 1865.

856 J. Todd—Planing and shaping metals
857 C. Burfitt—Paring potatoes
858 H. J. Walduck—Communication between passengers and guard
859 J. Buckingham—Oil feeders or cans
860 J. Rooke—Double cylinder steam engines
861 C. J. L. Leffler—Casting ingots of steel and mal eable iron
862 C. Matthews & J. Feredny—Furnaces for the consumption of smoke
863 J. Buckshaw & W. S. Underhill—Traction engines
864 F. Le Roy—Preventing the radiation or transmission of heat or cold
865 G. Bishop—Stamping
866 J. C. Thompson & J. J. M. Greene—Facilitating the passage of the guard or other person from end to end of train while in motion
867 W. West—Lubricating compounds

DATED MARCH 28th, 1865.

868 J. Williams—Ornamenting articles made of glass
869 J. Norris—Grooming horses
870 J. Miller & J. Laing—Apparatus for printing ornamental fabrics
871 J. C. C. Halkett—Compositions used for coating vessels
872 W. Walsh—Evaporation of all solutions where evaporation is required
873 T. Glover—Ships' yards and spars
874 A. D. Gascon—Febrifuge and digestive elixir
875 F. Thomas—Kitchen ranges
876 F. A. Mocquard—Gas burners
877 R. Young & F. O. Glassford—Treatment of sea weed
878 F. W. Webb—Manufacture of steel tyres for railway wheels
879 H. W. King—Ventilating blinds
880 E. Savage—Tempering steel
881 L. L. Pulvermacher—Fastenings for articles with metallic backs
882 J. Wright—Forging machines

DATED MARCH 29th, 1865.

883 W. N. Wilson—Sewing machines
884 W Irlam—Cranes, and in railway traversers and crossings
885 W. Brookes—File cutting machinery
886 R. C. Robinson—Cutting nails
887 E. Leigh & F. A. Leigh—Machinery for carding cotton
888 F. A. Leigh—Bridges
889 R. Holroyd & J. H. Bolton—Drying warps of cotton
890 A. Choplin—Instantaneous lowering of ships' boats
891 J Player—Heating the blast for furnaces used in smelting iron
892 S. Childs—Treating fatty matters
893 W. M. Fuller—Preparing waste animal matters for fertilising compounds

DATED MARCH 30th, 1865.

894 T. W. Nordenfelt—Portable covered hammock
895 G. Greenish—Propelling waggons in connection with railway hoists
896 W. M. Neilson—Shaping machines
897 B. Baugh—Reflectors
898 W. Savory—Dressing flour
899 W. Brookes—Melting ores
900 A. A. Croll—Sulphate of ammonia
901 A. Turner—Winding yarns, or threads on to quills
902 A. V. Newton—Cartridge and other boxes

DATED MARCH 31st, 1865.

903 W. Milner & D. R. Ratcliff—Fastenings for metallic safes
904 T. Cook—Construction of safes for valuable property
905 J. Pinchbeck—Engines worked by heated air or gases
906 J., D., B. & O. Swarbrick—Steam boilers
907 L. Bridge—Looms for weaving
908 J. Poole & T. Brown—Socks, soles, or feet protectors
909 E. Leak—Condensing or receiving pulverised fluid or dust
910 H. A. Bonneville—Telegraphic apparatus
911 B. Greenwood—Preventing or curing smoky chimneys
912 H. A. Bonneville—Iron rods and bars of different forms
913 A. V. Newton—Preventing the leakage of barrels
914 A. V. Newton—Inking rollers
915 J. H. Smith—Mounting photographs
916 G. R. Stephenson & G. H. Phipps—Locomotive engines
917 J. Bathgate—Gas meters
918 T. K. Mace—Rib holders for umbrellas

DATED APRIL 1st, 1865.

919 W. Moyall, J. Knott, & W. Dennis—Mules for spinning
920 J. Drinkwater—Painting brushes
921 W. Kilbey—Winding and rewinding silk and other fabrics
922 H. Lewis—Wringing machines
923 R. A. Brooman—Street railways
924 G. Burt—Ornamenting metal tubes
925 W. Gray—Forging steel
926 J Kennan—Cutting scrolls
927 R. Willacy—Preparing and supplying food for cattle
928 A. W. Pearce—Looms for weaving
929 J. C. Stovin—Signals from passengers in railway trains to the guards
930 P. Haenlein—Navigable balloons

DATED APRIL 3rd, 1865.

931 W. Bunger—Melting sealing wax
932 J. von der Poppenburg—Breech-loading fire arms
933 T. Corbett & J. R. Harrington—Letter clips
934 R. R. Riches & C. J. Watts—Cutting hay and such like substances
935 W. C. Gollings—Paddle-wheels
936 J. H. Johnson—Stamps
937 P. J Jamet—Safety tackle for unraising loads
938 G. K. Geyelin—Vermin traps
939 A. Lockwood & A. A. Lockwood, jun.—Bricks
940 F. Brown | Kitchen ranges
941 C. Vero—Felt hats
942 H. Brook—Furnaces for smelting ores and melting metals

DATED APRIL 4th, 1865.

943 C. D. Young—Double-acting lift and force pumps
944 R. Naths—Locks and fixing knobs and spindles for doors and latches
945 J. R. Wigham—Illuminating lighthouses
946 G. C. Thompson—Securing the doors of safes and other doors
947 H. Jenkins—Fastenings for links
948 A. Illingworth and H. Illingworth—Preparing wool
949 W. Brookes—Obtaining motive power
950 C. Martin—Polishing forks
951 R. Baynes—Pumps
952 W. Clark—Rounding and polishing balls or spheres
953 J. Vaughan—Hammers
954 W. Moody & W. J. Hubaud—Stringing and tuning pianofortes
955 W. E. Newton—Expressing liquids from semi-fluid substances
956 W. Bulstrode—Steam cultivation
957 J. Player—Balls or slabs of malleable iron or steel
958 G T. Bousfield—Separating fibre from vegetable materials
959 G. T. Bousfield—Flexible tubing

DATED APRIL 5th, 1865.

960 A. Millar—Electric telegraphs
961 R. Stanley—Hat ventilator
962 J. G N. Alleyne—Traction engines
963 H. Simon—Separating or sorting and washing minerals
964 J. Bethell—Building ships and other vessels
965 B. Johnson—Pianofortes
966 W. Teall, L. Lepaige, and E. T. Simpson—Oil and grease
967 J. I Darribet—Seats of closets
968 G. W. Dyson—Rabble or bar used in puddling iron
969 C. W. Lancaster—Fire-arms
970 E. Ritherdon—Protecting iron ships from corrosion
971 F. R Enson—Lace
972 C. Espiu—Regulating the supply of gas

DATED APRIL 6th, 1865.

973 R. Maynard—Cutting hair
974 J. Browo—Boilers
975 J. S. Watson & A. Horwood—Signal and alarms
976 E. H. Newby—Tapering the ends of metallic rods or wires
977 C. H. Williams—Manufacture of cornice pole and other rings
978 J. Badger—Agricultural implements
979 M. Doisy—Substitute for coffee
980 G Davies—Illumination
981 J. H. Johnson—Drilling rocks and other hard substances
982 J. G. Jones—Valves of engines
983 J. Ellis, C. Walker, & W. Preston—Carding wool
984 W. B. Richards—Corrosion or staining of the surface of glass
985 R. Garrett—Reducing wheat and other straw
986 P. Hugon—Gas engines

DATED APRIL 7th, 1865.

987 A. Muir—Breech-loading fire-arms
988 G. Rydill—Steam boilers
989 E Welch—Fire-places
990 J. Thompson—Preparing cotton and other fibrous substances
991 S. Smith & J. W. Jackson—Regulators for steam engines
992 T. Wilkes—Railway bolts, spikes, and other like articles
993 T. White—Nut crackers, lobster crackers, and grape scissors
994 J. Brown—Nail
995 H. Edmonds—Lighting and ventilating ships
996 W. Gray, E. Gray, & J. Gray—Ploughshares
997 W. Jackson—Mixing gases
998 M. S. Maynard—Preparing cotton and other fibrous substances
999 N. G. Kimberley—Locks
1000 T. Skidmore—Securing and protecting valuable property
1001 M. Henry—Purifying smoke

DATED APRIL 8th, 1865.

1002 W. E. Gedge—Locomotive steam power on ordinary roads
1003 H. J. Simlick—Machines for matches, vestas, and vesuvians
1004 A. Homfray—Forming the links of iron and steel chains
1005 W. Weatherly—Sizing paper, and machinery employed therein
1006 J. Isherwood—Printing upon the fabric known as sail cloth
1007 G. Davies—Buttons
1008 G. Davies—Preventing the fouling of ships and other vessels
1009 V. A. Prout—Cameras
1010 J. Dehnam—Ornamenting linen cuffs and collars
1011 A. G. Hunter—Soda and potash
1012 S. Moore—Electro-magnetic machines
1013 T. Turton—Cutting files
1014 J. B. Hausman—Supporting and steadying the arm in rifle shooting
1015 J. White—Hand-drilling machine

DATED APRIL 10th, 1865.

1016 A. Stewart—Apparel
1017 C. F. Gheerbrant—Deepening the bottoms of rivers
1018 R. A. Brooman—Forming tapered rods
1019 R Ferguson & W. Ralston—Finishing yarns and threads
1020 W. Brooks—Heating files
1021 G. Voigt—Retarding railway carriages and waggons

DATED APRIL 11th, 1865.

1022 J. J. Myers—Compensating wheel to be used with locomotives
1023 C. Vaughan—Iron and steel
1024 S. Wright—Wheels
1025 W. Clark—Horse shoes
1026 D Payne—Printing machinery
1027 R. A. Brooman—Storing petroleum and other inflammable liquids
1028 R. A. Brooman—Applying suction
1029 J. H. Johnson—Steam generators
1030 J. H. Johnson—Communication between passengers and guards
1031 W. E. Newton—Construction of telegraph cables
1032 A. Turner—Looms for weaving
1033 L. B. Phillips—Watches
1034 B. W. L. Nicoll—Flexible waist spring for boots
1035 J. Dadley—Coupling for railway carriages and other vehicles
1036 R. Turner—Iron cable shackle

DATED APRIL 12th, 1865.

1037 G. W. Rothler—Mechanism for flying through the air
1038 J. Haworth—Cleansing horses by mechanical power
1039 H. Bridson—Clamps for stretching frames and other purposes
1040 C. Boschan, J. Bindtuer, & W. Caffou—Lamps for burning petroleum
1041 F. P. Warren—Cooking utensil
1042 H. Sikes & G. Jormain—Treating wool in order to cleanse it from burrs
1043 J. Walker—Door locks
1044 G. A. Monteuut—Ejecting and spreading liquids
1045 J. M. Hart—Bolting and locking safe and other doors
1046 T. J. Maynll—Fire-arms, and in cartridges for the same
1047 F. Batty & E. B. Sayers—Guide applicable for sewing machines
1048 G. Jackson—Supports or rests for billiard cues
1049 J. S. Bickford—Safety fuze
1050 W. E. Newton—Elastic binders for boots and shoes
1051 A. V. Newton—Injectors
1052 H. Leonhardt—Motive power engine

DATED APRIL 13th, 1865.

1053 G. Rosselet—Motive power to be applied to ships
1054 G. Mountford—Sharpening articles for grinding articles of cutlery
1055 A. Westhead—Signalling on railway trains
1056 J. Chubb & R. Goater—Iron safes
1057 W. S. Tates—Machinery for folding fabrics for pressing
1058 C. F. Cotterill—Pipes for conveying water and gas
1059 S. Dawson, J. Burgess, & J. Moulsey—Metallic pistons
1060 J. Rippon—Lubricating spindles or other frictional surfaces
1061 C. Turner & T. Room—Looms
1062 R. A. Brooman—Feeding boilers and propelling vessels
1063 T. Bennett—Hoop iron
1064 W. Beardmore—Furnaces

DATED APRIL 15th, 1865.

1065 J. McDowall—Shaping corks
1066 J. M. Courtauld—Safety apparatus for steam boilers
1067 C. R. Fisher—Connecting a gaff to the mast of a vessel
1068 W. Clark—Material to be used as a substitute for india-rubber
1069 T. E. Harding—Support for invalids

DATED APRIL 17th, 1865.

1070 M. Smith—Looms for weaving
1071 A. Henry—Breech-loading fire-arms
1072 T. Newbigging, A. Hildle—Wet gas meters
1073 J. J. Matthewson & H. L. R. Schiee—Rotatory aerial swings
1074 L. de St Ceran—Gas ammoniacal engines
1075 E. Morgan & G. H. Morgan—Covering railway
1076 J. Dougan—Distilling hydrocarbons from coal and other minerals
1077 A. W. Hale—Machines for cutting or mincing meat
1078 G. W. Garrood—Signalling between passengers and guard of a railway train

DATED APRIL 18th, 1865.

1079 F. C. Bakewell—Cushions for steam cylinders
1080 J. C. A. Henderson—Manufacture of ladies' skirts
1081 J. J. Jenkin—Manufacture of tin and terne plates
1082 J. Todd—Straightening and bending plates of iron
1083 W. Bedder—Construction of ships
1084 T. Whitehead & N. Nussey—Combing fibrous substances

DATED APRIL 19th, 1865.

1085 J. Gardner, R. Lee, G. H. Wain, S. Hargrove, C. Hargrove, & S. Hargrove, jun.—Malleable iron sheaves
1086 J E. H. Andrew—Looms for weaving
1087 R. A. Brooman—Lace
1088 R. A. Jones and J. Hedges—Communicating intelligence by means of electricity
1089 J. Merritt—Inkstands
1090 W. Riddell—Covering railway trucks, vans, and other carriages
1091 F. W. Gilbert—Pulleys for lifting and lowering weights
1092 G. T. Bousfield—Breech-loading fire-arms
1093 M. Vogl—Cutting stones and other hard substances

DATED APRIL 20th, 1865.

1094 J. Hall, W. Dunkerley, and S. Schofield—Carding cotton
1095 J. Hocking—Preventing explosions of steam boilers
1096 H. K. Taylor—Indicators and fastenings for water-closets
1097 D. Hancock and T. Evans—Signalling between passengers and guard
1098 E. Smith and C. Sieberg—Obtaining colouring matters
1099 M. Houssepian—Pumps
1100 T. Hompton and J. Abbott—Bessemer steel ingots
1101 W. Clark—Stop cocks
1102 F. A. Abel—Explosive compounds
1103 W. Hale—Rockets
1104 D. Greig—Cultivating land
1105 W. Beaver—Screening, sifting, or riddling corn and seed
1106 W. Robinson—Roasting jacks
1107 H. Candwell—Ships of war
1108 J. Y. Betts—Baking bread
1109 F. Wise—Regulators

DATED APRIL 21st, 1865.

1110 T. Greaves and J. S. Wright—Manufacture of buttons
1111 D. S. Buchanan—Protecting ornamental designs on glass
1112 E. T. Hughes—Packing for steam cylinders and stuffing boxes
1113 E. Wilson—Lamp or signal
1114 W. Day—Wheels
1115 A. C. Hermann—Balance with index for weighing luggage
1116 J. Champion and J. B. Sheridon—Preparing fibrous material
1117 W. Scarritt & W. Dean—Taking impressions from the grain of wood
1118 R. Griffith—Propelling vessels
1119 G. Whitlock—Oiling cans
1120 H. E. Newton—Invalid carriages
1121 C. Betjemann, G. W. Betjemann, and J. Betjemann—Cases
1122 R. Canham—Casting
1123 C. Hall—Ploughing

DATED APRIL 22nd, 1865.

1124 O. C. Evans—Digging machinery
1125 E. Lord—Preparing cotton and other fibrous substances

NORMAND'S PATENT CURVILINEAR SAWING MACHINE

FOR SHIP FRAME TIMBERS

FIG. 1.

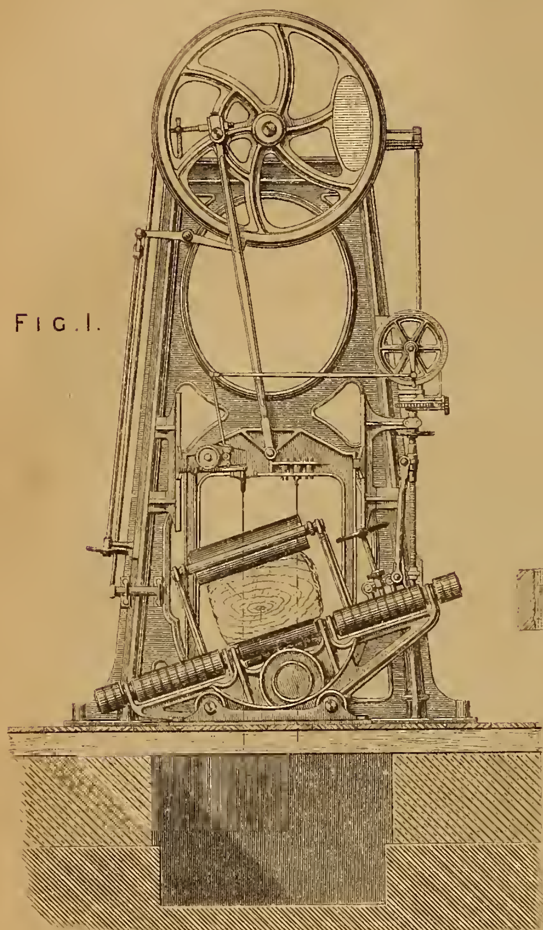


FIG. 2.

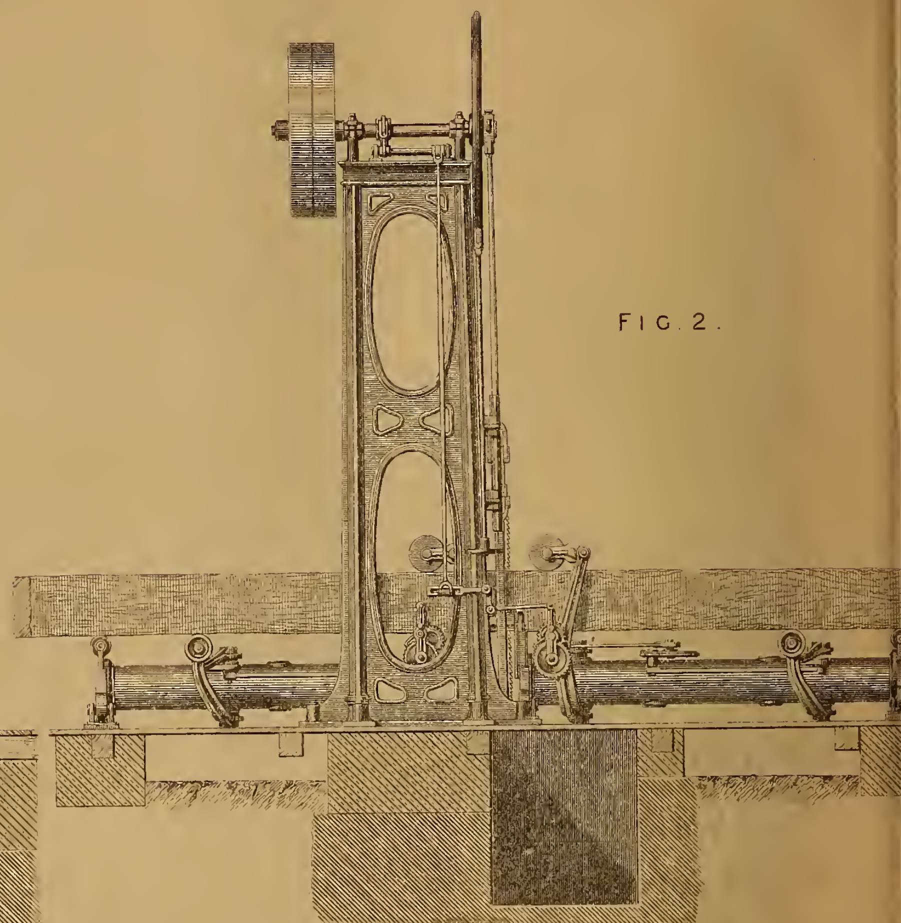
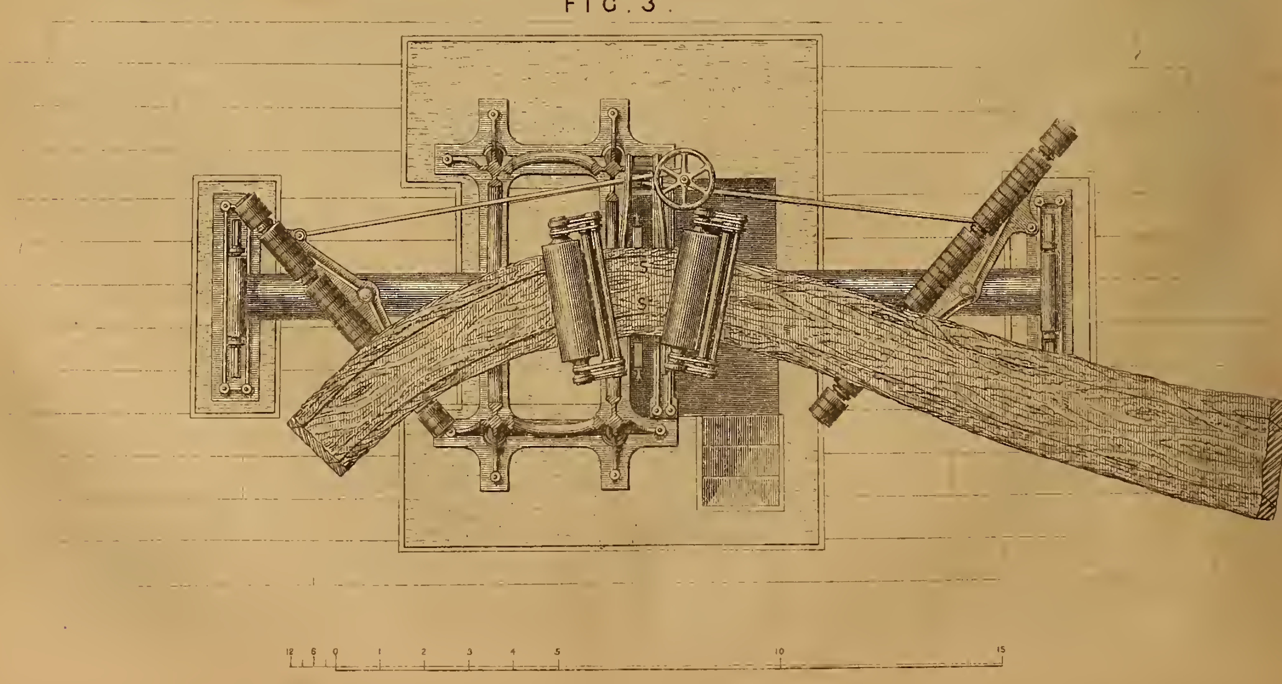


FIG. 3.



MERSEY DOCKS AND HARBOUR

FIG. 2.

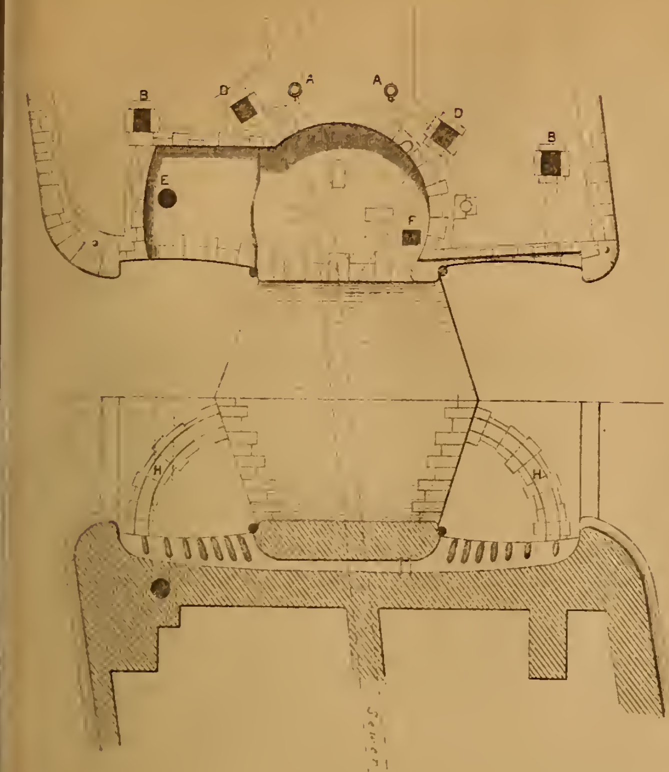


FIG. 6.

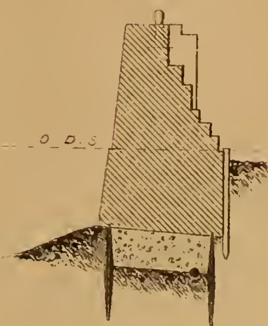


FIG. 8.

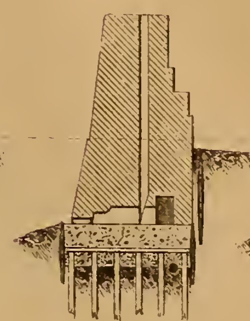


FIG. 7

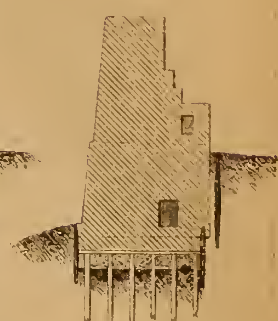


FIG. 10

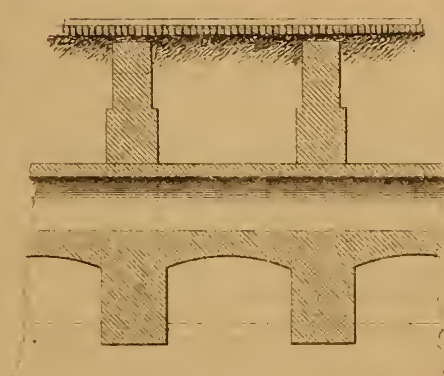


FIG. 9

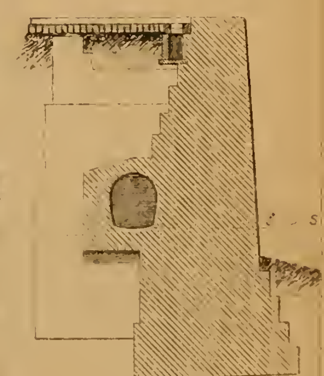


FIG. 1

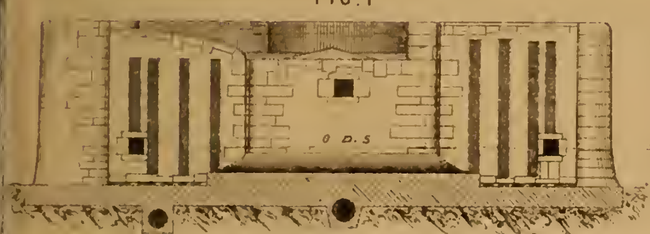


FIG. 11.

FIG. 3

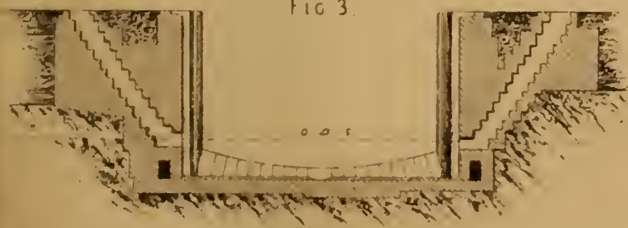


FIG. 5.

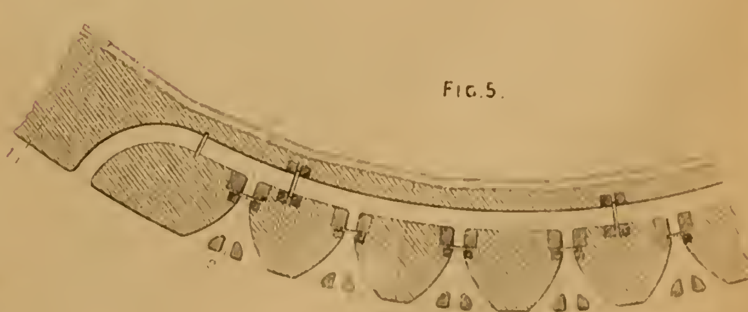
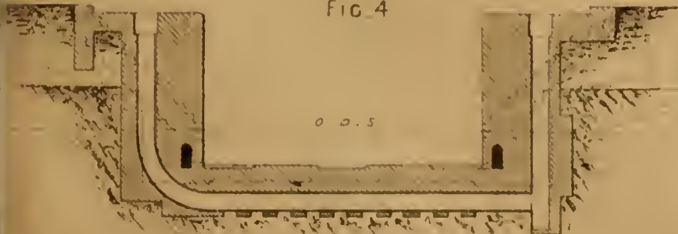
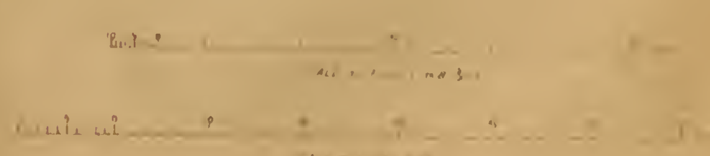


FIG. 4





THE ARTIZAN.

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NORMAND'S PATENT WOOD-SAWING MACHINES.

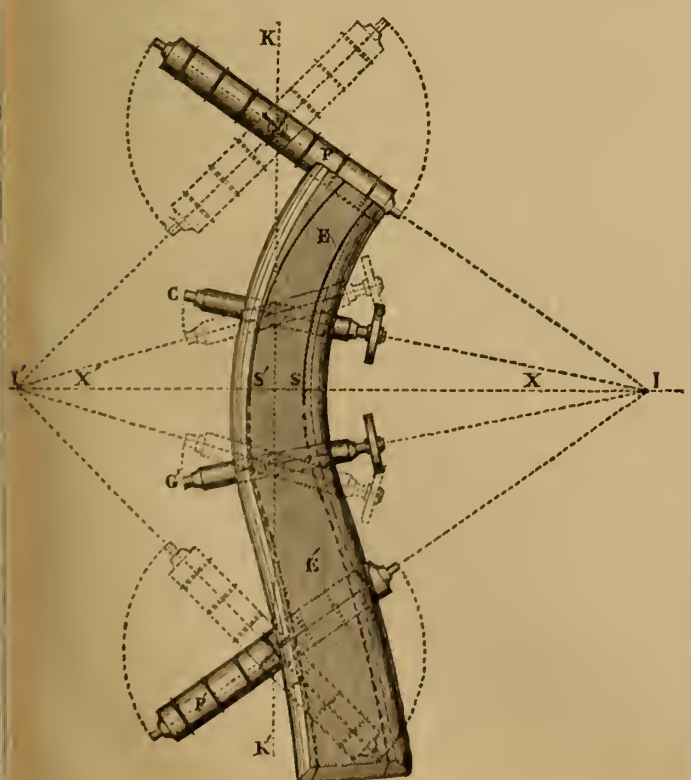
(*Illustrated by Plate* 280.)

Agreeably to the announcement in our last issue, we have illustrated, in the accompanying Plate 280, Messrs. Normand's Patent Machine for the Curvilinear Sawing of ship-frame timbers with bevels, twist, and taper. Fig. 1 being an end elevation; Fig. 2 a side elevation; and Fig. 3 a plan thereof.

We may here remark that the principle of the action of Messrs. Normand's Patent Curvilinear Machines is different from that of machines previously made and intended for accomplishing the same objects. In most of these latter, the timber to be operated upon is moved in a *straight line*, being a *chord* of the curve to be obtained, the saws being moved laterally and turned round their centres in an oblique direction, so as to meet the line to be followed on the timber.

In the machines now under notice, and illustrated in the accompanying Plate and woodcut, the position of the saws is constant, excepting a slight lateral motion to produce the taper, and the wood is brought forward in the requisite direction tangential to the plane of the saw blade.

The most irregular curve can always be reduced into a succession of small arcs of circles of different radii, all tangential one to another, and having their circles occasionally transferred from one side of the curved line to the other, every time the direction of the latter is reversed—that is, altered as in the letter S.



The accompanying woodcut shows how these successive and varying circular advances are obtained tangential to the fixed planes of the saw blades. The piece of timber after having been *sided*, that is, having the two straight parallel sides cut, is laid on the machine, consisting chiefly of four rollers, F F′ G G′, the upper edges of which are in the same plane, and pivoting around axes situated in the longitudinal centre line K K′, the saw blades being in S S′. The pivoting motion of the whole of these rollers is so connected by suitable mechanical arrangements (shown in the complete view of the machine, given in our Plate) that their prolonged axes *converge to one point*, I, movable on the transverse line X X′, perpendicular to the centre of the saws.

The piece of timber borne upon the rollers cannot, therefore, take any other advance but a revolving motion from this point of *convergence*, and the facility with which this convergence can be removed to a greater or lesser distance from the saw blades, transferred from one side to the other, enables the attendant to have any curved line marked on the timber brought to the cutting edge of the saw.

The whole of the mechanism bearing the timber and producing its *curve motion* is capable of being inclined, in either direction, to the extent of 20°, so as to present the wood to the action of the saws under the angle required by the *bevels*. It is almost superfluous to add that in a ship the inner and exterior surfaces of the hull being parallel, the cross sections of the frame timbers are everywhere a parallelogram, and thus the inner and outer bevels are always alike.

When the bevels are to vary through the length of a piece of timber a feed motion is given to the vertical screw on the right hand of the machine governing the angles, and the required degree of twist is obtained.

In order that the twist motion may not occasion a detrimental alteration of the tangential advance of the wood along the saw blades the axis of suspension of the system is placed at a near centre of the timber itself, the suspension being effected by rollers acting on segments of circle described from the said points; the twist motion therefore results in two small contrary actions of the wood against the saws, sensibly equal, and counteracting each other.

The third and last condition of the problem was to give to the saw blades a slow lateral motion, in order to obtain the alteration in the thickness or taper existing in every point of the ship's frame, from the keel to the rail, but in proportions varying sometimes from ¼in. to 1½in. per yard run. This end is obtained by suitable mechanism, contained part in the saw frame and part upon the fixed standards of the machine, at the right hand above the bevel and twist motion. Accordingly, as the fixed centre of the small transverse connecting rod is established higher on the quadrant, so the versed sines of the arc described by the other extremity will be increased; and, in the same ratio, the amount or intensity of the lateral feed motion of the saws, which it originates. By the addition of a double set of clicks, operating in contrary directions, all the positions of the fixed centre on the left of the quadrant correspond to an increasing motion of the distance of the saws, and the position on the other side of the quadrant originates a contrary action.

The whole of the required motions are thus under the control of the attendant who can, when necessary, introduce into the three motions governing the curve, the bevel, and the scantlings, the required corrections.

We must remark that the apparent complexity of Mr. Normand's machinery arises more from the nature of the work to be performed than in the means devised for its accomplishment.

So long as by universal assent the figure of a ship continues to defy any geometrical definition, and shipbuilding remains an art in which individual taste and momentary fashion enjoy such a wide range; so long as the materials of the wooden walls continue to grow crooked, twisted, and tapering, as if to adapt them better to their task, it will be difficult even to suppose very simple mechanical means of dealing with such materials.

But complexity which only amounts to a large number of moving parts not liable to derangement or rapid wearing, is unobjectionable when it does not prevent the work from being accomplished with an economy only equal to its wonderful precision.

We have now a great deal more than mere experiments or speculations to rely upon. One hundred of Normand's machines (one-half of which are for curvilinear sawing) are at work, and they have been for some years in use in the French, Spanish, Dutch, and Brazilian dockyards.

From a report to the Minister of the French navy, dated November, 1860, by Mr. Brocard, naval constructor, we extract the following information on the quantities and cost price of the work done by Normand's machines, in Cherbourg Dockyard in 1859; and may here remark that since that time Mr. Normand has so improved the machines as to obtain still better results.

Of the plane-sawing machine it is reported:—Mean production per day, 750 square feet; cost of labour, all included, per 100ft., 9*d.*, or one-eleventh only of the tariff price at Toulon, for the same sort of work by hand labour.

As to curve sawing of ship frame timbers, it is reported:—Mean produce per day, 650 square feet; total cost of labour, interest, &c., 2*s.* 1*d.* per 100ft., against 12*s.* by hand labour; economy, 82½ per 100.

As to curvilinear sawing of long trees into planks, &c., it is reported:—One of these machines has performed in one year the enormous amount of 390,000 square feet, at a cost of 7½*d.* per 100ft. for labour, or 1*s.* 3*d.*, all included. The economy produced by the machine was such, that it has repaid its own cost price twice every year.

Mr. Normand, we are informed, has made arrangements with Messrs. Samuel Worssam and Co., of Chelsea, for the construction of his patent machines. Under the direction of these experienced makers of sawing machines, the new sawing machines are likely to obtain a rapid and we trust extensive introduction in this country.

HISTORICAL AND DESCRIPTIVE SKETCH OF THE MERSEY DOCKS AND HARBOUR.

By J. J. Birckel.

(*Illustrated by Plate* 281.)

We now proceed to describe the general characteristics of the masonry as carried out on these works, and to explain the details of construction of those portions whose functions render them worthy of special notice.

Of the system of masonry adopted in the early docks constructed by Mr. Steers, very little can be said, for the first of them, known as the old dock, was filled up in 1826, as has been mentioned before; and the others, comprising the Salthouse, the George's, the King's and the Queen's Docks, have all been so entirely remodelled during the long and laborious surveyorship of Mr. Jesse Hartley, that little, if anything, remains of the original masony work.

The Prince's Dock, projected in 1809 by Rennie, together with other works at the request of the Dock Committee, and no doubt built afterwards under his general direction and supervision, is the only one whose walls and entrances remain intact, excepting of course those repairs which are rendered necessary everywhere by that natural process of disintegration inherent to all structures reared by the hands of man. The walls of this dock and its entrances in their entirety are built of red sandstone, the faces being made of ashlar, laid in regular courses; the stone no doubt was quarried in the neighbourhood from among the Triassic strata, which, as we have seen, underlie the upper surface of the ground or crop out from beneath it, both in and all around Liverpool. This system of masonry was also adopted by Mr. Hartley in his earlier works, though it appears that from the very date of his appointment in 1826 he made the copings of the walls and some portions of the work in the dock entrances of granite blocks of large dimensions; and there cannot be the least doubt but that Mr. Steers built his walls in the same manner, because it was evidently the cheapest mode of carrying out the work, owing to the presence of the material on the very spot, and with the use of soft stone, probably the only advisable method to adopt, in so far as this relates to building the faces of the walls in regular ashlar courses.

Hartley, however, of whom it is said that he prided himself in not being *an engineer*, but *an artizan*, and who in the mason's art was probably the most original genius that ever has been produced, how much soever in other respects his boast may have been devoid of truth—Hartley seems to have discovered early that the new red sandstone is not a desirable material to employ in works of this kind, where it is not only subject in an intense degree to the ordinary causes of delitation and disintegration by the combined action of atmospheric, and what may be termed hydroscopic changes, but also to abrasion and destruction by the ofttimes violent action of the shipping, and to continuous wear from a constantly increasing traffic; and be no doubt found that the cost of frequent repairs, entailed by the use of the cheaper material, would go far to counterbalance an extra outlay in first cost incurred by the use of a more durable material upon works in the total cost of which the purchase of land and the cost of labour necessarily must form two considerable items. The above conclusion is justified by inference from the fact that the Albert Dock walls and its entrances, built between 1840 and 1846, are faced throughout with granite, and that the second batch of North Docks, built between 1844 and 1848, commencing with the Salisbury,* the Collingwood, and the Stanley Docks, are built in the same manner. Hence it would appear that from 1840, onward, Mr. Hartley discontinued the practice of facing his dock walls with soft stone ashlar courses, excepting to a limited height, and adopted instead of it the granite rubble face. This kind of masonry has both a very quaint and an exceedingly bold appearance, and in adopting it we venture to say that Mr. Hartley was entirely singular, for to the best of our knowledge the same style is not to be met with anywhere else, either in this country or abroad. To initiate it he had to train his own staff of foremen and workmen, and it was no uncommon thing to see him among them, dressing a block of granite, or building up a portion of a wall, the natural result of which was that be exercised over them a kind of awe not often exacted in these days by superior from subordinate, and was certainly looked upon by them as an entirely extraordinary being. Over the Dock Committee he exercised a similar influence, so that in matters technical his sway was absolutely supreme, and thus it is that he was enabled not only to introduce, but also to perpetuate, his own ideas. We say to perpetuate them, because at the present date, that is eight years after his death, nearly the whole of his responsible staff remain upon these works carrying out these ideas as though he walked in the midst of them. As referring to this style of hydraulic masonry, we remember conducting a French Government engineer over the line of docks, who, when he saw it, exclaimed, "We durst not do that; it shows an amount of confidence in the materials used, and in the skill of the workmen employed which we do not possess." It is not too much, therefore, to say that as a mason Mr. Jesse Hartley has stood unexampled in our days.

The backing of the walls is invariably made of soft stone rubble, chiefly quarried at Flaybrick hill on the Cheshire side of the Mersey, and the cost of this stone is about five shillings per cubic yard; not unfrequently it is quarried on the spot where it is to be used, when, of course, its cost is considerably diminished. The sandstone ashlar, which is still used on those portions of the work less exposed to deterioration, and on the face of the walls up to a limited height, is chiefly quarried at Runcorn. The granite work in the walls is from 2ft. to 2ft. 6in. in thickness, and is made of stone of the most irregular sizes possible. In pier heads, however,

* So named as a mark of courtesy to the Marquis of Salisbury, owing to his connection with Liverpool, through descent from the Gascoynes, of Childwall.

and in the wing walls of the dock entrances, which are subject to much rubbing and chafing by the shipping when it is hauled in and out of dock, granite blocks of very large dimensions are introduced at short distances, and are placed in an upward sloping position at an angle of about 45° (for which reason they are termed rakers), for the purpose of binding the small work more firmly together. These rakers are from 8ft. to 10ft. long, by about 3ft. 6in. deep, and 2ft. 6in. thick; a part elevation of such a wall is illustrated in Fig. 11. The price of granite ashlars is from 1s. 8d. to 2s. 6d. per cubic foot, according to their size; and it is scarcely necessary to mention that economy is the principal reason for adopting this style of masonry. The rubble is obtained from the quarries of the Dock board in Scotland, and, we believe, in Wales, but its cost, though no doubt known to them, is not easily to be ascertained by outsiders. The platforms, sills, hollow quoins, cutwaters with their covers, the clough* jambs, and, indeed, the entrances in their entirety, as constructed by Mr. Hartley, are made of and faced with granite ashlar; the copings of the walls are invariably made of large granite blocks joggled together with pebbles; the hollow quoins and the blocks facing the edges of the sills are joggled together also.

Mr. Lyster, who has succeeded the younger Hartley as engineer to the Dock Trust, has shown great wisdom by encouraging the staff which he found upon these works, and by following generally in the track of his predecessors in matters relating to masonry details. For the sake of economy he uses a carboniferous limestone for the covers of the cutwaters, for the clough jambs, for the copings of some of the graving dock walls, and in various places where it may do quite as good service as granite would. Some of this limestone comes from Wales, and some from Wicklow, in Ireland, and it is probably quarried among the strata of the Gannister series; its cost is only half that of granite. The stone is invariably set in mortar, of which there are two mixtures, as follows:—

For the backing.—3 parts of lime, 5½ parts of sand, and ½ of ashes, ground together for 30 minutes.

For the facing.—4 parts of lime, 4½ parts of sand, and ½ of ashes, ground together for 40 minutes.

The lime used is the blue lias limestone, and is obtained from the Halkin mountains in Wales; the sand is taken out of the river, generally from the Devil's Bank, and the ashes are common smithy ashes. The work is generally pointed with cement, because it is more impermeable to water, and consequently prevents, to a considerable extent, injury to the masonry by frost.

Of the quality of the masonry work, as carried out on the dock works, it can only be said that it is difficult to conceive of anything better, and the desire on the part of the Dock Trust to have it done in the best possible manner, is fully evinced by the fact that no portion of it is allowed to be made by contract, but the whole is executed by their own workmen under the immediate superintendence of the engineer to the Trust, and of his staff. This remark, of course, does not apply to excavations, which are generally done by contract.

Notwithstanding all the care that is taken, the water does work its way through the joints of the stones to the back of the walls, and as the ground behind them is all *made ground*, a fact which will be readily understood when it is remembered that the docks all stand upon land which was formerly overflowed by the tidal waters, there is in this circumstance what might be termed a constitutional source of danger to the stability of the walls, since the loose material with which the space behind them is filled may, by infiltration of the water, be rendered semi-liquid, and thus with increased pressure tend to push the walls forward away from their footings. In order to reduce that source of danger as much as possible, loose stone or fragments of stone are placed immediately behind the walls.

The bottom of the docks remains invariably as excavated without artificial covering of any kind.

Upon the plate illustration, No. 281, Figs. 1 to 4 represent one of the 50ft. dock entrances, which may be taken as a fair type of all the entrances of varying widths as constructed on these works. Fig. 1 is a longitudinal section through the centre of the entrance, showing the recess for the turnbridge, the level of which is in this particular instance about 4ft. 6in. below the level of the highest spring tides. This view shows also the back and front chain holes in elevation, the recesses for the gates, the culvert for the gas and water pipes, the sewer, and the cutwaters in elevation. The level of the sill is 6ft. below the datum of the old dock sill, and 4ft. above the level of lowest spring tides. In some of the entrances, however, it is lower, such level being evidently dependent upon the depth of the water in the bed of the river immediately outside the respective entrances to the docks. The rise of the sill from the platform varies from 2ft. to 3ft. 3in., according to the width of the entrance, and the depth of masonry below the level of the platform varies of course with the nature of the foundation to a minimum of about 3ft., being the depth of the granite ashlar, with which the platform is faced. The level of the coping in the case illustrated is 26ft. above the old dock sill datum, or about 2ft. above the level of highest spring tides; but this also varies in some of the docks, and the coping of portions of the river wall is 30ft. above that datum. A tabular statement of these levels, together with the areas of the docks and other particulars, was given with our paper of October 1864.

Fig. 2 is a half-plan at the level of the coping, showing the position of the several chain holes, the recesses for the gates, the shape of the hollow quoins and the recess for the turnbridge, and a half plan at the level of the sill, showing the shape and position of the cutwaters, and the position of the paddle-sluice or clough, which admits the water to the outside platform at low tides whenever that is required. The same view shows also the position of the granite blocks, which carry the cast iron segment upon which the gates travel when they are opened or closed; in the 80ft. and 100ft. entrances two such segments are provided for each wing of the gates. The special functions of the cutwaters is to scour the platform when the tide has receded, and to remove any silt that may have been deposited there. Fig. 3 is a section through the chain holes behind the gates; and Fig. 4 a section through the culvert for the gas and water pipes. These culverts are invariably lined with strong cast iron cylinders, from 4ft. to 4ft. 6in. diameter, and from 1in. to 1¼in. thick, united by means of socket joints.

Fig. 5 is a part horizontal section of a wing wall through the sewer and cutwaters, and Figs. 6, 7, and 8 are cross sections through the points 1, 2, and 3 respectively on the horizontal section. The particular wall here illustrated is taken from the Birkenhead works, at a point where the water is considerably deeper than it is on the Liverpool side; hence the great depth of the foundations below the datum of the Old Dock sill. The footings of the wall and their artificial foundation are lined both in front and at the back with a row of cast iron sheet piling, bound together with wrought iron tie rods, with the object, probably, of protecting it against the mining influence of the current whose set is strongly in that direction. The thickness of the wall appears to be somewhat excessive, but those who know what severe storms burst periodically upon this port will no doubt think with us that it is probably a fortunate circumstance that Jesse Hartley did not calculate the thickness of his walls by any other formula than the one deduced from his own experience, and which, we believe, was worded somewhat as follows:—*Make the wall thick enough.*

The cutwaters differ from those of the entrances in that every set of three openings merges into a single one fitted with a clough, so that sluicing may be carried on independently through any one set of openings; the sewer of course communicates with the dock whose river entrance these cutwaters are intended to scour.

Figs. 9 and 10 are respectively an elevation of, and a section through, the east wall of the Canada Dock, at a point where, in consequence of very loose foundation Mr. Hartley had deemed it advisable to provide the wall with land ties. During the early part of 1863 this wall began to give way, by slipping forward and breaking loose from the land ties whilst

* Clough is the local name for a paddle sluice valve.

the dock had been run dry for the purpose of cleaning it. On the first signs, however, of its giving way the water was again admitted into the dock and its forward movement thus checked, when upon examination it was found that the sewer was broken in. The cause of this failure was naturally attributed, in a great measure, to the presence of the sewer; and we believe Mr. Lyster gave it as his opinion, in a report to the Dock Board, that it was not desirable to have these built into the walls, as forming an integral part of them. A somewhat similar accident befel the south wall of the low water basin at Birkenhead, which also was attributed to the presence of the sewer within the wall; and it is probable, therefore, that in all new docks to be constructed this manner of carrying out the detail of the sewer will not be repeated.

(To be continued.)

TEMPERATURES AND PRESSURES OF HIGH PRESSURE STEAM.

By R. A. PEACOCK, C.E., Jersey.

An examination of the following table—which has never been published before, and, with the exception of Dr. Fairbairn's experiments, is quite new—will satisfy the reader that from 25lbs. per square inch up to 411·6lbs. per square inch, the temperature increases as the $4\frac{1}{2}$ root of the pressure. The greatest variation from M. Regnault's experiments is with his temperature of 300° Fahr.; such variation, however, is less than $\frac{1}{4}$ per cent., viz., ·232, or 1 in 431. It will be further observed that even with regard to that small variation the result ought to be considered as modified by the very close approximation of the calculation to Dr. Fairbairn's experiments with a temperature only a little less, viz., 292·53° Fahr., for which the calculation gives a difference of only ·017 per cent., or 1 in 5,882. With M. Regnault's temperature of 410° Fahr. the calculation is all but identical, the difference being only ·002 per cent., or 1 in 50,000, while with his last temperature, viz., 447° Fahr., the difference between experiment and calculation is still unimportant, being no more than ·159 per cent., or 1 in 629. And it may be further observed that the formula, *Temp. increases as* $4\frac{1}{2}$ *root of pressure*, is, so to speak, still more moderate than M. Regnault's own formula; because it will be seen that the former requires 447·71° to give the pressure of 411·6lbs., whereas M. Regnault's formula gets that pressure with 447° Fahr. only. That is to say, if both formulæ were to be applied (hypothetically) to calculate very high temperatures of say 2,000° or 3,000° Fahr., M. Regnault's formula would give greater pressures than the other. Probably the means do not exist for ascertaining how far either formula differs from fact at those high temperatures.

Yet, although exact knowledge does not exist, we are fortunately not without some indications of the force of steam pressure at very high temperatures. The Rev. John Michell wrote a very valuable paper, in which he contended that earthquakes were caused by steam,* which paper does not appear to have gained as much consideration as it probably deserves. He says that in casting two brass cannon "the heat of the metal of the first gun drove so much damp into the mould of the second, which was near it, that as soon as the metal was let into it, it blew up with the greatest violence, tearing up the ground some feet deep, breaking down the furnace, untiling the house, killing many spectators on the spot with the streams of melted metal, and scalding others in the most miserable manner." These great effects were evidently produced by the steam of a few ounces of water only, for it is called merely "damp," and it

* Phil. Trans. R.S. 1760, Vol. xi., p. 447, &c.

Pressures per Square Inch.	Regnault's Exp'ments.	Dr. Fairbairn's Experiments.	As $4\frac{1}{2}$ Roots of Pressures.	Differences.	Differences per cent.	Pressures per Square Inch.	Regnault's Exp'ments.	As $4\frac{1}{2}$ Roots of Pressures.	Differences.	Differences per cent.
lbs.	Temp. F. deg.	Temp. F. deg.	Temp. F. deg.	deg.	deg.	lbs.	Temp. F. deg.	Temp. F. deg.	deg.	deg.
24·998	240	...	240·244	− ·244	− ·102	77·9345	310	309·303	+ ·697	+ ·225
26·5	...	242·90	243·375	− ·475	− ·195	83·7802	315	314·315	+ ·685	+ ·218
27·3518	245	...	245·093	− ·093	− ·038	89·9689	320	319·332	+ ·668	+ ·209
27·4	...	244·82	245·188	− ·368	− ·150	96·5104	325	324·352	+ ·648	+ ·200
27·6	...	245·22	245·585	− ·365	− ·149	103·4292	330	329·381	+ ·619	+ ·188
29·8753	250	...	249·946	+ ·054	+ ·022	110·7302	335	334·412	+ ·588	+ ·176
32·5899	255	...	254·824	+ ·176	+ ·069	118·433	340	339·446	+ ·554	+ ·163
33·1	...	255·50	255·705	− ·205	− ·080	126·5523	345	344·486	+ ·514	+ ·149
35·5005	260	...	259·715	+ ·285	+ ·110	135·1028	350	349·527	+ ·473	+ ·135
37·8	...	263·14	263·362	− ·222	− ·084	144·0992	355	354·565	+ ·435	+ ·123
38·6169	265	...	264·617	+ ·383	+ ·145	153·5562	360	359·614	+ ·386	+ ·107
40·3	...	267·21	267·137	+ ·073	+ ·027	163·4934	365	364·660	+ ·340	+ ·093 = $\frac{1}{1075}$
41·7	...	269·20	269·17	+ ·03	+ ·011	173·9206	370	369·705	+ ·295	+ ·079
41·9587	270	...	269·543	+ ·457	+ ·170	184·8574	375	374·750	+ ·250	+ ·067
45·5259	275	...	274·474	+ ·526	+ ·192	196·3234	380	379·795	+ ·205	+ ·054
45·7	...	274·76	274·71	+ ·05	+ ·018	208·3284	385	384·838	+ ·162	+ ·042
49·3332	280	...	279·417	+ ·583	+ ·209	220·8871	390	389·876	+ ·124	+ ·032
49·4	...	279·42	279·50	− ·08	− ·029	234·024	395	394·918	+ ·082	+ ·021
51·7	...	282·58	282·34	+ ·24	+ ·085	247·7538	400	399·949	+ ·051	+ ·013
53·3953	285	...	284·374	+ ·626	+ ·220	262·0912	405	404·980	+ ·020	+ ·005
55·9	...	287·25	287·29	− ·04	− ·014	277·0509	410	410·007	− ·007	− ·002 = $\frac{1}{50000}$
56·7	...	288·25	288·20	+ ·05	+ ·017	292·6525	415	415·020	− ·029	− ·007
57·722	290	...	289·34	+ ·66	+ ·228	308·9156	420	420·047	− ·047	− ·011
60·6	...	292·53	292·48	+ ·05	+ ·017 = $\frac{1}{5882}$	325·85	425	425·058	− ·058	− ·014
62·328	295	...	294·319	+ ·681	+ ·231	343·4753	430	430·063	− ·063	− ·015
67·2231	300	...	299·306	+ ·694	+ ·232 = $\frac{1}{431}$	350·7224	432	432·063	− ·063	− ·015
72·422	305	...	304·302	+ ·698	+ ·229	411·6*	447†	447·71	− ·71	− ·159 = $\frac{1}{629}$

* = 28 atmospheres, and † = 230·56 centigrade. See Rev. R. V. Dixon's "Treatise on Heat," p. 183.

must, therefore, have been very powerfnl steam. Now, according to the late Professor Daniell, F.R.S., brass melts at 1869° F., but the heat of the steam could not have been as much as that, because, amongst other reasons, a portion of the heat must have been taken up by raising the temperature of the "damp," aud the "mould," and the neighbouring sand. If the temperature of steam could have been 1869° F., the hypothetical pressnre would bave been by the formula, 114 tons per square inch; but the real force consequent on the reduced temperature most likely was considerably below 100 tons. What is intended to be inferred is, tbat the pressure of steam continues to increase at all events as high as up to water converted into steam by an initial heat of 1869° F. The law of increase may either be according to either of the formulæ, or to some of the other well known formulæ, or to some other unknown law, but at all events the force *had* continued to increase.

The colnmns headed "Pressures per square inch," so far as they relate to M. Regnault's experiments, are reduced from Table 1, pp. 259-260, of the Rev. R. V. Dixon's "Treatise on Heat,"* where he gives the pressure or force in inches of mercury. He was elaborately accurate in reducing M. Regnault's temperatures and pressures to English denominations, having calculated the values of the constants from Vlacq's tables, in which the logarithms are given to ten places of decimals (p. 252).

Further particulars of this formula appeared in The Artizan of January and February, 1864.

The present writer exhibited before the Mathematical and Physical Section of the British Association at Bath (but did not read) a MS. containing abont sixty evidences of the presence of water in some of its forms, in every species of natural distnrbance of the earth's crust. Additional evidences have since been collected, and the whole number now amounts to about seventy; and a summary of these evidences gives the following results:—

Humboldt, who, perhaps, personally inspected more volcanoes than any other man who ever lived, and Sir Humphrey Davy, both condemn the alkaloid theory as co-operative only; and

1. We have Humboldt, Davy, Lyell, Von Buch, Dana, Sir William Hamilton, Dr. Scherzer, and three anonymous writers, testifying to the ejection of abundance of steam from volcanoes generally, and some of them from Vesuvius in particular.

2. Steam is ejected from earthquake fissures.

3. It is *said* that steam is exclusively the moving force in geysers, and *proved* that it issues from them in great force and abundance.

4. Large rocks are ejected by steam.

5. Snbmarine volcanoes necessarily produce steam, and one of them has been active for 2,000 years. Earthquakes often accompany. Steam was very active when Graham Island rose from the Mediterranean.

6. In 1822, at Galangoon, in Java, the waters of the river Kunir, which flowed from the flanks of a volcano, became for a time hot and turbid. About two months after there was a loud explosion, and immense columns of hot water, boiling mud, burning brimstone, ashes, and lapilli were projected like a water spout, with prodigious violence, and to a great distance. The first eruption lasted nearly five hours, and on the following days the rain fell in torrents, and the rivers, densely charged with mud, deluged the country far and wide. At the end of four days, a second eruption occurred more violent than the first, in which hot water and mud were again vomited, and great blocks of basalt were thrown to a distance of seven miles. There was at the same time a violent earthquake, and 2,000 people were killed.

7. Hot or boiling water and rocks are ejected from volcanoes, and sometimes accompanied by earthquakes. A large lake has its level lowered during a volcano and earthquake, and two small rivers disappear and break out again as hot springs.

8. Water, often hot, is ejected from earthquake fissures, and from risings and sinkings of strata.

9. Earthquakes are fed by water.

10. Deposits of water, ice, or snow, are ready to descend into volcanoes by gravitation.

11. Active volcanoes are fed by water, and absorb all the rain which falls upon them.

12. Volcanoes in action, earthquakes, hot water, and increased heat of hot springs, are sometimes all connected together.

13. The lava of five volcanoes emits copious volumes of steam or gas.

14. In extensive reading on the subject, the writer has found no reason to believe, nor any allegation, that steam or its components is ever absent.

15. "A deplorable accident has lately happened at Etna by an explosion caused by the contact of burning lava with some cistern or watercourse, by the effects of which a number of sappers are reported to have lost their lives, but the particulars are not known."* Thus steam and hot water have literally a great deal to do with volcanos and earthquakes, for steam cannot be idle.

The ancient Greeks used to personify everything. Would they not, if they had known all these things, have been likely to represent Etna pointing to the explosion of the cistern as the principle of her own explosions? And ought not the same point to be a grave question now?

Sir Henry de la Beche and Mr. L. L. Dillwyn made experiments† by which they found that Cornish granites and elvans melted with a heat about equal to the required for melting malleable iron, which is the greatest heat that can be obtained in a smith's forge. But even with this great heat black non-lithia micas remained unfused. We may, therefore, safely assume, for these and other reasons, that the heat of melted lava is not less than 3000° F. But since we have seen that the force of steam has increased according to some unknown ratio up to an initial temperature of 1869°, it would be contrary to all precedent, and therefore rash to assume that there is not also a further increase with 3000°.

Supposing, for the sake of argument, and by way of illustration (for the moment only), that the temperature continues to increase as the 4½ root of the pressure until the net thermometrical temperature of the steam has become 2200° F., which Professor Daniell found is the heat of melted gold. Then the (hypothetical) pressure would be 237,494 tons per square inch, which, by calculation, would suffice to propel a certain large mass of granite from a supposed focus three miles below sea level up to one mile above sea level—in all four miles of vertical height, inclusive of the resistance of the air, which is very great. It would follow, then, that it is *possible* that there *may be* such a thing as steam powerful enough to produce the greatest effects of earthquakes and volcanoes, for 2200° is by no means the maximum temperature attainable.

* Hodges and Smith, Dublin, 1849.

ROYAL INSTITUTION OF GREAT BRITAIN.

ON ART EDUCATION, AND HOW WORKS OF ART SHOULD BE VIEWED.

By Professor Westmacott, R.A., F.R.S.

The speaker felt that it would be expected of him to discourse on art, and especially on that art to which he had given many years' attention. As, however, it would be impossible to condense, within the short time allowed, any sufficient history of sculpture, or a clear exposition of the various characteristics of the art during the long period of its ancient and modern practice, or to enter thoroughly upon merely technical matter, as if he were addressing art students, he proposed to take a view of the subject which should interest a general and unprofessional audience, namely, in what way works of art should be considered by the public, so as to afford the largest amount of gratification and profit.

The interest now taken in art is a fair ground for offering some remarks on the best way of directing the public intelligence in this important field. Museums, collections, exhibitions, abound all over the country, and the large numbers of visitors to these show beyond dispute how willing people are to find amusements in such displays. The statistics on this subject would be very curious; but, beyond this, they would suggest serious reflection whether this class of entertainment might not be made a

* Mr. J. J. Jeans, British Vice-Consul at Catania, Feb. 4, 1865. See *Illustrated London News*, Feb. 25, 1865.

† Sir H. de la Beche's "Cornwall," p. 191, foot note.

means of greatly benefitting the moral and intellectual condition of the people. It is well known that many thousands visit, in the course of every week in the year, the two great public museums of art in London; while during the ten or twelve weeks only to which the exhibition of the Royal Academy is, of necessity, confined, and when 1*s.* is paid for admission, such large numbers attend that, last season, considerably above £12,000 was taken at the doors.

Now, a question arises whether, and how far, this general interest felt in art has had any beneficial influence on the public taste. The answer scarcely can be considered satisfactory. As a nation, we cannot be said to exhibit this quality in any eminent degree; and the inquiry naturally suggests itself, why, with this large supply of art and this disposition to look at art productions, should this inferiority exist?

Chiefly, then, if not entirely, it may be attributed to the absence of any education in the principles of art. It is not recognised, even in our universities, as a part of polite training; so that usually, even among the superior classes, the most crude notions prevail upon the theory and principles of design; while all the higher aims and objects of art are utterly ignored.

The value of any production, whether of high art or literature, and the measure of enjoyment to be derived from it, must be in the *ratio* of a person's capacity or power to understand it. How is this power to be acquired?

That there is no indisposition, generally, in the public to be better informed is shown by the readiness with which they seek direction where they fancy it may be obtained. In public galleries an eager interest is shown to listen to any chance explanations that may be going on. On visiting exhibitions of pictures, people seek direction in the same way, or they are found procuring marked catalogues from some one or other whose judgment they may think superior to their own; a proof, at least, of willingness to be assisted, though the advantages gained may sometimes be questioned. They may be told what to look at; but they are not taught *how* to see it. They are without any guide to explain to them the broad principles of art; in what its value really consists; and what are its claims to consideration as a means of expressing and developing the beautiful. They simply find particular works pointed out for examination; but no reasons are asked or given for their being thought good, or condemned as bad; and the critic and guide may himself be totally incompetent, if not, as is too often the case, biassed by favouritism or prejudice.

Is is precisely here that the want of a sound education in the theory and the principles of art, as distinct from the merely technical, is seen. The public is thrown upon individual, and, perhaps, extremely one-sided, opinion, from which it takes its impressions, instead of having the power of forming for itself a judgment based upon a safe foundation.

Amongst the errors to which an uneducated public is prone in estimating works of art is the fancy that mere imitation constitutes excellence. It has its own very great merit. As a mechanical accomplishment it, no doubt, ranks, and should rank, very high; and an artist cannot be too diligent in mastering this most important element of practice as his language of expression. But it never should be forgotten that imitation is only a means to an end, and not the end, as many seem to think it. It is what words are to the orator—the language by which ideas are to be conveyed. This erroneous opinion as to the extreme merit of mere imitation, *per se*, has led to much degradation of art. Instead of making art the medium of expressing the great and the good in forms of beauty —as all the great artists of the great periods of art have done—modern art is frequently found illustrating the most ordinary and commonplace subjects, selected, as it would seem, simply with the view of enabling the artist to show his skill in the minute and elaborate imitation of what very often are but mean and undignified details. Art should aspire to raise men's thoughts to the beautiful in all things—in subject, as well as in form and treatment—and not to depress and drag them down to the commonplace, and even to what is low and repulsive. Plato made the good and the beautiful identical.

Colour, light, and shade, perspective, and the ease with which familiar objects may be exhibited in the sister art, offer great temptation to the painter, and much attraction to the general mass of the public; and where the taste is not refined the low quality of a subject will not be felt as any drawback. It is not so in sculpture. Any attempt, here, to indulge in the ordinary and commonplace meets its sure Nemesis. Its fate is certain. While the productions of the great Greek schools, in spite of discoloration, dirt, and mutilation, still justly claim the admiration of all real judges of excellence in this art, there is not a single instance of a work in sculpture of a low or vulgar school that is suffered to have a place in any collection. Yet how are those who are desirous to understand art to be taught this if no means are afforded for their learning it? Again, then, the want of education in what is true and good in art is apparent, for here, especially, the better influence of a cultivated taste in the public might have good effect.

It would be a great mistake to suppose that this knowledge may not be imparted. It is not intuitive, but is to be acquired. In Greece the national habits educated the people to a sense of the beautiful. In Italy, in the fifteenth and sixteenth centuries especially, the influence of the higher classes interested the populations in works of art, and thus their education was practically advanced; and without denying the existence of a more keen sensibility to the beautiful, and more acute observation, in some persons, and even nations, compared with others, it may fairly be assumed that all may in different degrees be improved in their power of appreciating the good wherever it is to be found. Probably all present are acquainted with that charming work on Italy, "Corinne," and may remember the chapters in which the works of art in Rome are described. The value of the knowledge referred to is fully exhibited here. And yet this was the result of education, of its kind. Madame de Staël had been intimate with Schlegel, and she improved her own natural faculties by acquiring from him the power to view art through an elevated, and, it may be said, a true and proper medium.

In judging a work of art the first thing to be considered is the intention or purpose of the design, and whether the meaning is clearly expressed. Secondly, it must be tested by the degree of refinement it exhibits in the choice and character of its subject, and by the mode of presentation adopted by the artist; and here the quality of his taste and mind will be at once seen. Thirdly, the forms should command attention, not only in the human and other figures, but in drapery and all the accessories. Normal beauty should be recognised as essential to all fine art, and even in the less ambitious subjects there should be a careful avoidance of ugly or repulsive forms. So the Greeks felt, and in this, though we may no longer sympathise with their subjects, their productions still are and ever will be a standard. It was this radical principle that enabled them, or rather obliged them, to make beauty an element in all their productions. It was seen not only in their nobler works, but it spread over and down to the commonest objects: their furniture, vases, *tazze*, earrings, necklaces, &c. So it was also in the fifteenth and sixteenth centuries, when the works of the great Italian masters influenced the taste in small things, as is seen in the beautiful performances of Benvenuto Cellini and other artists of the time; and more modern examples might easily be found. This is one of the *material* consequences of a cultivated taste in art, and by no means an unimportant one.

The commonplace, and, it must be admitted, pleasing theory of the necessarily refining influence of the arts, needs scarcely to be noticed here. No doubt the proper office of art, and of all exercises of human intelligence, should be to refine and elevate; but art does not effect this, of necessity. Experience has shown that, though it may be employed for the noblest objects, it may also be used as an easy means of corruption, and that the existence of a very refined taste in art is no security for a high moral condition of society. It is in its use or its abuse that its worth is tried. The social state of Italy in the reigns of Alexander VI., of Julius II., of Leo X., and other Popes were, according to their own native historians, characterised by the prevalence of the most shocking demoralisation and profligacy, at the very time that Leonardo, M. Angelo, Francesco Francia, and Raffaelle were producing their masterpieces in painting and sculpture; and France in the reigns of Louis XIV. and Louis XV. was as remarkable for the general corruption of morals pervading all classes, as for the glory derived from her triumphs in literature and art.

Here, then, is another reason for endeavouring to show the public how so fascinating an appendage or accessory of civilisation may be turned to good instead of to evil; how it may be made an instrument of moral refinement and instruction, as well as a source of pleasure.

In conclusion, the value of art education would be felt in the great increase of enjoyment people would have in art. It would teach them how to observe, and it would quicken their intelligence in seizing and appreciating nature in her true and proper aspect. Its effects would be seen also on the public taste. The want of it has, there can be no doubt, a lowering influence both on art and artists; for where the knowledge and feeling of the public is wanting in tone, the artists are not likely to rise above the standard of those from whom they look for employment. An intelligent public would raise the standard.

Another very important benefit might be expected from thus qualifying the public to judge correctly of art. It would go far to put a stop to the pretentious dictation that prevails in matters of art, where self elected and incompetent critics make themselves the dispensers of not only fame but employment. Competition, sound in principle, has lost all its value, from the feeling that exists among the comparatively better class of artists that it is a delusion. Few or none of any position will now submit to be judged by such judges as ordinarily compose these competition committees, where, in addition to the possible danger of inadequate qualification in its members, a well-organised party may have arranged beforehand whose design shall have the preference, quite irrespectively of its comparative merit. Nothing would be so calculated to remedy some of the evils here complained of as the improvement of the public intelligence in the requirements and principles of true art; and in all competitions it might be an advantage to have the advice and assistance of professional, but disinterested men, upon technical questions. The consequences of the absence of such securities for a better class and treatment of public works are sufficiently obvious, without the necessity of more particular reference.

ON SCIENTIFIC EXPERIMENTS IN BALLOONS.

By JAMES GLAISHER, Esq., F.R.S., &c.

Mr. Glaisher, at the beginning, referred to the discourse given by him two years since, when he had made eight ascents, for the purpose of scientific researches, in the higher regions of the atmosphere, and said since that time he had made seventeen additional. He described the process of filling a large balloon, and briefly described a balloon ascent, speaking of the novel sensation at first experienced, of the extreme coldness and dryness of the air at great elevations; of the painless death awaiting the aërial traveller who should ascend to an elevation too great for his power of endurance, and compared it to that of the mountain traveller, who, benumbed and insensible to suffering, yields to the lethargy of approaching sleep, and reposes to wake no more. Moral energy in both cases, he stated, was the only means of safety.

He then exhibited the several instruments used, pointing out their extreme sensitiveness and delicacy, and then spoke of the primary objects of balloon research.

Subjects of Research by means of Balloons.

1st. To determine the rate of decrease of temperature, with increase of elevation; and to ascertain whether the results obtained by observations on mountain sides—viz., a lowering of temperature of 1° for every increase of elevation of 300ft.—be true or not.

2nd. To determine the distribution of the water, in the invisible shape of vapour, in the air below the clouds, in the clouds, and above them, at different elevations.

3rd. To compare the results, as found by different instruments together:—

1. The temperature of the Dew Point, as found by—
   Dry and Wet Thermometers—(Free).
   Dry and Wet Thermometers—(Aspirated, or air made to pass rapidly).
   Daniell's Dew Point.
   Regnault's Dew Point—(Blowing).
   Regnault's Dew Point—(Air made to pass rapidly).
2. To compare the readings of—
   Mercurial and Aneroid Barometers, &c.

4th. Solar radiation, by taking readings of the blackened bulb thermometer fully exposed to the sun, with simultaneous observations of the dry bulb thermometer, and also of observations of Herschel's Actinometer.

5th. To determine whether the solar spectrum, when viewed from the earth, and far above it, exhibited any difference; whether there were a greater or less number of dark lines crossing it, particularly when near sun-setting.

6th. To determine whether the horizontal intensity of the earth's magnetism was less or greater with elevation.

Propagation of sound.

Amount of ozone, &c.

In every ascent a second or third thermometer, differently graduated, has been used to check the accuracy of the readings of the dry thermometer, and the truthfulness of the temperature shown by it. In some of the ascents a delicate blackened bulb thermometer was placed near to the place of the dry-bulb thermometer, fully exposed to the sun in cloudless skies, or to the sky at all times: the readings of this instrument were nearly identical with those of the dry-bulb thermometer in clouded states of the sky, and thus acted as an additional check.

At all times, one or the other, or both, Regnault's and Daniell's hygrometers have been used sufficiently often at all heights to show whether the wet-bulb thermometer was in proper action, and to check the results given by the use of the dry and wet-bulb thermometer on the reduction of the observations.

The author said he would not give a detailed account of the experiments in the years 1862 and 1863, as they were published, but would confine himself to some of the results.

He said it was soon found that the state of the sky exercised a great influence, and the experiments had to be repeated with two groups, one with cloudy skies, and the other with clear skies.

The results are as follows:—

The Decline of the Temperature of the Air, with Elevation, when the Sky was Cloudy.

	Feet.	Feet.	Deg.		Feet.
From	0 to	1,000	was 4·5	from 17 experiments, or 1 degree in	223
„	1,000 „	2,000	„ 3·6	„ 21 „	278
„	2,000 „	3,000	„ 3·7	„ 22 „	271
„	3,000 „	4,000	„ 3·4	„ 20 „	295
„	4,000 „	5,000	„ 3·3	„ 13 „	333
„	5,000 „	6,000	„ 3·2	„ 7 „	313
„	6,000 „	7,000	„ 2·7	„ 5 „	371
„	7,000 „	8,000	„ 2·4	„ 4 „	417
„	8,000 „	9,000	„ 2·2	„ 4 „	455
„	9,000 „	10,000	„ 2·2	„ 4 „	455
„	10,000 „	11,000	„ 2·2	„ 4 „	455
„	11,000 „	12,000	„ 2·2	„ 4 „	455
„	12,000 „	13,000	„ 2·2	„ 4 „	455
„	13,000 „	14,000	„ 2·3	„ 4 „	435
„	14,000 „	15,000	„ 2·0	„ 4 „	500
„	15,000 „	16,000	„ 2·1	„ 4 „	477
„	16,000 „	17,000	„ 1·2	„ 2 „	833
„	17,000 „	18,000	„ 1·3	„ 2 „	771
„	18,000 „	19,000	„ 1·4	„ 2 „	715
„	19,000 „	20,000	„ 0·9	„ 2 „	909
„	20,000 „	21,000	„ 1·1	„ 2 „	911
„	21,000 „	22,000	„ 0·8	„ 2 „	1,250
„	22,000 „	23,000	„ 0·8	„ 2 „	1,250

These results show, when the sky is cloudy, the decline of temperature at every 1,000ft. increase of elevation. Up to 5,000ft. the number of experiments upon which each result is based vary from 13 to 22; at 6,000ft. and 7,000ft. to 7 and 5 respectively; from 7,000ft. to 16,000ft. to 4; these having been made on two days, viz. 1863, June 26 and September 29, on which days the balloon was frequently enveloped in fog and clouds to the height of three and four miles, and those above 16,000ft. on the former of these two days only, during the ascent and descent, the sky being still covered with cloud when the balloon was between four and five miles high.

The Decline of the Temperature of the Air, with Elevation, when the Sky was Clear, or chiefly Clear.

	Feet.	Feet.	Deg.		Feet.
From	0 to	1,000	was 6·2	from 9 experiments or 1 degree in	162
„	1,000 „	2,000	„ 4·7	„ 9 „	213
„	2,000 „	3,000	„ 3·8	„ 11 „	264
„	3,000 „	4,000	„ 3·3	„ 12 „	304
„	4,000 „	5,000	„ 2·9	„ 12 „	345
„	5,000 „	6,000	„ 2·6	„ 17 „	385
„	6,000 „	7,000	„ 2·5	„ 15 „	401
„	7,000 „	8,000	„ 2·7	„ 12 „	371
„	8,000 „	9,000	„ 2·5	„ 12 „	400
„	9,000 „	10,000	„ 2·4	„ 12 „	417
„	10,000 „	11,000	„ 2·6	„ 13 „	385
„	11,000 „	12,000	„ 2·3	„ 11 „	435
„	12,000 „	13,000	„ 2·2	„ 11 „	455
„	13,000 „	14,000	„ 2·0	„ 11 „	500
„	14,000 „	15,000	„ 1·7	„ 9 „	588
„	15,000 „	16,000	„ 2·2	„ 9 „	455
„	16,000 „	17,000	„ 1·9	„ 7 „	526
„	17,000 „	18,000	„ 1·7	„ 7 „	588
„	18,000 „	19,000	„ 1·5	„ 7 „	666
„	19,000 „	20,000	„ 1·3	„ 7 „	771
„	20,000 „	21,000	„ 1·2	„ 7 „	833
„	21,000 „	22,000	„ 1·1	„ 7 „	911
„	22,000 „	23,000	„ 1·0	„ 4 „	1,000
„	23,000 „	24,000	„ 1·3	„ 2 „	771
„	24,000 „	25,000	„ 1·1	„ 2 „	909
„	25,000 „	26,000	„ 1·0	„ 1 „	1,000
„	26,000 „	27,000	„ 1·0	„ 1 „	1,000
„	27,000 „	28,000	„ 0·9	„ 1 „	1,111
„	28,000 „	29,000	„ 0·8	„ 1 „	1,250

Up to the height of 22,000ft., the number of experiments vary from 7 to 17; and there can be but little doubt that the number showing the decrease of temperature are very nearly true, and approximate closely to the general law. Above 24,000ft. the number of experiments are too few to speak confidently upon them, but they are in accordance with the series deduced from the experiments at less elevations.

A decline of temperature under a clear sky of 1° takes place within 100ft. of the earth, and at heights exceeding 25,000ft. it is necessary to pass through 1,000ft. of vertical height, as appears in the last column of the preceding table, for a decline of 1° of temperature.

By adding together successively the decline of temperature for each 1,000ft. the whole decrease of temperature from the earth to the different elevations is found; the results, with a cloudy sky, are as follows:—

When the Sky was Cloudy.

	Feet.	Feet.		Deg.		Feet.
From	0 to	1,000	the decrease was	4·5	or 1 deg. on the average of	223
„	0 „	2,000	„	8·1	„	247
„	0 „	3,000	„	11·8	„	255
„	0 „	4,000	„	15·2	„	263
„	0 „	5,000	„	18·5	„	271
„	0 „	6,000	„	21·7	„	277
„	0 „	7,000	„	24·4	„	287
„	0 „	8,000	„	26·8	„	299
„	0 „	9,000	„	29·0	„	311
„	0 „	10,000	„	31·0	„	321
„	0 „	11,000	„	33·0	„	329
„	0 „	12,000	„	35·6	„	337
„	0 „	13,000	„	37·8	„	344
„	0 „	14,000	„	40·1	„	349
„	0 „	15,000	„	42·1	„	356
„	0 „	16,000	„	44·2	„	362
„	0 „	17,000	„	45·4	„	375
„	0 „	18,000	„	46·7	„	386
„	0 „	19,000	„	48·1	„	395
„	0 „	20,000	„	49·0	„	409
„	0 „	21,000	„	50·1	„	419
„	0 „	22,000	„	50·9	„	432
„	0 „	23,000	„	51·7	„	445

These results, showing the whole decrease of temperature of the air from the earth up to 23,000ft., differ very considerably from those with a clear sky, to be spoken of presently. The number in the last column show the average increment of height for a decline of 1°, as found by using the temperature of the extremities of the column alone. To 1,000ft. high the average is 1° in 223ft., increasing gradually to 1° in 445ft. at 23,000ft.

When the Sky was Clear, or chiefly Clear.

Feet.	Feet.		Deg.		Feet.
From 0 to	1,000	the decrease was	6·2	or 1 deg. on the average of	162
„ 0 „	2,000	„	10·9	„	184
„ 0 „	3,000	„	14·7	„	204
„ 0 „	4,000	„	18·0	„	223
„ 0 „	5,000	„	20·9	„	239
„ 0 „	6,000	„	23·5	„	256
„ 0 „	7,000	„	26·0	„	271
„ 0 „	8,000	„	28·7	„	279
„ 0 „	9,000	„	31·2	„	289
„ 0 „	10,000	„	33·6	„	298
„ 0 „	11,000	„	35·6	„	309
„ 0 „	12,000	„	37·9	„	317
„ 0 „	13,000	„	40·1	„	324
„ 0 „	14,000	„	42·1	„	333
„ 0 „	15,000	„	43·8	„	343
„ 0 „	16,000	„	46·0	„	348
„ 0 „	17,000	„	47·9	„	355
„ 0 „	18,000	„	49·6	„	363
„ 0 „	19,000	„	51·1	„	372
„ 0 „	20,000	„	52·4	„	382
„ 0 „	21,000	„	53·6	„	392
„ 0 „	22,000	„	54·7	„	405
„ 0 „	23,000	„	55·7	„	413
„ 0 „	24,000	„	57·0	„	422
„ 0 „	25,000	„	58·1	„	431
„ 0 „	26,000	„	59·1	„	441
„ 0 „	27,000	„	60·1	„	449
„ 0 „	28,000	„	61·0	„	459
„ 0 „	29,000	„	61·8	„	469
„ 0 „	30,000	„	62·3	„	482

These results, showing the whole decrease of temperature from the ground to 30,000ft., differ greatly, as just mentioned, from those with a cloudy sky.

The numbers in the last column, showing the average increase of height for a decline of 1° of temperature from the ground, to that elevation, are all smaller than those with a cloudy sky at the same elevation. Each result is based upon at least seven experiments, taken at different times of the year, and up to this height considerable confidence may be placed in the results; they show that a change takes place in the first 1,000ft. of 1° on an average in 162ft., increasing to about 300 at 10,000ft. In the year 1862, this space of 300ft. was at 14,000ft. high, and in 1863 at 12,000ft. Therefore, the change of temperature has been less in 1863 than those in 1862, and less in 1864 than in 1863, but the experiments have all been taken at different times of the year.

Without exception the fall of 1° has always taken place in the smallest space when near the earth.

Treating the observations for determining the degrees of humidity of the air in the same way, the following are the results:—

When the sky was cloudy, saturation being considered as 100, the degree of humidity on the earth was	74	from 19	experiments.
At 1,000 feet	76	„ 33	„
„ 2,000 „	76	„ 34	„
„ 3,000 „	78	„ 35	„
„ 4,000 „	75	„ 27	„
„ 5,000 „	74	„ 16	„
„ 6,000 „	73	„ 14	„
„ 7,000 „	62	„ 11	„
„ 8,000 „	54	„ 11	„
„ 9,000 „	50	„ 11	„
„ 10,000 „	48	„ 10	„
„ 11,000 „	47	„ 10	„
„ 12,000 „	52	„ 6	„
„ 13,000 „	58	„ 6	„
„ 14,000 „	52	„ 5	„
„ 15,000 „	59	„ 3	„
„ 16,000 „	59	„ 2	„
„ 17,000 „	47	„ 2	„
„ 18,000 „	33	„ 2	„
„ 19,000 „	24	„ 2	„
„ 20,000 „	29	„ 2	„
„ 21,000 „	22	„ 2	„
„ 22,000 „	34	„ ·1	„
„ 23,000 „	40	„ 1	„

The law of moisture here shown is a slight increase from the earth to the height of 3,000ft., and then a slight decrease to 6,000ft., the degree of humidity being at this elevation nearly of the same value as on the ground; from 6,000ft. to 7,000ft., there is a large decrease, and then an almost uniform decrease to 11,000ft.; it increases from 12,000ft. to 16,000ft., and then decreases. The number of experiments up to 11,000ft. vary from 10 to 33; and I think good confidence may be placed in the result to this elevation, but at heights of 12,000ft. the number of experiments are evidently too small to speak with any confidence in respect to the results.

By treating the results with a clear or a nearly clear sky in the same way, the following results were obtained:—

With a clear sky the degree of humidity on the ground was	59	from 9	experiments.
At 1,000 feet	61	„ 14	„
„ 2,000 „	70	„ 17	„
„ 3,000 „	71	„ 23	„
„ 4,000 „	71	„ 19	„
„ 5,000 „	69	„ 17	„
„ 6,000 „	62	„ 15	„
„ 7,000 „	56	„ 16	„
„ 8,000 „	50	„ 14	„
„ 9,000 „	50	„ 9	„
„ 10,000 „	46	„ 18	„
„ 11,000 „	43	„ 10	„
„ 12,000 „	35	„ 8	„
„ 13,000 „	37	„ 7	„
„ 14,000 „	37	„ 7	„
„ 15,000 „	41	„ 5	„
„ 16,000 „	40	„ 5	„
„ 17,000 „	39	„ 4	„
„ 18,000 „	21	„ 2	„
„ 19,000 „	36	„ 2	„
„ 20,000 „	33	„ 1	„
„ 21,000 „	32	„ 1	„
„ 22,000 „	21	„ 1	„
„ 23,000 „	16	„ 1	„

The law of moisture here shown is a slight increase to 1,000ft., a considerable increase between 1,000ft. and 2,000ft., a nearly constant degree of humidity from 2,000ft. to 5,000ft., and a gradual decrease afterwards to 12,000ft. At greater heights, the numbers are less regular. The results up to 11,000ft. are based upon experiments varying from 10 to 23, and are most likely very nearly true normal values; at heights, exceeding 12,000ft., the number of experiments have varied from 1 to 8, and no general confidence can be placed in them.

By comparing the results from the two states of the sky, the degree of humidity of the air up to 1,000ft. high is 15 less with a clear sky than with a cloudy; from 2,000 to 5,000 is from 4 to 6 less; at 6,000ft. the air with a clear sky is much drier than at 5,000ft., but with a cloudy sky it is nearly of the same degree of humidity, so that the difference between the two states is large, amounting to no less than 11; the difference decreases to 0 at 9,000ft., but increases to 4 at 11,000ft.; at heights exceeding 11,000ft., the air with clear skies generally becomes very dry, but with cloudy skies frequently becomes more humid, as was to be expected from the fact of the presence of clouds at heights exceeding three and four miles.

In both states of the sky at extreme elevations, the air becomes very dry, but so far as my experiments go is never free from water.

The speaker stated that at the end of the year 1863, the results for temperature were laid down on a diagram, and the resulting curve was a hyperbola; continuing this curve upwards, and reading out the decrease of elevation the following were the results. That at the height of

50,000ft.	the decline of temperature from the earth would be		83	degrees.
100,000ft. or 19 miles	„	„	97	„
200,000ft. or 38	„	„	106	„
538,000ft. or 100	„	„	112¾	„
1,056,000ft. or 200	„	„	115½	„

Showing that large changes take place near the earth, amounting to 24° in the first mile, becoming less and less the farther removed, till the change from 100 miles to 200 miles is less than 3°.

The speaker then said, as these results were deduced chiefly from experiments in the summer and during the hours of the day, it became desirable to take experiments at other times in the year to ascertain whether this law would hold good at all times of the year, and at all times of the day.

For this purpose it was necessary to take experiments in the winter, spring, and autumn. He then described the experiments made at these seasons, and pointed out that experiments made on September 29, January 12, and April 6, during the day, differed very much from the general laws, and those on June 13, 20, and 27, made a little before, at the time of sunset, and a little afterwards, differed materially from those made when the sun was at a good altitude; for instance, on June 13, at the time of sunset, no difference in temperature was experienced for 2,000ft. from the earth.

The speaker then said, it is very clear from the particulars of each ascent, that they cannot all be combined, or all used in deducing general laws. Those ascents which have been made during the past year under similar circumstances to those from which the laws of decrease of temperature were found, when combined do not change the values previously found to any great amount; but those which have been made under other circumstances, such as in the winter, and at times of the setting sun, differ very greatly indeed.

The deviation from this law, however, in winter is certainly of the highest importance to us. The meeting of a strong current of air from the S.W. of so great a depth as nearly one mile, over our country on January 12, in the season of winter, which current I know continued many days, must have exercised great influence. This was the first instance of meeting with a stream of air of higher temperature than on the earth; above this the air was dry, and higher still it was very dry: fine granular snow was falling thickly above this warm stream of air.

The S.W. current being thus observed is of the highest importance, as bearing upon the very high mean temperature we experience during winter, so much higher than is due to our position on the earth's surface, and it is highly probable that to its fluctuations the variations of our winters are due.

Our high winter temperature has hitherto been referred for the most part to the influence of the heated water of the Gulf Stream; but if this were the case the same agency being at work around the coast of France should exercise the same influence, yet we know that the winters of France are more severe than our own, though situated so much south of us.

Dr. Stark, of Edinburgh, some years since referred the mildness of the winters in Britain for the most part to prevalence of the S.W. or anti-trade wind which is the prevailing aërial current in this latitude during winter.

He observes, so long as these winds blow, we have no frosts or intense colds; but the moment the wind changes during winter to an easterly, north-easterly, or northerly direction, we have both frost and snow, and more or less intense cold.

The S.W. winds in their course meet with no obstruction in coming to us, but they blow directly to us and to Norway over the Atlantic; and hence we enjoy a much milder climate during winter than any other lands not similarly situated with regard to such winds.

The south-west winds cannot reach France till they have crossed the whole of Spain and the high mountain range of the Pyrenees; and by the time they have crossed that mountainous country they are so much cooled that France can derive comparatively little benefit from them, and hence apparently her more severe winters.

Another fact may be inferred from this winter trip: it has always been a matter of great difficulty to me to account for the simultaneous appearance of dense fog over the whole country and extending far out to sea, but the fact of a warm current of air, situated under a mass of snow falling, would fully account for the production of any amount of fog.

Another inference may be drawn from the facts noticed; one only I will mention, and it is this: If, during the prevalence of a warm current of air passing over these islands, there can be currents of air of so low a temperature as I experienced, it is evident that as it is but a struggle between two or more forces, either of which may preponderate at any moment; it is not safe, therefore, in the winter months, how mild soever the weather may be, to go thinly clothed at any time, for at any moment this warm current may be deflected, and its place occupied by the cold current, and thus some of our sudden and apparently unaccountable changes may be due.

The fact of no change of temperature being met with at the time of sunset on June 13 for 2,000ft. from the earth—that a much smaller change took place than usual on June 20, a little before sunset—and that on June 27, after sunset, as well as could be determined, the change to 3,000ft. was small, it would seem that the laws which hold good by day do not hold good by night; indeed, it seems probable that at night, for some little distance, the temperature may increase with elevation instead of decreasing. This can only be determined by experiments at night.

Comparing the results of one experiment with another with respect to the moisture in the air at the same elevation, it is found to be very different at different times; and that on the same day the moisture is very differently distributed, there having been on some of the days of experiments several successive wet and dry strata placed one above the other.

The variation in this climate, its frequently disturbed atmosphere, the smallness of the country, causing great anxiety after passing through clouds and out of sight of the earth for fear of descending over the sea, when the balloon has no longer power to keep up, rendering each experiment limited in its duration, that perhaps this country is not the best for determining the laws which govern atmospheric changes.

I am glad to learn that similar observations are contemplated being made in France, and I hope that similar observations will be made in other countries; for it is probable that above the large plains of the continent where the weather is more uniform, and where an observer can be for hours out of sight of land without anxiety—that the experiments can be more easily made, and probably, too, the general laws made more easily apparent.

Many ascents will, however, be necessary; clouds as large, and clouds far colder than any I have met with, were experienced by Messrs. Bixio and Barral, in their ascents in June and July, 1850, from Paris. These gentlemen made two ascents for scientific purposes, and although from accidents the ascents were of short duration, the results were of high interest. Among them, they noticed that they passed through a cloud of icicles, which sustained themselves in the air, as it appeared to them, contrary to the laws of gravity; but upon their horizontal surfaces they saw beneath them, however, an exact image of the sun, formed by the reflection of the luminous rays on the crystals of ice, floating about in a foggy atmosphere; and they noticed the temperature of the cloud to be as low as minus 40°, a far greater degree of cold than I ever experienced.

With such variations as these, as many ascents will be necessary to be made in France as in England, to determine general laws; but each ascent may be made far richer in results than any one in England. In France, the duration of a journey will be limited only by the wishes of the observer, and not, as here, by the sea, or by one solitary hour's observations—that being the time frequently in which we approach the sea.

It is certain that there are in the higher regions of the earth's atmosphere spaces subjected to great cold, and others to considerable heat; that there exist some clouds of very low temperature; and some, as those passed through on January 12, for a mile in thickness, of comparatively high temperature.

The presence of such, either cold or hot currents, passing over the country, must play an important part in all our meteorological phenomena, and must exert a great influence upon our climate.

When I first undertook to make these experiments, I expected that a few ascents would have given the information sought; the number of experiments I have now made is twenty-five, and so far from exhausting the subject, they have only indicated a much wider field for future operations.

The law of decrease of temperature under ordinary circumstances, both with a clear and a cloudy sky, when the sun is above the horizon, in the months of summer, I think is pretty well determined; but from the series of observations made in winter, we cannot say such laws hold good throughout the year; neither can we say that the laws which hold good by day will be true by night; and the general result of these differences must be that the theoretical law of refraction now used, must be abandoned, and that every observatory will have to determine its own laws, independently.

Solar Radiation: Blackened Bulb Thermometer, and Herschel's Actinometer Observations.

On August 31st, at the heights of 7,000ft. and 8,000ft., the blackened bulb thermometer, exposed to the full influence of the sun, read 3° only higher than the shaded thermometer.

On September 29th, at the height of 14,000ft., the excess of reading of the blackened bulb thermometer was $2\frac{1}{2}$° only under a bright sun—the increase of readings of the actinometer was from 3 to 5 divisions only; at 13,000ft. the excess of the blackened bulb readings increased to 4° and 5°, and the increase in one minute of the actinometer reading were 7 to 8 divisions. At the height of 3,000ft. and 4,000ft. the influence of the sun increased, raising the blackened bulb to 7° and 8° in excess of the readings of the shaded thermometer, the scale readings of the actinometer increased to 20 and 25 divisions in one minute, and on reaching the ground the increase in the same time was from 45 to 50 divisions.

On January 12th, the readings of the exposed and shaded thermometers were nearly alike.

On April 6th, I was unable to use the actinometer, and never succeeded in placing it properly. The excess of reading of the blackened bulb thermometer was but small during the cloudy state of the sky, and increased to 5° and 6° at 10,000ft.; this excess increased on descending into the lower atmosphere, until cloud was entered.

On June 13th, the excess was at all times small.

On June 20th, at many inspections the readings of the two thermometers were identical.

On June 27th, the exposed thermometers nearly always read lower than the shaded thermometer; on examination of these instruments afterwards, they were both found to read correctly.

On August 29th, the blackened bulb thermometer read lower than the shaded thermometer till 6,000ft. were passed; it then read higher, increasing to 7° at 14,000ft. high.

From all these experiments it seems that the heat rays in their passage from the sun pass the small bulb of a thermometer, communicating very little or no heat to it, similar results being shown by the use of Herschel's actinometer on every occasion that I have had an opportunity of using it. From these experiments we may infer that the heat rays from the sun pass through space without loss, and become effective in proportion to the density of the atmosphere or the amount of water present through which they pass; and if so, the proportion of heat received at Mercury, Venus, Jupiter, and Saturn, may be the same as that received at the Earth, if the constituents of their atmospheres be the same as that of the Earth, and greater if the density be greater; so that the effective solar heat at Jupiter and Saturn may be greater than at either the interior planets Mercury or Venus, notwithstanding their far greater distances from the Sun.

Different Velocities of Air.—The Wind.

On September 29th, the balloon left Wolverhampton at 7 hours 43 min. a.m., and fell near Sleaford, a place ninety-five miles from the place of ascent, at 10 hours 30 min. a.m. During this time the horizontal movement of air was thirty-three miles, as registered at Wrottesley Observatory.

On October 9th, the balloon left the Crystal Palace at 4 hours 49 min. p.m., and descended at Pirton Grange, a place thirty-five miles from the place of ascent, at 6 hours 30 min. p.m.; Robinson's anemometer during this time registered eight miles at the Royal Observatory, Greenwich, as the horizontal movement of the air.

On January 12th, the balloon left the Royal Arsenal, Woolwich, at 2 hours 8 min. p.m., and descended at Lakenheath, a place seventy miles from the place of ascent, at 4 hours 10 min. p.m.; at the Royal Observatory, by Robinson's anemometer during this time the motion of the air was six miles only.

On April 6th, the balloon left the Royal Arsenal, Woolwich, at 4 hours 8 min. p.m.: its correct path is not known, as it entered several different currents of air, the earth being invisible owing to the mist; it descended at Sevenoaks, in Kent, at 5 hours 37 min. p.m., a point fifteen miles from the place of ascent; five miles were registered during this time by Robinson's anemometer, at the Royal Observatory, Greenwich.

From all the experiments, the velocity of the air at the earth's surface appears to be very much less than at a high elevation.

Different Currents in the Atmosphere.—The Wind.

1862.—July 30.

The direction of the wind before starting was N.W.

At 4 hours 41 min. 15 sec.,	at 480ft.	the direction of the wind was	S.W.
„ 5 hours 17 min. 30 sec.,	„ 5,165ft.	„	N.N.W.
„ 5 hours 40 min. 30 sec.,	„ 6,183ft.	„	N.

1862.—September 1.

The direction of the wind before starting was E.N.E. verging to E.

At 5 hours 4 min. 0 sec. p.m.,	at 3,268ft.,	the direction of the wind	E.N.E.
„ 5 hours 10 min. 0 sec.	„ 3,318ft.,	„	E.
„ 5 hours 11 min. 30 sec.	„ 3,560ft.,	„	E.S.E.
„ 5 hours 17 min. 0 sec.	„ 3,580ft.,	„	E.N.E.
„ 5 hours 36 min. 0 sec.	„ 4,190ft.,	„	W.

1863.—March 31.

At 4 hours 58 min. 0 sec. p.m.,	at 18,302ft.,	the direction of the wind	N.E.
„ 4 hours 58 min. 30 sec.	„ 17,097ft.,	„	S.W.
„ 5 hours 12 min. 0 sec.	„ 20,865ft.,	„	nearly W.
„ 6 hours 15 min. 0 sec.	„ 4,441ft.,	„	S.E.
„ 6 hours 16 min. 0 sec.	„ 5,168ft., moving back again.		

1863.—July 11.

Before starting the wind was E.

At 4 hours 59 min. 30 sec.,	at 2,633ft.,	the direction of the wind was	N.
„ 7 hours 14 min. 0 sec.,	„ 1,876ft.,	„	E.
„ 7 hours 56 min. 45 sec.,	„ 1,020ft.,	„	S.E.
„ 7 hours 57 min. 0 sec.,	„ 1,000ft.,	„	W.

1864.—January 12.

At 2 hours 9 min. 0 sec.,	at 655ft.,	direction of the wind was	N.E.
„ 2 hours 14 min. 0 sec.,	„ 1,328ft.,	„	E.
„ 2 hours 11 min. 0 sec.,	„ 1,518ft.,	„	S.W.
„ 2 hours 32 min. 0 sec.,	„ 5,401ft.,	„	S.
„ 3 hours 3 min. 0 sec.,	„ 8,086ft.,	„	S.S.W.
„ 3 hours 20 min. 0 sec.,	„ 10,017ft.,	„	S.S.E.

Comparison of the Temperature of the Dew Point by different Instruments.

In the experiments of every year, there seems to be no certain difference in the determination of the temperature of the dew point by Daniell's and Regnault's hygrometers, and this temperature determined by the use of the dry and wet-bulb thermometers, seems to be very closely approximate indeed to the results obtained by either of these instruments, as will be seen by the following comparison of results.

As found from all the simultaneous determinations of the temperature of the dew point by Daniell's hygrometer, and the dry and wet-bulb thermometers (free).

The temperature of the dew point by the dry and wet-bulb (free) up—

	Feet.		Feet.		Deg.			Experiments.
From	0	to	1,000	was	0·1	lower than by	Daniell's hygrometer from	21
„	1,000	„	2,000	„	0·1	„	„	40
„	2,000	„	3,000	„		the same as by	„	54
„	3,000	„	4,000	„		„	„	60
„	4,000	„	5,000	„	0·4	lower than by	„	33
„	5,000	„	6,000	„	0·6	„	„	33
„	6,000	„	7,000	„	0·2	„	„	34
„	7,000	„	8,000	„		the same as by	„	8
„	8,000	„	9,000	„	1·5	higher than by	„	2
„	9,000	„	10,000	„	1·2	„	„	2
„	10,000	„	11,000	„	0·3	„	„	1
„	11,000	„	12,000	„	5·6	lower than by	„	3
„	12,000	„	13,000	„	0·3	higher than by	„	5
„	13,000	„	14,000	„	0·8	lower than by	„	7
„	14,000	„	15,000	„	1·0	„	„	2

The number of experiments made up to the height of 7,000ft., varying from 21 to 60 in each 1,000ft. as taken in the last three years, are sufficient to enable us to speak with confidence; the results are, that the temperatures of the dew point as found by the use of the dry and wet-bulb thermometers, and my hygrometrical tables, are worthy of full confidence up to this point. At heights exceeding 7,000ft., the three years' experiences do not yield a sufficient number of experiments to give satisfactory results. Before we can speak with certainty at these elevations more experiments must be made.

Let us take the balloon as we find it, and apply it to the uses of vertical ascent; let us make it subservient to the purposes of war, an instrument of legitimate strategy; or employ it to ascend to the verge of our lower atmosphere; and as it is, the balloon will claim its place among the most important of human inventions, even if it remain an isolated power, and should never become engrafted as the ruling principle of the mechanism we have yet to seek.

Whether we regard the atmosphere as the great laboratory of changes which contain the germ of future discoveries, as they unfold to the chemist, the meteorologist, the physician its physical relation to animal life at different heights; the form of death, which at certain elevations is certain to take place; the effect of diminished pressure upon individuals similarly placed; the comparison of mountain ascents with the experience of aëronauts; these are some of the inquiries which suggest themselves, and faintly indicate researches which naturally ally themselves to the course of balloon experiments.

Sufficiently varied and important they will be seen to rank the balloon as a valuable aid to the uses of philosophy, and rescue it from the impending degradation as a toy, fit only to be exhibited or to administer to the pleasures of the curious.

Already it has done for us that which no other power has accomplished; it has gratified the desire, natural to man, to view the earth in a new aspect, and to sustain himself in a new element, hitherto the exclusive privilege of birds and insects. We have been enabled by its aid to ascend among the phenomena of the heavens, and to exchange conjecture for instrumental facts, recorded at twice the elevation the highest mountain permits us to observe.

Prevention of Accidents in Blasting.—Captain James Whitley, proposes that the sand or fine dust used in tamping should be put in lightly, instead of tight, as usual, the fuse being at last passed through a wooden plug, with which the hole is closed. The suggestion is admirable for quarries or places in which the hole is vertical, or nearly so, but frequently does not act well in a horizontal hole.

SOCIETY OF ARTS.

ON THE ART OF LAYING SUBMARINE CABLES FROM SHIPS.

By Captain Jasper Selwyn, R.N.

I venture to claim your attention this evening for the purpose of considering a subject, the importance of which, at the present moment, can scarcely be exaggerated.

A renewed attempt is about to be made to connect, by a submarine electric wire, the intelligences and interests of the old world with those of the new, and no enterprise of this age promises so much benefit to the whole human race as the realisation of such a method of instantaneous communication. The subject, therefore, may fairly be considered as one well fitted to interest the members of a society devoted to the cultivation of the arts—the highest art being that which is calculated to benefit mankind; while, on the other hand, by no other body could the views for which a hearing is sought be more fitly stamped as current coin or repudiated as base metal. But that I am aided by the observations of some of the first mathematicians and the most celebrated engineers—of this or any other country—if I had not secured the direct support of many of the most distinguished members of my own naval service—I should scarcely have dared to advance here what may be stigmatised as crude opinions or ill-considered theories. Yet I feel that I must ask your indulgence if, while asserting some things with the enthusiastic feeling which must animate every officer of my profession who thinks that he may perchance contribute something, however small, to the solution of a great nautical problem, I should fail adequately to explain, in all cases, points where the apparently intuitive knowledge of a seaman leads him confidently to predict results for which to the landsman's mind there seems no sufficient cause.

It will readily be conceded that just as no railway could be constructed with any chance of economy or ultimate success, unless after the most careful surveys and calculations—as, again, any fundamental error in such calculations would deserve the most careful elimination—so in this great work of laying an Atlantic telegraph cable, which is immeasurably more difficult, it behoves us to examine and re-examine the bases on which we are to proceed, and to refuse attention to no suggestion, from whatever quarter it may come, until we are absolutely convinced of its worthlessness.

Among those considerations which, as I hope to show, may most favourably or most fatally influence the success of the delicate operation of laying a comparative thread of electric communication across the Atlantic, the curves described by the cable in sinking may claim the very foremost place. The question first to be be solved is—Is the path of the cable during its descent to its ocean bed a straight line, an upward, or a downward curve? Is it an inclined plane? Is it a parabola, with a small curve of contrary flexure? Is it, or when is it, a catenarian curve?

As no less an authority than Professor Airy has held and published the last-mentioned opinion, I will, if you please, consider that case first. A ship at rest in an ocean of two miles in depth, allows a sounding line, carrying an iron weight of 96lbs., to run freely to the bottom. By many and accurately made experiments we find its time of descent to be fifty minutes nearly. We may treat it roughly for our present purposes, as two nautical miles per hour. Now we can by no means expect that any telegraph cable, more especially the present Atlantic (a specimen of which is on the table), could sink at a materially greater rate. More probably it would be considerably longer in reaching the bottom. But we will assume that it sinks as fast. Then, in one hour, a cable which is being paid out without strain, will reach the bottom in two miles depth of water. If, during that hour, the ship has made a progress of only one mile, and the natural acceleration of the descending cable has not been interfered with by brakes, the curve described will inevitably be a catenarian one; and this will be the case whenever, no strain being kept on by mechanical appliances, the rate of sinking of the cable is in excess of the rate of progress of the ship. It is always thus in shallow water, with heavy cables; a catenarian curve is there the invariable rule.

Next we will consider under what circumstances the cable will pursue a straight path, on an inclined plane, to the bottom. If the rate of sinking of the cable be again assumed as two miles per hour, and any rate of speed be given to the ship less than or equal to this, while a strain by brakes is placed on the issuing cable sufficient to prevent acceleration beyond the speed at which it is dragged out of the ship, then the line of descent will be a straight one, or little varying from an inclined plane. But in both these cases we have assumed a speed of ship of two miles only per hour, which in practice would be inadmissable.

We will now pass on to the case in which, as always really occurs in practice, the speed of the ship is materially greater than the rate of sinking of the cable. The cable issues from the ship, still under some strain, at from 20 to 30 per cent. in excess of her speed, which we will call five miles in the hour; that is, in one hour the ship has passed over five miles of ground, two miles of the cable has sunk, and, say, six miles of it has been paid out, or has issued from the stern of the ship. What has become of this—and in what curve, or on what inclined plane, is it now arranged? This, so far, is the real point at issue. I venture to hold that the curvature which, under these circumstances, takes place is an upward one, of the nature of a parabola, having a small curve of contrary flexure near the bottom, the general convexity being towards the surface. My reasons for this opinion are as follows:—First, whatever may be the speed of the ship, the rate of sinking of the cable can never be increased correspondingly, or, indeed, in any degree. Second, the slack paid out, averaging 25 per cent., is very much more than the difference between the horizontal distance, five miles made good in one hour, and the diagonal distance from the surface to the bottom on the same route. And this excess will certainly not be expended in producing a serpentine form, for which there is no possible cause, unless a very large proportion of slack is paid out, but in that upward curve, the cause for which is to be found in the resistance to cutting descent of the fluid through which the cable is moving. The less the sp. gr. of the cable, and the larger its diameter, the longer will be the comparatively straight part of the parabola, and consequently the more cable will be exposed to the effect of lateral surface currents, wherever such exist. Indeed, a valid proof that there is a considerable portion of the cable so exposed to currents, and therefore that there is such an upward curve, is to be found in the fact that on several occasions the issuing cable was run away with by a comparatively trifling current, making it take an angle with the ship's course. This could not have been the case had only the small portion of cable been exposed to the effects of currents, which would be due to the cable following an inclined plane between the ship and the bottom. This upward curve would also be liable to be produced or increased when there existed a current in a direction opposed to that of the ship's progress, for thus there would be an increased resistance to the cutting descent. While I thus attempt to show what is probably the curve taken by the cable, and what are the dangers attendant upon it, how it is produced, and what are its limits, I also wish to point out that, if this be the truth, there is an important advantage which may possibly be realised in case of a breakage of the cable. We all, I am sure, sincerely hope that this may not be the case; but should it occur, with proper apparatus attached to a strong hawser or line, and by steaming, so soon as the signal of rupture was heard, directly across the track previously followed by the cable-laying vessel—her consort, whose station should always be about three miles on the lee quarter, might catch the cable again before it was irreparably gone. I exhibit some apparatus for doing this automatically and without such assistance, but there will be considerable difficulty in using it, unless by men of great nautical skill.

I propose now to consider the lateral curves, with their effects, which may be made by the cable, owing to surface currents at an angle to the ship's course. If, the ship's course being west, a surface current be entered whose direction is southerly—*i.e.*, towards south—no effect can be noticed on the ship herself until, by astronomical observation, the existence of such a current is evidenced in the difference between the true and dead reckoning position; but it is otherwise with the issuing cable. It may immediately be observed to have deviated from its former line straight astern, and is now carried at a greater or less angle on the port or left-hand quarter; also, the strain shown by the dynamometer and the rate of issue will rapidly increase. Now no more fatal error can be committed by the engineer than to load the breaks and attempt to resist this. The only remedy is to go faster, steer a current course, and get out of the current as soon as possible, yielding so much to the increased demand for cable as never to bring more than a very small strain on. But it may be objected that, by so doing, an enormous percentage of slack will be lost. It is so apparently, but not really; for, as the current is but a surface disturbance, so soon as the cable in sinking has passed through it, the line in which it is laid follows really the true track of the ship as she is carried by the current, although, while in the current, it is carried in a loop far away to leeward. This it is very difficult to explain clearly without a diagram or model, to which I must therefore refer you; but it results from the fact that the cable exposes a very large surface to the lateral action, and is not, like the ship, forced against it by the motive power. If we conceive a fluid surface, like oil, floating on water of a certain depth—that this oil is carried laterally at a given rate by a cause which does not affect the water under it; if next we imagine a cord laid over the oil and sinking first through it and then through the water, we shall be able to understand how in the oil the cord may be carried off in a loop, or bight, as it is called by seamen laterally, falling thereafter through the water in the true line in which it is laid. But, of course, this will only be the case where the current has no great depth, for if from top to bottom the whole body of water moved, there must be a uniform lateral curve, just as there is a vertical one owing to the resistance to cutting descent.

It will be useful to remember that the new Atlantic cable, having a diameter of 1¼in., exposes about 633ft. of section per mile, and a two-knot current at 11·8 lbs. per square foot brings a strain upon each mile exposed to it of over 3 tons. Now, as in yielding to the set of the current more and more cable will constantly be demanded, and, therefore, more will be exposed to it (the rate of sinking never being capable of increase), it would at first sight appear that this demand ought to be resisted; and, in the first attempt at laying, there was an instance in which this course was pursued, which, as I should have expected, resulted in the breaking of the cable. I hope that so unwise a proceeding will not be repeated. It should be a rule with those who are laying deep-sea cables, that the maximum allowable strain must never exceed one-fourth of the breaking strain, even where the cable is made comparatively inextensible by the use of longitudinal fibre or wire; but where spirals of iron or steel wire enter into the construction of a telegraph cable, not being in contact with an incompressible core, then no strain sufficient to stretch the copper wire, which is now acknowledged not to be protected from such tension by any spirals—I say no strain, not even that due to its own weight in any great depth, can safely be borne by it. Again, the rule of the cable-maker ought to be that, his cable being hung freely in air, the weight is to be accurately observed which suffices, not to break it, but to stretch it 2 per cent., and on no account must more than a half of this be afterwards brought upon it.

If, after accurately calculating the number of pounds of copper per mile which will carry messages a certain distance at a certain remunerative rate, I then subject that wire to any tension which can decrease its area, and do so, moreover, to an uncertain extent, at any place where the wire, although seven-stranded, happens to be unusually soft, I might as well not have calculated, for I cannot secure the result. Therefore, even 1 per cent. of stretching is to be avoided if possible. There is no other way of doing this than by adopting either straight steel wires, enclosed in an elastic compound, as in Mr. Macintosh's cable, or less perfectly, but probably sufficiently near inextensibility, by the steel spiral in contact with the incompressible copper conductor of Mr. Allan.

The next branch of my subject to which I will beg your attention is the formation of kinks. The causes for their formation are various, the process of coiling and uncoiling being the first. The means of avoiding those so caused, while securing many other advantages, I have so often brought before the public that it would unnecessarily detain you if I were to do more than point out the mode and diagrams of the floating cylinders which I have always consistently advocated. But there are other causes for kinks which might be avoided. No treatment could well be more unfavourable for a telegraph cable than that of forcing it to pass round comparatively small drums from 4ft. to 8ft. in diameter, as brakes under a heavy strain, and none could be found more certain to induce the formation of those kinks which are so much to be dreaded. Now, kinks thus formed may occur under water, after the cable has been lost to sight in the waves, and this will happen most often when the ship is pitching, and so suddenly slacking up the cable, which then, not being able to sink faster than it did before—being, in fact, partially waterborne—arranges itself into a curve such as it had when tightened round the drum. The next upward pitch produces a kink which may, if it does not break the cable, yet cause inside the elastic sheath solution of electrical continuity. This recovers itself temporarily at the end of an hour or so, when the strain is taken off by the approach of that part of the cable to the bottom, and the ends of the broken copper wire come together again, only eventually to be destroyed by the accumulation of electrical resistance at that point.

Now, this can be in part avoided by the use of an elastic connection for the retarding apparatus—I will not call it by the ill-omened name of brake—nor should it be in any way similar to those machines which have been hitherto used for such purposes, but rather like the human hand, with the difference that the rubbing surfaces must be rolling surfaces also. By such means there must be established a continual give and take of the cable whenever the ship is pitching heavily, as even the *Great Eastern* may do if she gets a sea on the quarter or bow. It should not be forgotten that the danger of bad weather will, in this instance, be double what it was in the *Agamemnon's* case, because the time occupied by one ship in laying must necessarily be twice as great as when two are employed starting from the mid-Atlantic.

I am sure that every one who is interested in the spread of Ocean Telegraphy, not alone those who are pecuniarily interested, but also that far larger body who feel that the more rapid communication of thought must sensibly influence the happiness of the whole race (and to that body who does not belong?) unite in wishing success to the renewed attempt to unite England and America by an electric cable. Of the advantages to the fortunate company who shall succeed, we have often heard; there is little doubt that one year's good work would pay the whole cost. But immediately after such success ocean telegraphy would stride where hitherto it has only crept, and then we all trust that each who has some idea on the subject which would secure diminished risk or cost, will have a fair chance of seeing (if it be really good) his pet project brought into practical use. Now, my pet is a drum, not, as you have heard to-night, a small one, but one so large as to have been objected to on that score, and which I have promised you not to beat to-night. But you will not, I am sure, object to my mentioning another pet, of quite a different character. No one deserves more credit in connection with submarine telegraphy, for the money they have expended, and the perfection they have attained, than the manufacturers of insulating substances; and I fully believe that whatever was possible has been done by the india rubber manufacturers for caoutchouc, and by the Gutta Percha Company for their admirable gum. But new materials of hitherto unattainable qualities must make themselves felt in every social want, and the discovery of paraffin, and its power of combining with india rubber in small proportion, bids fair to revolutionise the whole system of insulating cables. Not only is the insulation better, but the inductive capacity is less than the best virgin Para rubber, while, for plasticity and durability, it surpasses any gutta percha. More than this, the price at which it can be manufactured will leave these gums far behind, and its general adoption can only be a question of time.

I will conclude by saying that, in my opinion, there ought to be no difficulty in laying telegraph cables wherever required; that there is no reason whatever for preferring along shore lines, but the contrary; and that if we can only hail the success of the Atlantic cable this year, half-a-dozen more cables will immediately be required. I hope that the questions I have raised here on this occasion will have a value stamped on them by discussion such as my feeble efforts could never give; and thanking you for your kind attention, I trust you will believe that my aim has been and will always be "to assist a known friend in view," in the language of the Articles of War, to the utmost of my power and ability.

INSTITUTION OF CIVIL ENGINEERS.

THE FESTINIOG RAILWAY FOR PASSENGERS—AS A 2FT. GAUGE, WITH SHARP CURVES, AND WORKED BY LOCOMOTIVE ENGINES.

By CAPTAIN H. W. TYLER, R.E., Assoc. Inst. C.E.

This line was designed to facilitate communication between the principal slate and other quarries in the county of Merioneth and the shipping places, and for the conveyance of coals and other heavy articles to the quarries and mines. As in 1832, when the Act for its construction was obtained, the population was very limited, the line was laid out in an economical manner, with a width between the rails of 2ft. only. It commenced at Portmadoc, and after passing along the Traeth Mawr embankment, it ascended to the mountain terminus at Dinas, the level of which was 700ft. above the station at Portmadoc, by an average gradient of 1 in 92, for 12¼ miles, the total length of line being 13 miles. The steepest gradient on the portion now used for passengers was 1 in 79·82, and on that traversed by locomotive engines 1 in 60. Some of the curves had radii of 2, 3, and 4 chains. The maximum super-elevation of the outer rail on 2-chain curves was 2½in. for a speed of 8 miles an hour. The estimated cost of the line was £24,185, but the parliamentary capital was raised to £50,185.

The quarries being situated at different altitudes in the mountains, the slates were first brought down the quarry inclines to the railway, and the trucks were collected until fifty or sixty had accumulated to form a train, which was then allowed to run down by gravity. Until the year 1863, the empty trucks, or those loaded with coals, goods, furniture, materials, machinery, and tools for the quarries and the neighbourhood, were drawn up by horses, who travelled down with the trains, as on mineral or colliery lines in the North of England. As the traffic increased, the line was gradually improved, by flattening the curves, by making better gradients, and by improvements in the permanent way, and as the trade still continued to progress, the practicability of employing locomotives was constantly discussed. The apparent difficulties caused the idea to be more than once abandoned, but ultimately, in June, 1863, two locomotive engines, designed by Mr. England, under ther direction of Mr. C. E. Spooner, the engineer to the company, were placed upon the line, and having been found successful, two others were subsequently supplied. These four engines had run 57,000 miles up to February, 1855, without leaving the rails. During the last autumn, the company carried passengers without taking fares, but at the commencement of the present year the line was regularly opened for passenger traffic. In ascending from Portmadoc, the passenger carriages were drawn by the engines with other vehicles, the passenger carriages being placed between the empty slate trucks, which were always last in the trains, and the goods waggons which were next behind the tender. In descending, the loaded slate trucks, with empty goods trucks attached behind them, ran first in a train by themselves; the engine followed, tender first, and the passenger vehicles brought up the rear, with a break in front, but detached from the engine and tender, and at a little distance behind them. The speed was limited to about six miles an hour in passing round the sharpest curve, and to ten miles an hour on other parts of the line.

The engines were somewhat similar to, though much smaller than, those which had been found so useful to contractors. There were two pair of wheels, coupled together, and 5ft. apart from centre to centre, the wheels being each 2ft. in diameter. The cylinders, which were outside the framing, were 8in. in diameter, with a length of stroke of 12in., and they were only 6in. above the rails. The maximum working pressure of the steam was 200lbs. to the square inch. Water was carried in tanks surrounding the boilers, and coal in small four-wheeled tenders. The heaviest of these engines weighed 7½ tons in working order, and they cost £900 each. They could take up, at ten miles an hour, about fifty tons including the weight of the carriages and trucks, but exclusive of that of the engine and tender. They actually conveyed daily, on the up journey, an average of fifty tons of goods and 100 passengers, besides parcels. Two hundred and sixty tons of slates were taken down to Portmadoc daily. The engines were well adapted for convenience in starting and in working at slow speeds; but their short wheel base and the weight overhanging the trailing wheels gave them more or less of a jumping motion when running. Safety guards, similar in form to snow ploughs, had been added in front of the engines, behind the tenders and under the platforms of the break-vans, in consequence of their being so near to the rails.

The passenger carriages were 6ft. 6in. high in the middle above the rails, 10ft. long, and 6ft. 3in. wide. They were on four wheels, 18in. in diameter, and 4ft. apart from centre to centre of the axles. There was a longitudinal partition down the centre, and the passengers were seated back to back, so as to avoid overhanging weight outside the rails. The second and third, costing £100 each, did not differ from the first class carriages, which cost £120 each, except in their fittings. Each carriage would convey ten passengers. The floors of the carriages being only 9in. above the rails, no platforms were required; and there being no break in the longitudinal partitions, the passengers got in and out through doors on both sides. There were also some open cars for summer use, without sides or roof, into which the passengers were strapped by means of longitudinal and cross straps. The couplings were central, 15in. above the rails, and working upon volute springs. The buffers were also central, and were 4½in. above the couplings.

The rails weighed 30lbs. to the lineal yard, and were supported in cast iron chairs, weighing 13lbs. at the joints, and 10lbs. each in the intermediate spaces, placed upon transverse sleepers of larch. In transforming this horse-tramway, thirty-three years old, into a passenger line worked by locomotives, the narrowness of the works, among other things, caused some difficulty. The author thought that in all new lines a minimum distance of 2ft. 6in. should be preserved between the sides of the carriages and the works, and that where there were two lines of way an intermediate space of 7ft. should be allowed, to admit of the doors of the carriages in one train swinging clear of those of another train.

The author conceived that the employment of locomotive engines on this little railway and its opening for passenger traffic were not only highly interesting experiments, but were likely to be followed by important results. Although there were still, doubtless, numerous districts where railways on a gauge of 4ft. 8½in. might be profitably made, yet there were also many others in which lines of cheaper construction were required. With a narrower gauge, lighter rails and sleepers, less ballast, and cheaper works generally might be adopted; sharper curves might be laid down; very heavy gradients, particularly in mountainous regions, might be more cheaply avoided; and lighter engines with lighter vehicles might be made to do all the work, where high speed was not demanded, and where the traffic was not heavy.

The Norwegian Government, as appeared from a report by Mr. C. D. Fox, had in operation two line on a gauge of 3ft. 6in—one from Grundsett to Hamar, 24 miles long, the other from Tondlijen to Staren, 30 miles long. The former, with gradients of 1 in 70 and curves of 1,000ft. radius, had cost, including rolling stock and stations, £3,000 a mile. The latter, through a more difficult country, with gradients of 1 in 42 and curves of 700ft. to 1,000ft. radius, had cost £6,000 a mile. The engines weighed 14 tons in steam, and the speed was about fifteen miles an hour, including stoppages. A further length of 56 miles was in course of construction, and no other gauge was contemplated for the traffic of that nation.

It was, however, illegal at present to construct any passenger lines in Great Britain on a narrower guage than 4ft. 8½in. or in Ireland than 5ft. 3in. Consequently, it would appear to be desirable to endeavour to obtain the repeal—or at least a modification of the provisions of the Act 9 & 10 Vic. c. 87, which regulated the width of the gauge of passenger lines, as there was now an increasing demand for railways of a minor class. Many coal and mineral lines on a less gauge than 4ft. 8½in. were in use, and others were projected, with ultimate views of passenger traffic, and it would be advantageous if some narrower gauge were recognised. Whether the exact gauge should be 2ft., 2ft. 6in., or 3ft., or any other dimension, it was believed there could be no question that a system of branch lines costing two-thirds of those now ordinarily constructed, and worked and maintained at three-fourths of the expense, would be of great benefit to Great Britain and in Ireland, and would be most valuable in India and the colonies—in fact, wherever there were people to travel, produce to be transported, resources to be developed—in cases in which it would not be commercially profitable to go to the expense, at the outset, of a first class railway.

ON UNIFORM STRESS IN GIRDER WORK; ILLUSTRATED BY REFERENCE TO TWO BRIDGES RECENTLY BUILT.

By Mr. Calcott Reilly, Assoc. Inst., C.E.

This communication was suggested by a previous discussion at the Institution, when Mr. Phipps, M. Inst. C.E., condemned the trough-shaped section, commonly adopted for the top and bottom members of truss girders, because the intensity, per square unit, of the stress upon any vertical cross section, was necessarily variable, when the connection of the vertical web with the trough was made in the usual manner. In the construction of the iron work of the two bridges under consideration, attention was invited chiefly to those details which were designed with the object of carrying out, as nearly as possible, in every part of the girders, the condition of uniform stress.

After alluding to the distinction drawn by Professor Rankine between the words "strain" and "stress," and to his definition of "uniform stress," in which the "centre of stress," or "centre of pressure," must be coincident with the centre of gravity of the surface of action, and of "uniformly varying stress," when the centre of gravity deviated from the "centre of stress" in a certain known direction, it was remarked, that the failure of any member of a girder would begin, where the resistance to strain was really least, that was where the intensity of the stress was greatest; from which it followed that the opinion which upheld as right in principle the trough-shaped section, as applied in the usual manner, must be a mistake. And, moreover, every form of section, of any number of a girder, or other framework, which did not admit of the approximate coincidence of the centre of stress with its centre of gravity was liable in degree to the same objection.

The two bridges illustrated different conditions of loading; one carrying the platform on the top, the other having the platform between the main girders near the bottom. Both were of wrought iron, and both exhibited an economy of material in the main girders, that, so far as the author was aware, was not common, at least in this country. In order to determine the causes of this economy, a comparison was made with two other forms of truss more generally adopted. In one bridge, over the River Desmochado, on the line of the Central Argentine Railway, the pair of trusses, 93ft. 4in. span between the centres of bearings, was designed to carry, in addition to the fixed load, a moving railway load of 1 ton per foot of span for a single line of way, with a maximum intensity of stress of 5 tons per square inch of tension, and of 3½ tons per square inch of compression; and the total weight of wrought iron in the framework of the pair of trusses was 18 tons. The cast iron saddles, riveted on at the ends, weighed 9 cwt.; if these were included, the weight of iron, both wrought and cast, in the pair of trusses, was under 4 cwt. per lineal foot of span.

The other bridge over the Wey and Arun Canal, on the Horsham and Guilford Railway, was 80ft. span between the centres of bearings; it was designed to carry, in addition to the fixed load, a moving load of 1·875 ton per foot of single line of way, at the same maximum intensity of stress as in the other case; and the total weight of wrought iron in the pair of trusses was 20 tons 18 cwt. The cast iron saddles weighed 5½ cwt. each; bringing up the weight of both wrought and cast iron in the pair of trusses to 5½ cwt. per lineal foot of span. This weight was greater than in the first bridge, although the span was less; but the intensisy of the moving load was 87½ per cent. greater, and the roadway lying between the trusses instead of on the top, its weight was necessarily much greater. The cross girders were also heavier, each being adapted to support, separately, the heaviest load that could be brought on by a driving axle weighted with 16 tons; the moving load thus brought upon each cross girder, and to which its strength was proportioned, was 18 tons, eqnal to 2¼ tons per foot of span of bridge.

The particular form of truss chosen for these two bridges, was that extensively known in the United States as the Murphy-Whipple Truss. Each of these trusses was minutely compared, according to the plan adopted on a previous occasion by Mr. Bramwell (M. Inst. C.E.) with two equivalent trusses of the types generally used in this country, viz., the Warren truss, with bars making an angle of 63° 26′ with the horizon, and the simple diagonal truss with two sets of triangles, the bars crossing each other at the angle of 45°; the various circumstances of, ratio of depth to span, which was as 1 to 10, and of application and distribution of load, and consequently the number and position of the loaded joints, being common to the three trusses.

The details of the comparison were fully given in the paper, and the proportionate results arrived at in the two cases were exhibited in the following tables, relating to the trusses of the two bridges, contrasted respectively with the other equivalent trusses:—

BRIDGE NO. 1, WITH LOAD ON THE TOP.

	No. 1. Murphy-Whipple Truss.	No. 1 A. Warren Truss.	No. 1 B. Diagonal Truss.
Theoretical weight	Units. 250	Units. 237·5	Units. 227
Weight of transverse stiffenings to struts	17·4	29·2	42·2
Excess of practicable minimum over theoretical minimum	6·18	11·5	81·6
Total weight exclusive of joints and packings	273·58	278·2	300·8

From this it appeared that the least practicable weight of No. 1 truss was less than that of No. 1A by only 1·7 per cent. It might, therefore, be said that, practically, the two trusses were equal in point of economy; and that there could be no motive for preferring one to the other, except such as might arise from considerations of workshop convenience and facility of construction. The advantage, in point of economy of weight, of No. 1 over No. 1B, was more decided, being 10 per cent. sufficient, it was submitted, speaking generally, and without denying that special circumstances might, in particular cases, justify a choice of the heavier truss, to entitle No. 1 to a preference over No. 1B.

BRIDGE NO. 2, WITH LOAD ON THE BOTTOM.

	No. 2. Murphy-Whipple Truss.	No. 2A. Warren Truss.	No. 2B. Diagonal Truss.
Theoretical weight	Units. 237·8	Units. 237·5	Units. 228
Weight of transverse stiffening to struts	6·6	16·1	26
Excess of practicable minimum over theoretical minimum......	11·98	13·42	32·82
Total weight, exclusive of joints and packings	256·38	267·02	286·82

It thus appeared that No. 2 truss was lighter than either of the others, by 4·15 and 11·87 per cent. respectively.

With regard to the peculiarities of detail of the two bridges, it was remarked that in order that the stress might be uniformly distributed over the surface of any cross section of either "boom," it was necessary that the two halves of the double web of each truss should each suppart, one half the load upon that truss. Thus it was urged, could not be realised by the ordinary modes of fixing the cross girders; but, in the cases under consideration, it was arrived at, by supporting the cross girders in the middle of the width of the truss. Thus, in bridge No. 1, each cross girder rested upon a light cast iron saddle, or bridge, which spanned the width of the top bottom, and had its bearing partly upon the top edges of the vertical struts, and partly upon rivets passing through it, the struts, and the vertical side plates of the top boom; in such a way that the line of action of the vertical force, transmitted from the cross girder to the truss, coincided, exactly, with the vertical centre line of its width. In bridge No. 2, a different arrangement was necessary. In that case each vertical strut consisted of two pairs of angle irons, separated, in the plane of the truss, by a space just wide enough to permit the end of the cross girder to pass in between the pairs. At the same level as the cross girder, a plate was riveted to each pair of angle iron, and the resulting stress was equally distributed between the two halves of each boom. In both bridges, the centre lines of the vertical struts, the diagonal ties, and the top and bottom booms, intersected each other at the centre of gravity of the group of rivets, which attached each strut and tie to the boom, and, in order to satisfy the condition of uniform stress, all the centre lines were axes of symmetry. In the top booms of both bridges, a section had been adopted which was believed to be new. It was somewhat like an elongated capital letter H, or like a common plate girder placed upon its side; the horizontal web, or diaphragm, being only sufficiently thick to ensure lateral stiffness. In this section, all the centre lines were axes of symmetry, and consequently intersected each other in its centre of gravity; and the horizontal axes were easily made to intersect each other in its centres of gravity of the web joints. The chief mass of metal was also placed immediately contiguous to the bars of the web, which transferred the stress to the boom—instead of being at some distance from them, as in the trough shaped and T shaped form of boom. The material was likewise disposed in the best possible manner for resisting vibration; while this section gave complete facilities for examination and painting. The ends of each truss rested upon hinged bearings, by means of cast iron saddles rivetted to the junction of the endmost bars of the truss, rollers being provided at one end.

The means adopted in the design of these girders, to obtain the utmost economy of weight, consistent with moderate economy of workmanship, were—the closest practicable approximation of the average strength to the minimum strength; the observance throughout of the condition of uniform stress, in order that all the compressed members might be trusted with the least possible weight of stiffening; the preference of riveted web joints to those formed by single pins; and such an arrangement of the riveting, that every bar or plate subject to tension should have its whole width, less the diameter of only one rivet hole, available to resist the tensile force applied to it.

Lastly, the author demonstrated the true value of the condition of uniform stress, by an exact comparison of the state of a bar of the top boom of the truss of bridge No. 2, when under uniform stress, with that condition of unequally distributed stress that would occur, if the boom had a suitable trough-shaped section of equal area, breadth and depth, and therefore of equal nominal value; the elasticity of the material being assumed as perfect. The first case considered was where the stress was uniform in intensity, and the second in which the stress wat unequally distributed. The final result was denoted by the equation $p = p_0 \pm \frac{x L P}{I}$; and applying this formula* to the case of the trough shaped section of boom, supposed to be equivalent to the H shaped section actually used, the following was obtained:—The area of section was exactly the same, being 36·17 square inches. The inside depth of the trough, 10in., would permit precisely the same disposition of the rivets in the web joint, so that the centre of pressure was situated at the same perpendicular distance, 5in., from the lower edges of the trough, as from the edge of the H shaped section actually used. The centre of gravity was found to be situated at 8·088in. perpendicular distance from the lower edge of the trough, and 2·537in. from the top edge. The magnitude of the total stress upon the section was 125 tons. The uniform intensity of this stress was 3·45 tons per square inch; and the moment of inertia, with respect to the axis, was 366·892. From these data the greatest stress was found to be 12·717 tons per square inch at the extreme edges or corners of the sides, and the least intensity 0·544 ton per square inch along the extreme bottom of the trough. In this result the effect of flexure was purposely omitted.

In summing up the conclusions sought to be established, it was submitted that:—

First, a comparatively small deviation of the centre of stress, upon the cross section of any bar, of any piece of framework, from the centre of gravity of that section, produced, within the limits of elasticity, a very great inequality, in the distribution of the stress upon that section.

Secondly, if it were conceded that the real strength of every structure was inversely proportional to the greatest strain suffered by its weakest member; then the existence of this unequal distribution of the stress must be detrimental to the strength of any structure in which it existed, and which had been designed on the supposition, that the mean intensity of the stress upon any bar, was necessarily a correct measure of its strength.

Thirdly, there was no practical or theoretical difficulty in designing a truss or girder, in which the stress upon every cross section, of all the important members at all events, should be absolutely uniform.

Fourthly, the condition of uniform stress was perfectly consistent, with the utmost economy of material, in the structure to which it was applied.

ON THE MAINTENANCE OF RAILWAY ROLLING STOCK.

By MR. EDWARD FLETCHER.

This communication related to the rolling stock belonging to the North-Eastern Railway Company, the statistics of which was comprised in twenty-nine tables, made up at annual periods extending over thirteen years, from 1852 to 1864 inclusive, showing the total number of the different descriptions of stock, and the average age of every class, at the end of each year.

The rolling stock was embraced under four distinct heads—locomotive engines, carriages, merchandise waggons, and chaldron coal waggons: the carriages and merchandise waggons being again subdivided into separate classes, of all of which a summary was given. The tables had been arranged with the view of showing, in a comprehensive form, the age of the different classes of stock, and the average of the whole. And it was submitted that, if the average age of all the stock did not exceed one-half the number of years which might be found by experience to be a fair average of the existence, or life, of the stock, then that justice was done to the stock in maintenance. Another object of these tables had been to show what per centage the annual expenditure in maintenance bore to the first cost of the stock. It was believed that if these, or similar tables were kept up with care, they would in a few years be the means of affording to the directors of any railway company good data for checking the annual expenditure, and for forming a correct opinion as to the sufficiency or insufficiency of the maintenance. The tables likewise showed the cost of maintenance of each vehicle per annum, and, in the case of locomotive engines, the cost per mile run.

With regard to the ultimate age, or life, of rolling stock, the author was of opinion that the improved rolling stock of the present day, built of carefully-selected and well-seasoned timber, and materials of the best quality—superior as it was in all respects to that built twenty years ago—might be fully calculated

* In this formula, p is the intensity of the stress per unit of area at the distance x from the neutral axis of the stress, which intersects the centre of gravity of the section. p_0 is the intensity of the stress considered as uniformly distributed over the surface of section —that is the total stress P upon the entire surface of section divided by the area of that surface. L is the perpendicular distance of the centre of pressure from the neutral axis, and I is the moment of inertia of the surface with respect to that axis. x is + or — according as it is measured on one or the other of the neutral axis.—C.R.

to have a life of from twenty-five to thirty years, assuming always that the stock was of such a character that it would not be necessary to break it up on any other ground than that of decay. It was also to be remarked that, on all large railways, the quantity of rolling stock was always increasing, the result of which was to keep down the average age of the stock; and having a large amount of new stock, on which there was little expenditure for some years, the per centage of outlay was proportionately diminished. Making allowances on these points, the conclusion was arrived at, that carriage stock might be fully maintained by an outlay of about 12 per cent. on its cost, waggon stock by an outlay of 6½ per cent., and locomotive stock by an outlay of 12½ per cent. The chaldron waggon stock, which was peculiar to the north of England, generally had cast iron wheels, was without springs, and was subject to great breakage by inclined planes and other hard usage; so that, whereas the general waggon stock only cost 6½ per cent. on its first cost for maintenance, the chaldron waggon stock cost 17½ per cent. This stock was by degrees being replaced by 8-ton waggons of superior construction. An 8-ton coal waggon would cost £90, and three chaldron waggons, to carry the same quantity of coals, £75; but the cost of maintenance in the first case would be only £5 10s., whilst in the second it would amount to £13, showing that the superior waggon was the cheaper one of the two.

The number of locomotive engines belonging to the Company at the end of 1864 was 504, and their average age was 12·48 years. Assuming that the duration or life, of an engine was twenty-five years, then the Company should have been rebuilding at the rate of twenty engines annually, to be paid for out of revenue, in order to keep the stock up to its original value; but the table showed that for the last five years an average of only eleven engines had been rebuilt, including under this head only those which were entirely new, and of a different class when rebuilt. But taking into account the engines of the same class which had been so treated, the total number reconstructed had been twenty per annum. The principal part of the engine so altered during the thirteen years from 1852 to 1864 were those which were old when they came into the possession of the Company.

The following statement showed the total number of different descriptions of stock, and the average age at the end of the year 1864; also the average cost of repairing per vehicle per annum, and the per centage of repairs, and of rebuilding on the first cost, for the thirteen years:—

Description.	Total Number.	Average Age.	Cost of Repairing and Rebuilding per Vehicle per Annum.	Per Centage of Repairs and Rebuilding on Total Cost.	Per Centage of Rebuilding on Total Cost.	Cost per Mile for Repairing and Upholding.	Cost per Mile for Extraordinary Repairs, included under "Repairs and Upholding."
		Years.	£ s. d.			d.	d.
Locomotive Engines	504	12·48	—	12·55	—	2·95	1·92
Carriages........................	1,370	9·75	22 0 9	11·26	4.46	—	—
Waggons........................	17,429	10·31	4 8 4	6·39	2·89	—	—
Chaldron Coal Waggons ...	11,872	—	2 15 0	17·42	—	—	—

The communication was accompanied by a very elaborate series of tables.

MANCHESTER ASSOCIATION FOR THE PREVENTION OF STEAM BOILER EXPLOSIONS.

The monthly meeting of this association was held on the 2nd ult., when the chief engineer presented his report, of which the following is an abstract:—

"During the last month 180 engines have been examined, and 308 boilers, 16 of the latter being examined specially, and 3 of them tested with hydraulic pressure. Of the boiler examinations, 197 have been external, 13 internal, and 98 entire. In the boilers examined 172 defects have been discovered, 11 of the defects being dangerous.

"Injury to furnace crowns from shortness of water appears of late to have been of very frequent occurrence. Three cases have already been reported since the commencement of the year, while two more have happened during the past month. The majority of these cases of injury occur at night time, when the furnaces are banked up; but the first of those now under consideration took place at about half-past one in the afternoon, when the fireman was at his post. It appears that he misread the glass gauge, mistaking a small piece of white scale, which clung to the inside of the tube, for the surface of the water, and was not undeceived until being alarmed by hearing a cracking and thudding noise inside the boiler, as well as by noticing that the steam began to rush out at the furnace-mouth angle irons, and at the transverse seam of rivets in the front end plate, he called the engineman, who at once blew the glass gauge through, and discovered that the boiler was short of water. The engineman promptly put down the damper, and drew the fire, just in time to prevent explosion, but not before the furnace crowns were very seriously drawn out of shape.

"The boiler was of the internally-fired two-flued class, and was one of a series of seven, all of which worked at a pressure of 60lb. per square inch, with the exception of the one under consideration, which was used for heating the mill, and only worked at 10lb. Had the boiler been working at the same pressure as the remainder, explosion, it is thought, would have been inevitable.

"The second case of injury through shortness of water occurred at night time, when the fires were banked up, and the boiler was in charge of the watchman. The boiler had two furnaces, but one only being charged at the time the other escaped.

"Both the boilers referred to above were fitted with fusible plugs, and which it will be seen proved as useless in both these cases as they did in the three, particulars of which were given in the last report. The experience of this Association with low-water safety-valves, which allow the steam to escape as soon as the water falls below a fixed level, certainly shows that they are more reliable than fusible plugs.

"Entire" or "Thorough" Examinations.

"Advantage has been taken of the stoppage of the works during the past month at the Easter holidays for making as many 'Internal' and 'Flue'-examinations as possible, the total number of which amounts to 111, which is a higher number than has been obtained during any previous Easter month.

Explosions.

"Eight explosions, by which three persons have been killed and nine others injured, have occurred, during the past month to boilers not under the inspection of this Association. The following is a tabular statement:—

From March 24th, 1865, to April 21st, 1865, inclusive.

Progressive No. for 1865	Date.	General Description of Boiler.	Persons Killed.	Persons Injured.	Total.
12	Mar. 24.	Particulars not yet fully ascertained ...	0	2	2
13	Mar. 25.	Particulars not yet fully ascertained ...	0	0	0
14	Mar. 27.	Ordinary double flue, or "Lancashire." Internally-fired	0	0	0
15	Mar. 30.	Locomotive..........................	1	2	3
16	April 7.	Locomotive..........................	1	0	1
17	April 10.	Marine..........................	0	1	1
18	April 10.	Plain Cylindrical: Externally-fired	0	3	3
19	April 14.	Locomotive..........................	1	1	2
		Total	3	9	12

"No. 11 Explosion, which took its rank in the table given in last month's report, occurred at about five o'clock on the afternoon of Thursday, March 23, at an ironworks, and by it two men were killed and five others injured. The boiler, which was not under the inspection of this Association, was one of a series of six, set at a short distance one from the other, all of them being worked and connected together. They were furnace boilers of horizontal, double-flued construction, each of them being heated by the flames passing off from a couple of puddling furnaces, the flames first passing through the internal tubes, and then returning through external brickwork flues round the shell. The length of the exploded boiler was sixteen feet, the diameter seven feet, the thickness of the plates $\frac{5}{16}$ of an inch, while the working pressure appears to have been very moderate, not exceeding from 10lb. to 15lb.

"With regard to the cause of the explosion, the boiler, which was stated at the inquest to have been thirty years old, and is reported to have lain idle during twenty years out of that time, failed in the cylindrical portion of the external shell, and was found, on examination subsequent to the explosion, to have been so reduced by corrosion as not to be thicker in places than a sheet of paper, while there were other evidences of general neglect both in this boiler and in the condition of those that had worked alongside of it, thus:—The furnace crowns of the exploded boiler were out of shape from injuries received some time since through shortness of water; and one of the twin boilers was found to be in a disgracefully dirty condition inside, being coated to a depth of 2in. with a thick, slimy deposit, which with ordinary care might have been readily removed. There was, therefore, every appearance that the boiler had been altogether maltreated, and that the explosion was one of those that are simply due to neglect, and which may be prevented by common care.

"It was given in evidence that the boilers were examined and cleaned out every fortnight, as a rule, but sometimes as often as once a week; and that it was the especial duty of the head engineman to see that the plates were properly freed from deposit and incrustation. The fireman stated that after the last occasion on which the boilers were cleaned out, when it had been done by two boys, he had himself made an internal examination, and found that all was right, adding, that part of the brickwork of the boiler had been removed some time since, when the under portions were exposed, but no defects discovered or reported to the manager. The engineman, whose duty it was to report when the boilers were out of order, had never noticed anything to justify him in so doing. The blacksmith, who repaired the boiler when necessary, stated that it was thoroughly examined three weeks before the explosion, and he considered that the boiler was safe at the pressure at which it was working at the moment it burst, in which opinion the fireman and engineman agreed. The manager had not received any reports of the boilers being in a defective condition, and had no suspicion of its being out of order; so that it appears that the fireman, the engineman, the blacksmith, and the manager all agreed in thinking the boiler well attended and perfectly safe up to the moment of its explosion.

"A comparison of the actual condition in which the boiler was found on examination, with that in which it was supposed to be by those who had it in charge, may serve to show the value of an independent system of Periodical Inspection.

"The coroner charged the jury that it appeared from the evidence that everything had been done which human foresight could suggest to prevent the explosion, and therefore it was his duty to direct them to return a verdict of Accidental Death, in accordance with which the jury found that 'the deceased was killed by the *accidental* explosion of a steam boiler.' Another inquest followed in the course of a few days, in consequence of the second death that resulted from the explosion, when a similar verdict was returned.

"Since these reports are entirely void of all personalities, no names being given either of individuals, works, or localities, the object being to discuss these explosions merely in a scientific light for the purpose of their prevention, and the saving of human life, it may not be thought out of place to suggest the inquiry whether such an inquisition as that just referred to, and which is by no means an isolated specimen, does not rather hush up than promote investigation, and conceal rather than elicit and ventilate the truth. At all events, it would appear that there is yet considerable necessity for the persevering publication of the real cause of these frequent explosions, by which so much property is annually lost, and so many lives are sacrificed.

"No. 18 Explosion took place at a colliery, at half-past nine on the morning of Monday, April 10th. By it three persons were injured, but fortunately no lives were lost.

"The boiler was externally-fired, and of plain cylindrical construction, with flat ends, which were flanged and riveted to the shell, without angle iron, its length being 28ft., its diameter 5ft., the thickness of the plates from three-eighths to seven sixteenths of an inch throughout, and the ordinary pressure of the steam about 55lbs. per square inch.

"The boiler gave way at the front end plate, which was completely separated from the rest of the shell, being rent round its entire circumference through the solid metal at the root of the flange.

"The main portion of the shell was thrown backwards in a straight line with the seating, knocking down the chimney in its course, and falling to the ground at a distance of about 56 yards from its original position, while the front end was thrown much further in the opposite direction, striking in its flight the winding gear at the top of the pit, and cutting through one of the ropes as it was either raising or lowering a skip in the shaft. The skip was precipitated to the bottom, but it fortunately had no workmen in it at the time, and no loss of life resulted therefrom.

"Examination left no room for doubt as to the cause of the explosion. The flat ends of the boiler were very insecurely stayed. Instead of being stiffened with gussets, which would have rendered them perfectly safe, they depended entirely on a single longitudinal stay, made of iron $1\frac{1}{4}$in. square, while this was not in one length, but composed of two bars insecurely coupled together in the middle by means of two small bolts. The two parts of this stay were found to be entire, one of them attached to the front end of the boiler, and the other to the back, so that it appears that the joint in the middle had failed in the first instance, and then the front end, being deprived of its support, had given way under the strain. These end plates should have been strengthened with ordinary gusset stays, and had that been done, the explosion would not have happened, so that its occurrence is attributable simply to the mal-construction of the boiler."

SHIPBUILDING AT TRIESTE.

On the 24th of May, at the shipbuilding yard of St. Marco, near Trieste, was launched the wooden iron-cased frigate *Erzherzog Ferdinand Max*, built for the Austrian Government by Herr Ritter von Tonello.

The chief dimensions of this magnificent war ship are as follows, and she is to be armed with thirty-four rifled 100-pounders:—

	Vienna measured.
Length between perpendiculars	253ft.
Maximum breadth on frames	48ft.
Maximum breadth on outside iron casing	50ft. 6in.
Depth from top of floors to top of deck beams	30ft. 7in.
Load draught, aft.	24ft. 9in.
Load draught, forward	20ft.
Height of gun ports above the load line at midships	7ft. 1in.
Displacement on frames	4734 tons.
Displacement on outside planking	5314 tons.
Tonnage B.M.	3065 $\frac{45}{94}$ tons.
Area of midship section outside planking	872 sq. ft.

To be barque rigged with lower masts of Styrian Bessemer steel, built hollow, and made to serve for ventilation. Thickness of the iron casing, $4\frac{3}{8}$in.; thickness of wood underneath in the battery, 18in. The *Erzherzog Ferdinand Max* is to be propelled by a pair of horizontal double piston rod engines of 800 horse-power nominal, and is expected to steam at a rate of 13 knots an hour. Diameter of cylinder, 82in.; stroke, 4ft.; expected number of revolutions, 48 to 50 per min.; safety valves loaded to 25lbs. per sq. in.; Griffith's propeller with two blades, of 20ft. diameter and 29ft. mean pitch; six boilers with 0·82 sq. ft. grate surface per horse-power; 19 sq. ft. heating surface pro. nom. horse-power, after deduction of $\frac{1}{3}$ of the tube surface; 418 tons of coals in bunkers; her long-boat is to be screw propelled, and provided with a 10 horse-power high-pressure engine.

Within the last fifteen years Herr von Tonello has built the greatest part of the Austrian navy, viz.:—

In 1849 the paddle steamers *St. Lucia* and *Volta*, of 6 guns, 300 horse-power, and 913 tons B.M., each within the course of 6 months.

In 1855 and 1856, in 18 months, the screw frigates *Andria* and *Donan*, of 31 guns, 300 horse-power, and 1,826 tons B.M.

In 1857 and 1858, within 18 months, the line-of-battle ship *Kaiser*, of 91 guns, 800 horse-power, and 3,255 tons B.M.

In 1859, in 4 months, the screw gunboats *Deutschmeister*, *Anslugger*, and *Pelikan*, of 2 guns, 50 horse-power, and 222 tons B.M.

In 1860, within 3 months, the gunboats *Ranfbold*, *Speiteufel*, *Uskoke*, *Scharfschütze*, *Wespe*, and *Wildfang*, of 4 guns, 90 horse-power, and 239 tons BM. Built in a provisionally erected establishment at Peschiera, on the Lake of Garda.

In the same year, 1860, within 5 months, the gunboats *Seebund*, *Streiter*, *Reka*, and *Wall*, of 4 guns, 230 horse-power, and 606 tons B.M.

In 1861, in 6 months, each of the iron-cased frigates *Drache* and *Salamander* of 28 guns, 500 horse-power, 1,805 tons B.M., and 3,155 tons displacement.

In 1861 and 1862, in 6 months, each of the iron-cased frigate, *Kaiser Max*, *Don Juan d'Austria*, and *Prinz Eugen*, of 31 guns, 650 horse-power, 2,228 tons B.M., and 3,647 tons displacement.

All these ships can contend with those of any other navy for cheapness, quality of workmanship, and choice materials. The Austrian Admiralty has found it in every respect most advantageous to address itself to private enterprise for supplying the wants of its navy, and such complaints, whether real or imaginery, which have been uttered by the Controller of the British Navy against English private shipbuilding yards, are quite unknown at Trieste. The engines are likewise supplied by private Austrian establishments.

Besides the above-named vessels Herr von Tonello has built, within two years, and completed, ready for sea, on his own account, the following trading steamers: *Baron Bruiger*, and *Baron Mamula* (paddles), each of 90 horse-power, and 450 tons; *Marco Polo* (s.s.), 150 horse-power, and 1,200 tons; *Maria Theresia*, (s.s.), 150 horse-power, and 1,500 tons; *Rudolf von Halsburg* (s.s.), 250 horse-power, and 2,500 tons.

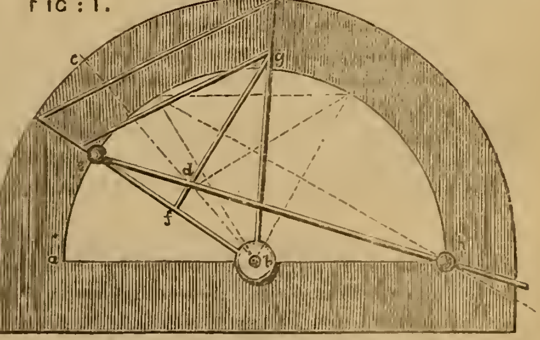
The number of sailing vessels built since 1850 by the same gentleman on the shipyards of San Marco and in Muggoir, opposite Trieste, surpasses forty, varying in their carrying capacities between 300 and 2,000 tons.

The Austrian shipbuilders had, until now, only an opportunity of excelling in the construction of wooden vessels; but lately a start has also been made in the way of iron shipbuilding; and as they now have also at their disposal at low price a Bessemer steel from Styria and Carinthia, which can only be equalled in quality, but not surpassed, by the best Swedish and Russian steel, it is expected that Trieste will become a well-suited locality for steel shipbuilding enterprises. Herr von Tonello is about to form a company for the purpose of adding this branch of trade to his building business of San Marco.

ROSENBLAD'S INSTRUMENT FOR TRISECTING ANGLES.

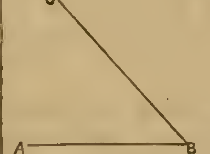
Mr. Rosenblad, of New York, and now residing in London, has submitted to us the instrument which we have the pleasure to illustrate and des-

FIG: 1.



cribe here, in the hope that its use may be found to facilitate the labours of some of our readers. Referring to the illustrations, $b\ e\ g$ is an equilateral triangle, divided in two equal parts, by $f\ g$, and revolving round the centre of the semicircle; the rod $e\ h$ accompanies the movements of the triangle, by means of the pivots e and h.

FIG: 2.



To use the instrument. If A B C be the angle, put the centre b on the pivot B, and let $a\ b$ cover A B; $a\ b\ c$ is then the angle to be divided. Adjust the triangle $b\ e\ g$ so that the three lines $f\ g$, $e\ h$, and $b\ e$, cross each other in one point, d. The angle $b\ e\ h$ is now equal to $e\ b\ c$, but $b\ e\ h = b\ h\ e$, therefore $c\ e\ b = b\ h\ e$; now $a\ b\ e = 2\ b\ h\ e$, therefore $a\ b\ e = 2\ c\ b\ e$. As $e\ b\ g = \frac{1}{3}$ of both angles, and $c\ b\ e = \frac{1}{3}$ of $a\ b\ c$, $c\ b\ g$ must be equal to $\frac{1}{3}$ of $c\ b\ h$. If we, therefore, let the instrument revolve round its centre till $b\ h$ covers $b\ c$, and let the other leg of the angle $a\ b\ c$ be crossed in one point by the lines $e\ h$ and $f\ g$, $b\ g$ will cut off another third from the angle $a\ b\ c$ (A B C), and thus divide it in three equal parts.

RIFLED SMALL ARMS.

(From the "*Portefeuille Economique des Machines.*")

We are indebted to an important aud recently issued work of Mons. Cavelier de Cuverville* for the following particulars on the history and construction of rifled small arms. Mons. Cuverville commences by treating of the

Object of Rifled Small Arms.—In the discharge of projectiles many errors are likely to arise which may be ascribed alike to the piece and to the marksman, as also to various external and accidental causes. But the most important deviations arise from the motion of the projectile itself, and to these we must chiefly devote our attention.

Thus, in unrifled arms, and with the old spherical bullet, the windage or difference of diameter between the projectile and bore of the piece occasions percussion of the projectile against the interior of the barrel, and it may be considered that an uniformly spherical bullet has imparted to it a rectilinear, and at the same time a rotary motion round an axis identical with the direction of the transmission; and hence arises the irregularity of the movement. Besides, a rotary motion may be imparted to the ball by its want of sphericity and uniformity of surface.

From theoretical and practical investigations made upon this subject, it appears that the deviations due to the rotary motion depend on the correlative positions of the axis of rotation aud the rectilinear direction of the ball.

The resistance of the air due to the variations in its density to the motion of a spherical body moving in a rectilinear direction and rotating at the same time tends to cause this body to deviate in pursuance of the rotary motion; while on the other hand, the friction of the air against the same body will tend to make it deviate in a direction opposed to the rotary motion. It is only in the case of the axis of rotation coinciding and being identical with the rectilinear direction of the spherical body, that the rotary motion will not occasion any deviation. This kind of rotation may be termed the normal rotary motion.

Thus, no irregular deviations of the projectile will arise so long as its rotary motion takes place round the tangent of the trajectory line described by its centre of gravity.

There are two ways of obviating all and every irregular deviation arising from this rotary motion of the projectile, viz.:—1st. Prevent the production of this motion. As the entire sphericity and smoothness of surface of the ball can never be relied upon, it remains but to suppress the percussion of the projectile against the interior of the barrel, which has been sought to be arrived at, without affecting the facility of loading, by the breech-loading system. 2nd. Compel the rotary motion to take place round the axis of the rectilinear motion. This is the direct object of rifled arms.

Historical data.—In the fire-arms first introduced, the drawback arising from the windage was sought to be obviated by loading with forced balls. The favourable influence of the grooves thus produced in the bore of the piece by long use soon became apparent, as they were found to facilitate the loading, and to secure the accuracy of fire.

About 1498, Kaspar Jollner, of Vienna, manufactured arms with straight grooves *i.e.* parallel to the axis of the piece. It was soon found that this improvement was insufficient, as the projectile, in emerging from the the barrel, was subject to the full power of the resistance of the atmosphere. Grooves slanting upon the axis of the piece were therefore substituted, it is supposed, by August Kotter, of Nuremberg (in 1500 to 1520.)

In France, the first rifled arms were tried under Louis XIV. for cavalry use. Their pattern was the Marshal of Saxe's *Amuzette;* but it was not till 1793 that the matter was earnestly taken in hand, when the *carabine de Versailles* was produced, loaded with forced ball and mallet. This trial, however, failed, and, in 1818, the studies were taken up anew for making a wall piece (*fusil de rempart*). Very oblique, helicoidal, and parobolic grooves were tried, the latter being thought preferable, as they allow of a progressive increase in the obliquity. As these grooves commenced in advance of the bullet, the latter, forcibly driven against them, was caused to assume only a portion of the rotary motion originally imparted to it.

In 1831, an improvement was taken up again, which had at first been pointed out by Mr. Delvigne, and was based upon the use of a breech with cylindrical chamber. This chamber, of smaller diameter than the bore, contained the charge, and was furnished with a projection with conical concavity, against which the spherical ball flattened itself by the force of the ramrod, so as to fill the grooves, and thus secure the forcing pressure. This ingenious contrivance did not, however, yield the expected result, as the ball was injured in its shape, and its centre of gravity being no longer within the axis of the piece, described a helix while travelling along the bore, and thus it emerged along the tangent of this helix, whence arose a new irregularity of motion. However, it was found that the accuracy of the Delvigne rifle was 3·2 as compared with the infantry musket.

(*To be continued.*)

* "Cours de tir. Etudes théorques et pratiques sur les armes portatives," par M. Cavelier de Cuverville, Lieutenant de Vaisseau Paris, Dumaine.

CORRESPONDENCE.

We cannot hold ourselves responsible for the opinions of our Correspondents.

LAKE'S DIFFERENTIAL ENGINE.

To the Editor of THE ARTIZAN.

Sir,—I observe that in Mr. Campin's reply to my letter in your last number, he objects to the calculations contained in my communication, on the score that they are only theoretical ones. I am quite aware that they are theoretical calculations, and I stated as much in the letter containing them: my object in introducing them being merely that they might be compared with the theoretical calculations of the power of Lake's engine contained in Mr. Campin's previous letter. Mr. Campin further states that if allowance be made for the "loss in steam passages, defective exhaust, friction in glands, slide valves, and eccentrics (existing in the ordinary engine but not in Lake's)" the advantages which I claim for the ordinary engine over Lake's will not be found to exist. I must, however, still retain my original opinion, and I shall be obliged if you will allow me space for explaining my reasons for doing so.

If for example, we take an ordinary high-pressure engine, having a cylinder of $9\frac{3}{4}$ in. diameter, or 74·7 sq. ins. area, working with steam of 75 lbs. total pressure cut off at ·2 feet of the stroke, the quantity of steam required for filling the cylinder for this portion of its length will be 179·28 cubic inches, and if we allow the further amount of 82·84 cubic inches for filling, clearance, and steam passages (it being remembered that these spaces remain filled with steam at atmospheric pressure at the end of the stroke) the total amount used for each stroke will be 241·92 cubic inches, or 483·84 cubic inches=·28 cubic feet for each revolution. This quantity is the same as that used by Mr. Campin's example. In order that this steam should expand five times, the piston would have to move through a further distance of 1·1 ft., making the total stroke 1·3ft., and the power developed would then be—

$$74{\cdot}7 \times {\cdot}2 \times 75 = 1120{\cdot}5 \text{ foot pounds}$$
$$74{\cdot}7 \times 1{\cdot}1 \times 45 = 3697{\cdot}6 \quad ,,$$

Gross power .... 4818·1 ,,

The back pressure, if the valves and exhaust passages are properly proportioned, should not average more than 4lbs.* above the atmosphere or a total resistance of 19lbs. per sq. inch. This would give $74{\cdot}7 \times 1{\cdot}3 \times 19 = 1815{\cdot}09$ foot pounds, which substracted from 4818·1 leaves 3003·01 foot pounds as the amount of work developed during one stroke or 6006 foot pounds for each revolution. It will therefore be seen that the amount of work done by this engine would, after all allowances have been made, still exceed that obtained from the differential engine even according to Mr. Campin's calculations. There are, however, some reductions to be made in these latter. In the first place the differential engine is not free from back pressure. Mr. Campin states, that during the down stroke the exhaust valve remains full open, I presume, however, that it is allowed to remain open during that portion of the stroke only which is performed before the opening of the port leading from the small to the large cylinder, as if otherwise, a great waste would ensue from the steam blowing through. As nearly as can be judged from the diagram

* I have in my possessign indicator diagrams taken from a high-pressure engine working at 120lbs. per square inch, in which the back pressure up to the commencement of the "cushioning" is less than $1\frac{1}{4}$lbs. per square inch.

accompanying Mr. Campin's first letter, the steam port would begin to uncover about ⅜ of an inch before the end of the down stroke, and for this distance, therefore, the steam would be admitted against the piston. If (allowing for the pressure of the atmosphere upon the top of the annular portion of the larger piston) we assume the average pressure against the piston during this portion of the stroke to be 50lb. per sq. inch, the total resistance during the down stroke would be

50 × 15 × ·94 = 705	foot pounds
200 × 50 × ·60 = 600	,,
Total resistance 1305	,,

instead of 750 foot pounds, as given by Mr. Campin, thus reducing the work developed in each revolution to 5545 foot pounds.

The above calculations refer to engines expanding the steam five times, that being the degree of expansion mentioned by Mr. Campin. Very few high-pressure stationary engines, however, are worked at that degree of expansion and if space allowed it would be easy to show that when a less degree (say 2½ or 3 times) is used, the comparison of the two engines is more in favour of the ordinary type. In the next place if the trunk is made of such a size that its capacity is equal to that of the small cylinder, the quantity of steam used will exceed ·28 cubic feet for each revolution as it will continue to flow into the lower part of cylinder during the up stroke until the port is closed by the piston, and if the port is ¾ in. wide ·08 cubic feet of steam would thus be admitted into Mr. Campin's engine at each stroke. I suppose, however, that Mr. Campin intends that the contents of trunk should be such that the quantity of steam admitted up to the closing of the port should be ·28 cubic feet.

Mr. Campin has not allowed for the loss of the steam which is required to fill the curved passages leading from the upper to the lower cylinder. This steam instead of giving out power during its expansion, as is the case with that filling the passages of an ordinary engine, escapes into the atmosphere as soon as the lower edge of the piston passes the lower port, and its quantity in the sample engine would be about ·03 cubic feet, or rather more than 10 per cent. of the whole steam used.

Next, as regards the comparative friction of the two engines. The piston friction is (the description of packing being the same) directly proportionate to the diameter of the piston multiplied by the length of the stroke, and, in the two examples, it will, therefore, be as 9·75 × 1·3 is to (8 + 16) × 1, or as 12·675 to 24. This excess of piston friction in Lake's engine will more than compensate for that arising from the use of glands in the ordinary engine. The total friction of the ordinary engine (independent of that due to the load) should not be more than equal to a resistance of 2½ lbs. per square inch of piston, and, in the example I have chosen, it would, therefore, not exceed 74·7 × 2·5 × 2·6 = 485·55 foot pounds for each revolution. If this amount be deducted from 8006 foot pounds, the remainder, 5521·45 foot pounds, would still be nearly equal to the *total* power of the differential engine quoted as an example, although, as shown above, this last would be using a larger quantity of steam.

The loss of heat by radiation from the cylinder should also be taken into consideration when comparing the two engines. In the ordinary engine this takes place from the exterior of the cylinder only, and it can be reduced to a very small amount by carefully clothing the cylinder with felt and wool. In the differential engine, in addition to a greatly-increased external surface, the interior of each cylinder is alternately exposed to the air, and, as no clothing can be applied to them, the loss of heat will be considerably in excess of that from the exterior surface.

Next, as to the mechanical arrangement of the differential engine. The exhaust valve is stated to be a self-acting one, and to be so arranged as to fall open when the pressure in the cylinder is reduced to 15 lbs per square inch. It is very doubtful if such a valve could be relied upon, as, if the pressure of steam in the boiler happened to exceed that necessary to produce a terminal pressure of 15lbs. in the cylinder, the valve would not open at all. To avoid this it would be necessary to arrange the valve to open at a greater pressure than 15lbs., and this would cause the total power developed by the engine to be less than that calculated by Mr. Campin. If, on the other hand, a tappet motion is introduced to work the valve, the valve gear becomes more complicated than in an ordinary engine, and the wear and noise when working at high speeds would be very objectionable. The connecting rods, crank shaft, &c., would have to be much stronger and heavier than for an ordinary engine of equal power, the maximum strain upon them being greater. The greatest strain upon the connecting rod of the high pressure engine which I have taken as an example, would be equal to 74·7 × 60 = 4,482lbs.; in Mr. Campin's engine, the strain at the commencement of the up stroke is 150 × 60 = 9,000lbs., or more than double. The two connecting rods used in his arrangement would also cost more for making, fitting, &c., than one of equal strength. I admit that the slide bars and crosshead are saved by the use of Mr. Campin's arrangement, but at the expense of increased wear in the cylinder and piston packing, resulting from the side pressure caused by the obliquity of the connecting rod having to be restrained by those parts. Another disadvantage of the differential engine is that there is nothing to determine in which direction motion shall take place. It is evident, from the construction of the engine, that when steam is turned on after the engine has been standing, the first stroke made must be a down stroke (unless the engine happens to have stopped very near to the end of the down stroke, so that the communicating port is uncovered) and the way in which the crank shaft would revolve would therefore depend entirely upon the position of the crank at the time of starting. In driving some machinery this would not only be inconvenient, but might be productive of considerable damage, if some arrangement was not introduced for preventing the rotation of the crank shaft in one direction.

I regret that this letter has extended to such a length and occupied so much of your valuable space, but the numerous points to be noticed have rendered it almost unavoidable.

I am, Sir, yours truly,

Stratford, May, 1865. W. H. MAW.

REVIEWS AND NOTICES OF NEW BOOKS.

Life, Times and Scientific Labours of Edward Somerset, Sixth Earl and Second Marquis of Worcester; to which is added a reprint of his "Century of Inventions," with a commentary thereon. By HENRY DIRCKS, Esq., C.E. London: Bernard Quaritch. 1865.

To the labours of Mr. Henry Dircks and his great quality of painstaking, we are indebted for one of the most interesting books of modern times. The man of science, no less than the lover of literary lore, is put under another debt of obligation to Mr. Dircks' whose *Perpetuum Mobile* and other books of like interest and involving similar laborious research, have tended so much to interest thousands of readers who previously were unable to appreciate the studies and labours of those bygone workers in practical science, who, by Mr. Dircks' literary ability, have been rescued from oblivion or placed before the reading and studying public in so agreeable a manner. This book will be read with the greatest possible interest.

The 650 pages, 8vo., of textual matter are printed on excellent paper in the clearest and best style of typography, and are illustrated with numerous excellent steel engravings and woodcuts, and bound most appropriately. Altogether the book is got up in a style highly creditable to Mr. Quaritch, the publisher, who, in that capacity at least, comes under our notice for the first time.

BOOKS RECEIVED.

"Book of Information for Railway Travellers and Railway Officials," illustrated with anecdotes. By R. BOND, Superintendent of Great Western Railway. Newport. Murray and Co., Paternoster-row. 1865.

"Oxygen Water—What is It? What is it good for?" London: The Oxygenated Water Company (Limited.) 1865.

"The Royal Naval Engineers." A discussion as to the pay, position, and prospects of the Engineers of the Royal Navy, in a series of letters between two brothers. 1865.

"On the Wear and Tear of Steam Boilers." By A. PAGET, Esq., C.E. Reprint of a paper read before the Society of Arts. London: W. Trounce, Cursitor street, Chancery-lane. 1865.

"The Alternating System." A brief account of Mr. Bardwell's improved method of utilizing sewage and urine, and for facilitating their passage through pipes to prevent the pollution of rivers and streams. London: Great Queen-street, Westminster. 1865.

[P.S.—In our notice, in THE ARTIZAN of April, of the work by Mr. Holland, "The Office and Cabin Companion, &c.," we omitted to state that the book is published by Messrs. Atchley and Co., Great Russell-street, London.]

NOTICES TO CORRESPONDENTS.

SUBSCRIBER.—The *usual* name for the curve of which you are speaking *is* an "interior epicycloid;" but this designation is evidently paradoxical, considering that ἐπικύκλοις means a curve described *above* a circle. A more appropriate expression for the curve generated by a circle revolving inside the periphery of another is *hypocycloid* (ὑποκύκλοις in Greek) a designation generally used by continental mathematicians.

J. W. N. (Philadelphia).—We have received the particulars advised, and purpose giving them in our next issue.

MINING STUDENT (South Hetten).—1. We sent you per post printed particulars, giving you the information sufficient, we presume, for your guidance. 2. The work referred to is, we are informed, likely to appear in the course of a few months.

BRIDGING THE FORTH.

One of the grandest engineering projects of the session has recently been under consideration—it is the scheme for crossing the Frith of Forth by a high level bridge a little above Queensferry. This undertaking is the main portion of a scheme for a railway communication between Dumfermline on the north, and the Edinburgh and Glasgow Railway, at a short distance from Linlithgow, on the south. The present session has been prolific in grand projects. There is, for instance, Mr. Fowler's viaduct across the Severn at Oldbury Sands, which stands at the head of the list, inasmuch as it would be the longest bridge in the world. The Severn bridge is 4,131 yards in length, although the entire length is not, we believe, over the high water mark. Its principal opening for the navigation is 600ft. span and 95ft. high. Next in order certainly, if not abreast of Mr. Fowler's scheme, of all the viaducts and bridges, either constructed or projected, is that of Mr. Bouch, for crossing the Frith of Forth by a viaduct upwards of two miles long. The four openings for the navigation are each 500ft. wide and 125ft. high. The viaduct consists, in addition, of nineteen openings of 100ft., ten of 150ft., ten of 175ft., and seventeen of 200ft. The piers are intended to be of stone to above high water mark, and the upper portion of open ironwork. Of the immense "illustrations" that cover the walls of the committee rooms there are few that attract the eye by their artistic excellence; but we have an exception in this case. The promoters of the great Forth viaduct are wise in their generation in having engaged some Clarkson Stansfield to prepare a very large and really clever water colour drawing of the principal portion of the proposed viaduct. The fine hazy distance, the clever handling of sea and sky, the spirited and varied craft, the showery effect in one portion of the picture, the grandeur with which the viaduct is invested, and the distinct relief in which it stands out, all combine to form a very effective picture upon which the eye rests with pleasure. Even the acute Mr. Hassard instinctively turned his eye to it, as the evidence of seafaring witnesses was given against the scheme, on the ground of its threatening a dangerous obstruction to the navigation. The artist has, of course, taken care that in the picture all is plain sailing. The estimate for the viaduct is £560,000. Another fine work of a like character, a high level bridge over the next northern Frith—the Tay—has been withdrawn by the promoters, the estimate, £180,000, having been found insufficient. This work had two openings for navigation, in separate portions of the viaduct, each of 300ft. span, the one 100ft. and the other 70ft. high, with seventy-nine other openings of various widths, the total length being about one and three-quarter miles.

PRICES CURRENT OF THE LONDON METAL MARKET.

	April 29.			May 6.			May 13.			May 20.			May 27.		
COPPER.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
Best, selected, per ton ...	93	0	0	93	0	0	92	0	0	92	0	0	92	0	0
Tough cake, do.	90	0	0	90	0	0	91	0	0	91	0	0	91	0	0
Copper wire, per lb.	0	1	0	0	1	0	0	1	0¼	0	1	0¼	0	1	0
„ tubes, do.	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1
Sheathing, per ton	95	0	0	95	10	0	95	0	0	95	0	0	93	0	0
Bottoms, do.	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0
IRON.															
Bars, Welsh, in London, per ton	7	7	6	7	7	6	7	12	6	7	12	6	7	12	6
Nail rods, do.	8	10	0	8	10	0	8	10	0	8	10	0	8	10	0
„ Stafford in London, do.	8	15	0	8	15	0	8	15	0	8	15	0	8	15	0
Bars, do.	8	15	0	8	15	0	8	15	0	8	15	0	8	15	0
Hoops, do.	9	15	0	9	15	0	9	15	0	9	15	0	9	15	0
Sheets, single, do.	10	7	6	10	7	6	10	7	6	10	7	6	10	7	6
Pig, No. 1, in Wales, do. ...	4	10	0	4	10	0	4	10	0	4	10	0	4	10	0
„ in Clyde, do. ...	2	15	0	2	15	6	2	14	6	2	14	3	2	14	3
LEAD.															
English pig, ord. soft, per ton	20	0	0	20	0	0	20	0	0	19	15	0	19	15	0
„ sheet, do. ...	20	10	0	20	10	0	20	5	0	20	5	0	20	5	0
„ red lead, do. ...	22	0	0	22	0	0	22	0	0	22	0	0	22	0	0
„ white, do. ...	26	0	0	26	0	0	26	0	0	26	0	0	26	0	0
Spanish, do.	19	0	0	19	5	0	19	0	0	19	0	0	19	0	0
BRASS.															
Sheets, per lb.	0	0	9½	0	0	9½	0	0	9½	0	0	9½	0	0	9½
Wire, do.	0	0	9	0	0	9	0	0	9	0	0	9	0	0	9
Tubes, do.	0	0	9¾	0	0	9¾	0	0	9¾	0	0	9¾	0	0	9¾
FOREIGN STEEL.															
Swedish, in kegs (rolled) ...	15	10	0	15	10	0	15	10	0	13	5	0	13	5	0
„ (hammered)	16	0	0	16	0	0	16	0	0	14	15	0	14	15	0
English, Spring	18	0	0	18	0	0	18	0	0	18	0	0	18	0	0
Bessemer's Engineers' Tool	44	0	0	44	0	0	44	0	0	44	0	0	44	0	0
TIN PLATES.															
IC Charcoal, 1st qu., per box	1	9	0	1	8	0	1	8	0	1	8	0	1	8	0
IX „ „ „	1	15	0	1	14	0	1	14	0	1	14	0	1	14	0
IC „ 2nd qua., „	1	7	0	1	6	6	1	6	6	1	6	6	1	6	6
IC Coke, per box	1	3	6	1	2	6	1	2	6	1	2	6	1	2	6
IX „ „	1	9	6	1	8	6	1	8	6	1	8	6	1	8	0

RECENT LEGAL DECISIONS

AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

Under this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least—less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

The North Stafford Steel, Iron, and Coal Company (Burslem) (Limited) *v.* Lord Camoys.—Mr. Glasse and Mr. W. W. Mackeson moved in this case to restrain the defendant and his agents from entering upon or taking possession of certain premises comprised in a mining lease, dated 1863, with reference to a mine of coal, iron, ironstone, &c., at Burslem; and from preventing the plaintiffs' completion of the works. It appeared that Lord Camoys granted this lease to one Martin, who assigned it to the company, and this instrument contained the following covenants, upon which, with reference to what had taken place, the case mainly turned. The lessee covenanted with all convenient speed after the commencement of the lease to commence and prosecute the working—faults, accidents by fire, &c., excepted; and to raise the minerals in the most advantageous manner, and within one year erect on a suitable spot, to be fixed and approved by the lessor's agent, a steam engine to work the mines; and within a like period to sink two shafts of 11ft. diameter; and within twenty years to complete the shafts to the depth of the chalky mine. And there was a proviso that on breach of these covenants the lessor should have a right to enter for forfeiture. It appeared that the plaintiffs commenced the works and sunk the shafts, but had not proceeded far when they were stopped by the water, and sunk other shafts elsewhere, and erected a steam engine to sink those pits; but never got the approval of Lord Camoys' agent, to such proceedings, he having selected and approved the original site for the engine and shafts under the lease. Under these circumstances this bill was filed, and motion made. His Honour was of opinion that the second set of shafts were no substitution for the former; that the fact that the lesees might sink shafts where they pleased did not dispense with the obligation to erect an engine on the original spot fixed by Mr. Bute, and that there had been no abandonment by Lord Camoys of his right to enter. Whatever doubt there might formerly have been, it was now well settled that if parties chose to make a bargain the Court had no right to say they should not. If it was a matter to be compensated by money the Court would not interfere except on special equitable grounds, such as acquiesence, accident, mistake, or surprise; but here there were none such to prevent Lord Camoys exercising his legal right. There had been a clear forfeiture by violation of the covenant, and this motion must be refused with costs.

Reserving "Minerals" on Sold Land.—In a case, Bell *v.* Wilson, Vice-Chancellor Kindersley, the question was the construction of a reservation or exception contained in a deed of conveyance of lands in Northumberland, at a place called Long Benton, dated in 1801. The bill was filed by the owner of the land to restrain the defendant from digging freestone, the plaintiff representing the purchaser, and the defendant the vendor. The reservation, as far as was material, was in these words:—"All mines and seams of coal, and other mines, metals, or minerals." Freestone was commonly found in the district, at distances varying from 6ft. to 20ft. below the surface. After hearing the parties, the Vice-Chancellor said there was great difficulty in determining what the term "royalty" meant, but the strong probability was that in this particular locality it was understood to apply to "mines and minerals." As to the exception, the word "mineral," in its largest sense, applied to every production constituting the earth's crust, even including the mould on which the vesture grew; but it was hardly possible to conceive that a vendor having sold land to a purchaser could reserve the right to that which formed, in fact, the whole subject matter; and it must, therefore, have some more limited meaning. The etymology of the word mineral was, that which was dug from a mine; but there was a clear distinction between a mine and a quarry. The words used did not include freestone—"mines" being the governing word; and inasmuch as it never could have been the intention that, having sold the soil, the vendor should have a right to come and break up the ground at any time and to any extent, the plaintiff was entitled to a decree for an injunction, for damages, and an account, with costs.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

On Food and Work.—At the Royal Institution, after the Easter recess, Professor Lyon Playfair delivered a lecture "On the Food of Man in relation to his useful Work." In his treatment of the subject he considered almost entirely nitrogenous food, or that kind which produces flesh, on which he remarked the power to do work depends; and consisting of the lean part of flesh, of corn, beans, and peas; such food as fat and potatoes only tending to keep up the animal heat. The amount of work which a man could do in a day had been estimated to be equal to a force that, if properly applied, would raise the weight of his own body one mile—the standard weight of a man being assumed to be 150lb. To enable him to do that amount of work, be should eat 4½ ounces of nitrogenous food, in addition to food that produced only heat. A horse could do eight times as much as a man, but it eats rather more than eight times the quantity of nitrogenous food in beans and corn. The lecturer alluded to the dynamical theory of heat, according to which heat and mechanical power may be converted into each other; but he did not explain why that theory does not apply to heat-producing food, such as fat and potatoes, which ought, he supposed, to have its dynamical effect. He mentioned, indeed, that the heat-producing food might probably contribute something towards the work done, but he considered it to be an insignificant portion, if any, and that the useful work of man is produced almost entirely by nitrogenous food.

Machinery for Driving Drifts or Galleries through Stone or Rock.—F. E. B. Beaumont, the patentee of this invention, employs a series of chisels or jumpers worked so as to produce a continuous chase or groove, not a number of holes. The chisels or jumpers act to cut the stone or rock by striking it with blows, which are rapidly and continually repeated, and they are made to cut a continuous chase or groove by causing them each to take short steps forward in the intervals between the blows. He prefers to employ a strong disc with the chisels or jumpers fixed around its periphery at equal distances apart; this disc is mounted on a strong axis, which is carried in bearings on a base plate or carriage in such manner as to be able to slide longitudinally, and also to rotate. The longitudinal sliding motion is conveniently given to the axis by a cylinder and piston worked by compressed air, or by water, and in this manner the disc (with its chisels or jumpers) is made to move to and from the face of the stone or rock in which the chase or groove is to be cut, and the chisels or jumpers strike the stone or rock at each stroke. It is convenient to make the cylinder itself the axis of the disc, and to work it in conjunction with a stationary piston fixed to the frame. The slow rotary motion is given to the disc and enters in any convenient manner; it may be by having a groove on the axis, into which there enters a stud capable of being slowly traversed around the centre of motion.

Street Paving in Liverpool.—At a recent meeting of the local health committee, Mr. Robertson Gladstone waited on the committee as to the use of Penmaenmawr stone for the paving, crossings, and channels of the streets of that borough. Mr. Newlands urged, as he understood, that the economy in price and the extra durability of the material were arguments in favour of its use. Now, against that, he would set the danger of the Penmaenmawr stone, whether as employed in the shape of square sets or macadam. In other towns not paved with Penmaenmawr stones, accidents were far less frequent than in Liverpool. A number of stones, taken from various parts of the town, were produced, with the view of showing the effect of the traffic over them during the past few years. Mr. Newlands said his experience was that, during the last fifteen years, since they had used the square sets, the accidents had been as one to five on what they formerly were. In the Strand in London he had seen as many as twenty accidents a day; and in Glasgow, where they used granite, he never passed through Argyle-street without seeing a horse come down.

Petroleum Stove.—Mr. C. H. Richman, of New York, has invented a simple and portable stove, in which coal may be economically used as a fuel. Coal oil, as is well known, generates, in a lamp burnt for illuminating purposes, a great amount of heat, and where a draught chimney is used a greater amount of heat is evolved or radiated from the lamp than when an open or no chimney burner has been used, in consequence of a more perfect combustion being obtained with the chimney burner. This invention consists in using with a coal oil lamp, of any suitable construction, a draught chimney, and a draw arranged in such a manner that the heat evolved or radiated from the lamp may be advantageously employed for cooking or culinary purposes. It consists further in applying to the chimney a door and a glass, by which the lamp may be lighted and the flame regulated, without removing the chimney from the lamp.

Our Coal Exports.—The exports of coal to France keep up very well this year, having amounted, in the first quarter, to 361,481 tons, as compared with 365,839 tons in 1864, and 314,029 tons in 1863 (corresponding periods). It will be observed that last year's total has not been quite maintained, but in March the exports to France amounted to 122,106 tons, as compared with 120,959 tons in March, 1864, and 117,138 tons in March, 1863. It is satisfactory to notice that our exports of coal to Prussia have sensibly revived, having amounted to 69,141 tons in the first quarter of this year, as compared with 19,398 tons in 1864, and 74,074 tons in 1863 (corresponding periods). Last year the Prussians were going to dispense with British coal, and resort to Westphalian combustible; it does not appear, however, that they are exactly able to do so. On the other hand, the exports to Russia, Sweden, Denmark, Italy, and the United States have been declining this year, the falling off in the latter direction being rather marked, although the United States never took a very large quantity of our coal. The general result is, that we export 1,843,552 tons, of the estimated value of £904,778 to March 31 this year; as compared with 1,889,678 tons, of the estimated value of £903,023, in the corresponding period of 1864; and 1,680,763 tons, of the estimated value of £765,536, in the corresponding period of 1863. Although the quantity exported shows a certain reduction this year, the value presents a small increase.

High Speed Compressed Air Hammer.—Mr. W. D. Grimshaw, of Birmingham, recently read a paper at the Institution of Mechanical Engineers, descriptive of a High speed compressed air hammer, for planishing, stamping, &c., the objects of which are to obtain a self-acting hammer with a great range in the force and rapidity of the blows, so as to be suitable for light forging, tilting, and planishing; or capable of being worked by hand with heavy blows for stamping, when required; and arranged to be driven by a belt from a shaft, in order to be applicable when direct steam power is not available. The air is compressed by a force pump worked by a crank pin on the driving pulley, and is delivered into the interior of the hammer frame, which forms the reservoir. The working cylinder and piston with hammer are arranged as in an ordinary steam hammer, but driven by the compressed air, which is admitted above and below the piston alternately by a slide valve, the pressure of the valve being regulated by a throttle valve worked by a foot treadle. The slide valve is worked by a crank pin on a horizontal disc wheel, which is driven by friction by contact with a vertical wheel upon the driving pulley shaft of the hammer; this vertical wheel slides upon a feather on the shaft, and is moved by a hand lever nearer to the centre of the horizontal disc, or further from it, thereby altering the speed of working the slide valve, and giving the means of increasing the number of blows of the hammer without stopping it, up to more than double the rate of revolution of the main driving pulley. By means of a handle the slide valve spindle is readily disconnected while at work from the disc that works it; and the valve is worked by a hand lever whenever it is required to use the hammer for stamping. The force, rapidity, and quality of the blow given by the hammer can be changed with great promptness and accuracy; and the hammer is found very advantageous in many situations, such as where there would be a loss of power by condensation in bringing steam from a great distance, or where the damp from leakage of steam or the dropping of condensed water on the anvil would be objectionable, as in planishing bright work. A working model of the hammer was exhibited, and shown in action.

Compressing Air and Gases.—An improved apparatus, by means of which atmospheric air or gases may be compressed in volume to a far greater degree than has yet been accomplished by other means, such highly compressed air or gas being applicable to various useful purposes, has been provisionally specified by Mr. T. Coughlin, of Bermondsey. He proposes a succession of pumps and receivers, the first pump receiving a supply of air from the atmosphere, and forcing the same into a receiver, whence it is conveyed to a second pump, already compressed; the second pump is then brought to bear upon the compressed air, which is then forced into a second receiver, and so on to a third or further series, and ultimately into a chamber or receiver of any kind or form, according to the purpose for which it is required. He proposes to make the diameter of the first pump larger than the second, and the second larger than the third, in order to compensate, as far as possible, the power required to actuate each, according as the air or gases are more and more highly compressed in each. The pumps are to be set on a suitable foundation, above which, on standards, a shaft and fly-wheel are supported, to be turned by hand or steam power; on the shaft an eccentric or crank is keyed, in order to work the plunger of the first pump. The shaft is also provided with a cog wheel or pinion, on each side of which is a shaft and toothed wheel gearing with the central pinion, in order to actuate by similar eccentrics the other two plungers of the pumps. If more pumps are required they may be connected by similar gearing. The toothed wheel actuating the third pump should have a greater number of teeth than the second, in order that it may travel at a slower rate to operate upon the densely compressed atmosphere or gas; underneath, or at the side of each pump, is its receiver, connected by suitable tubes and valves, the whole series of pumps and receivers being thus in communication.

Clavel's Lamp-glass Holders.—The specification of this patent, consists in constructing the sockets, holders, or supports for gas and lamp-glasses, or chimneys, adjustable as to size, or extensible and contractible, so that one holder will serve for various sizes of glass or chimney. This is effected by forming the socket or holder with slots, and tightening or loosening it, so as to vary it diameter, either by a conical outer ring, or by on incomplete ring or cylinder, with a break or opening in it, fitted with a screw; or the holder itself may be of the form of an incomplete ring or interrupted cylinder, opened and closed, or tightened or loosened, by a screw. The improvement may be applied to the rings or lower parts of frames or supports fitted round chimneys or glasses of lamps or burners to receive shades or reflectors.

At the Academy of Sciences, M. Collignon read a paper on a method of representing the surface of the earth on a plane, by making one of the poles the common centre of a series of circles representing the geographical parallels. By this system of projection, the deformations of the angles and changes of length may be easily ascertained, and thus, by easy rules and tables, constructed by the author, the real dimensions may be easily determined at each point of the map.—Mr. Reboul sent in a paper on a new carburet of hydrogen, which he calls *valylène*, and which is composed of ten equivalents of carbon and six of hydrogen. It is obtained by distillation from the bromide of valerylène, treated with an alcoholic solution of potash. The new substance only distils from the latter at a temperature of from 40° to 50° centigrade.

Respiratory Apparatus.—A series of experiments was recently made in Paris, with an apparatus, invented by M. Galibert, to enable a man to breathe in the midst of deleterious emanations. A quantity of flour of sulphur was set fire to in a cellar, and a sufficient quantity of sulphurous acid being thus evolved, a fireman, who had never used M. Galibert's apparatus, which is a combination of air tubes communicating with a sort of knapsack, filled with compressed air, entered the cellar, and stayed twelve minutes in it, witout experiencing any injurious effects. His nostrils during the time were strongly compressed by a sort of spring, and his eyes protected by a pair of spectacles made for the purpose. The man did not leave the cellar until called by his colonel. The cellar was then filled with a dense and acrid smoke, and another went in with the same success. At length Colonel Willerme himself put on the apparatus, and stayed a considerable time in that atmosphere of suffocating vapours of every description, and convinced himself by his own experience that a man could breathe as freely with the apparatus as if he were in the open air. Similar experiments have been performed at Versailles, and lately in one of the cellars of the Société d'Encouragement. When the air in the reservoir has become foul by the action of breathing, fresh air may be introduced; the knapsack, which is of metal, has a tin bottom, but the lid consists of a skin or leather bag. To drive out the foul air this leather bag has only to be pressed down, and to fill the space with fresh air this the bag is pulled up again. To fill a larger space, like that of a goatskin, with air, M. Galibert uses a pair of bellows, a slower process, but better adapted to the size of the recipient.

How to clean Quicksilver.—There are few things which cause more trouble in saving gold than the impurities which often exist in the quicksilver used for amalgamating. These impurities often consist of lead, sometimes of some greasy substance, and of copper and other metals held in metallic or mineral form. To separate these impurities from the quicksilver has by many been found a difficult matter. We are assured that the cleaning or separating may be readily accomplished by retorting, but in doing so the mercury in the retort should be covered an inch deep with pulverised charcoal, which at once absorbs all the impurities, and leaves the mercury clean. This method is extensively practised in some of our mining countries, and is said never to fail in its results. We recommend it to our miners.

Gellerat's Steam Rolling and Portable Engines.—This invention consists of an apparatus, mounted on axles which carry rollers, acting both as propelling and bearing wheels or rollers, and which can be caused to converge or move out of the parallel, in order to turn the engine to either side. Motion is communicated to them by a train of toothed wheels driving a chain-wheel, mounted on the axle-box, and transmitting rotary motion to the bearing wheels or rollers by a crank arm or short connecting rod jointed to a radial arm of such wheel or roller. The axles are not fixtures, but are suspended in brackets, fitted with friction rollers, and they are moved by a double-threaded worm, or right and left handed screw, which takes into nuts, and is worked by handle and bevel gear.

Masters and Operatives.—Lord St. Leonard's Bill has been printed. It proposes that any number of masters and workmen in any trade or trades, having been for the previous six months inhabitant householders, or part occupiers in the place (the masters having carried on their trade for the six months, and the workmen having worked at their trade for the seven previous years) may at a meeting agree to form a council of conciliation and arbitration; and, after due notice in a local newspaper, a licence may be granted by the Crown for the formation of such a council. The council is to consist of masters and workmen, not less than two nor more than ten of each, and a chairman unconnected with trade, the chairman to be elected by the council. The council are to be elected annually by masters and workmen qualified as above described, the masters appointing their portion of the council and the workmen theirs; and a register of electors is to be formed and kept by the clerk of the council. The council are to have power to hear and determine all disputes and differences between masters and workmen, as set forth in the Act of 5 George IV., cap. 96, which may be submitted to them by both parties, the award to be final and conclusive; and the council may adjudicate upon any other disputes submitted to them by mutual consent of masters and workmen. But nothing in this Bill is to authorise the council to establish a rate of wages, or price of labour or workmanship at which the workmen shall in future be paid; and no member of the council is to adjudicate in any case which he, or any relative of his, is plaintiff or defendant. Disputes are to be first referred to a committee of the council, the committee of conciliation, consisting of one master and one workman, who are to endeavour to reconcile the parties; if they are unsuccessful in this, the dispute is to go before the council, a quorum to consist of nor less than one master and one workman with the chairman. No counsel or attorneys are to be allowed to attend any hearing.

New Caloric Engine.—A caloric engine, which possesses some peculiarities, has been recently invented in Germany. Its principle consists in pumping atmospheric air into an air-tight furnace, for the support of the fuel which is introduced previously, and must be from time to time renewed. The combustion is effected within a fireplace of refractory clay, surrounded at some little distance by the closed cylinder which constitutes the furnace. The atmospheric air keeps the fuel in a state of such intense ignition that at a pressure of four atmospheres it will fuse wrought iron, and will change cast into malleable iron; it is at the same time greatly expanded by the high temperature. The gaseous products of combustion, mingled with a small quantity of steam—introduced chiefly with the object of lubricating the pistons—move two pistons of peculiar construction. After doing its work, the heated air passes into the atmosphere perfectly free from smell. There is a great tendency in this engine to acquire a very high velocity, since the combustion augments in intensity in proportion to its speed.

English Commission for the Universal Exhibition in France.—Her Majesty has nominated a commission to act for England in connection with the French Universal Exhibition. The Prince of Wales is president. Lord Granville, several peers, and gentlemen, with the presidents of artistic and commercial bodies, are appointed. Mr. Henry Cole will act as secretary.

A Feat in Casting.—At the meeting of the Polytechnic Association of the American Institute, on March 30, Mr. Norman Wiard described a novel method adopted by him for casting an iron tunnel. When the preparations for casting his great gun were nearly completed a need was discovered for a broad flat tunnel some 10ft. in diameter. Not having conveniences at hand for making it of boiler plate, it was necessary to cast it, and as there was not time to make a pattern he determined to cast it flat, and attempt to shrink it into dish form as it cooled. He swept an open mold and filled it with molten iron. The centre was first cooled, and as the edges began to harden, levers were placed under opposite sides, and weights were hung upon their ends, tending to pry up the edges while the centre was held down. Thus the rim was started up a very little, and then as it cooled and shrunk around the previously hardened centre it arose 10in., giving this depth of dish to the tunnel.

The Railways and the Post.—The amount required for payment to railway companies in England and Wales for the conveyance of mails is estimated at £406,939 for 1865-6, as compared with £405,566 in 1864-5; in Ireland £83,213, as compared with £86,833 in 1864-5; and in Scotland, £80,784, as compared with £81,837 in 1864-5. The following companies will receive more than £5,000 each this year for postal services rendered by them:—Bristol and Exeter, £9,875; Chester and Holyhead (merged in London and North Western), £30,200; Cornwall, £5,500; Great Eastern, £21,357; Great Northern, £9,785; Great Western, £50,371; Lancaster and Carlisle, £18,206; Lancashire and Yorkshire, £6,900; London and North-Western, £82,426; London and South-Western, £21,650; Midland, £44,000; North-Eastern, £41,359; South Devon, £7,485; South-Eastern, £23,657; Dublin and Belfast Junction, £5,917; Great Southern and Western, £29,500; Midland Great Western, £15,208; Caledonian, £28,562; Inverness and Aberdeen Junction, £10,404; North British, £6,085; Scottish Central, £10,332; and Edinburgh and Glasgow and Scottish North-Eastern, £16,820. It is clear that the postal business of the country could not now be carried on without the powerful appliances which railways bring to bear upon it.

England and Wales in 1831 and 1864.—It seems from a Parliamentary return just issued that the number of registered Parliamentary electors in England and Wales in 1832 was 285,077; in 1864 it was 491,229, being an increase of 72·3 per cent. The percentage of registered Parliamentary electors in boroughs to the population in boroughs has decreased within the same period 0·1 per cent. The total amount expended for the relief of the poor in 1831 was £6,798,889; in 1863 it was £6,527,036, or a decrease of 4·0 per cent. The number of persons committed for trial in 1831 was 19,647; last year it was 19,506. The number of letters delivered by the Post-office in 1839 was 59,983,000; last year the number was 560,321,000, or an increase of 834 per cent. The amount of deposits in general savings banks increased from £12,677,163 in 1831 to £34,650,298 last year; and in addition £4,687,891 was last year placed in the Post-office savings banks. 74 miles of railway were opened for traffic in 1831, and 8,568 miles in 1863. The amount of paid-up capital of railways in 1831 was £1,286,700; in 1863 the amount was £322,237,978. The total value of imports has increased 249·96 per cent., and of exports 377·45 per cent. The quantity of tea consumed in the United Kingdom has increased 195·36 per cent., and of coffee 38·5 per cent. Raw sugar has increased 119·26 per cent.; wine, 83·48 per cent.; and malt, 32 per cent.

Factory Chimneys.—Mr. Peter Carmichael has recorded a series of experiments for ascertaining the best size for factory chimneys, in a paper read at a recent meeting of the Institution of Engineers of Scotland. He observes that the importance of an effective chimney need only be named. On it depends, in a great measure, the success of the firing, so as to raise steam quickly and keep it up steadily, and also the perfect combustion of the fuel with the least amount of smoke. With a draught in the chimney less than 5-10ths on the pressure-gauge, the firing of the furnaces will, in most cases, be a constant toil to the fireman. He cannot avoid making a large quantity of black smoke, and in cases of an extra demand for steam it is impossible to meet it, for no stirring or coaxing of a fire will make it burn brightly, or produce the red glow which is the perfect condition for raising steam, without a full command of draught. His experience is that most factory chimneys are too large for the work they have to do; not too high (they can hardly be that), but too wide, especially at the top. In their practice, invariably as more boilers and furnaces have been added to a chimney the draught has been improved, and it is obvious that if the opening in the chimney be too large compared with the whole of the openings in the dampers passing into it, the draught will be reduced. Hence it is very noticeable in many chimneys, which are large in proportion to the number of furnaces they serve, or the coals consumed, or where a new chimney is put up to serve for prospective additional furnaces, the smoke issuing from such has a very lazy ascent, and they are generally blackened a long way down from the top by the smoke; for when a breeze is blowing, the smoke, instead of ascending, falls downs the leeward side of the chimney, and clings to it like a ragged black flag. From observations, frequently repeated and tried under various circumstances, it has been found that the temperature is nearly uniform at 600° behind the dampers. He builds his chimneys in the form of an obelisk. The taper top is found to answer the purpose well, the smoke ascending from it very freely, especially when there is a breeze of wind. At such times the ordinary top is acted on like a key when blown into to make it whistle, the blast of wind affecting very perceptibly the draught of the furnaces. In the taper top this is not much felt, as the wind can only blow into one or two of the four compartments at a time, and this still allows the other two to vent freely. The greatest want of draught is occasionally on Monday mornings, after a cold wet Sunday. In such cases the flues and chimney are cooled down, and the draught greatly reduced, so that the firemen have much difficulty in getting the fire to burn brightly, and keep up the supply of steam.

NAVAL ENGINEERING.

Iron Plates.—According to the *Giornale della Marina*, the Italian Government has caused a competitive trial upon iron plates to be performed at Genova. Some of these plates had been supplied by Mr. Petin-Gaudet, others by the Marelle, and others by the Millwall Iron Works. The most favourable result was exhibited by the last-named plates; they did not show the least fraction, after having been fired at with 80-pounders and a charge of 14lbs. of powder, at a distance of 40ft.

The Brazilian Iron-clad Corvette "Don Pedro II." was launched lately from the ship-yard of the Forges et Chantiers de la Seyne. Her chief dimensions are—length, 223ft.; beam, 33ft. 3in.; depth, 16ft. 5in.; displacement, 1,410 tons; nominal power, 250 horse-power; speed, 10½ knots; thickness of armour-plate, 4½in.; her artillery consists of four steel 72-pounders and four iron 68-pounders.

The "Hercules," Iron-clad.—The Lords of the Admiralty have decided on adopting the turret in connection with the broadside principle in the iron-plated frigate *Hercules*, the order for the commencement of which has been received at Chatham. The vessel is to be built from the designs of Mr. E. J. Reed. The plan decided upon is a central armour-plated battery for the broadside 300-pounder and other guns, as in the *Bellerophon*, just completed at Chatham, the *Pallas* at Woolwich, and others of Mr. Reed's ships, together with two turrets carried one aft and the other forward. The drawings and moulds for the *Hercules* are now being prepared, and no time will be lost before she is commenced.

The Turret-ship question recently entered upon a new phase in the assembling of a commission of naval officers to inspect and report upon, for the information of the Lords of the Admiralty, a set of drawings for a seagoing turret vessel that have been prepared by the chief draughtsman of Portsmouth Dockyard. The duties of the commission were to report upon the "stowage," "accommodation for officers and crew," "rig," "armament," and other essential points in the designs for the ship. In fixing upon the size of the ship, both Capt. Coles and the Admiralty appear to have selected Mr. Reed's *Pallas* as the comparative ship, and to have assimilated her general dimensions as nearly as possible to the lines of the turret-ship, the dimensions and character of both being as follows:—

	"Pallas."		Turret-ship.
	Ft. in.		Ft. in.
Length between perpendiculars	225 0	......	225 0
Ditto, keel for tonnage	187 0	......	187 8⅝
Extreme breadth	50 0	......	49 0
Ditto, for tonnage...............	48 9	......	48 10
Ditto, moulded	48 1	......	48 1
Depth in hold	16 5	......	20 2
Draught of water	24 3	......	22 6
Burden in tons (builders' measurement) ...	2,372	......	2,409
Thickness of armour	0 4½	......	0 6
Weight of broadsides...............	Four 100-prs. Two 100-prs. =310lb.		Two 600-prs. = 1,200lb.

The *Pallas* carries her guns in a central square armoured tower. The turret-ship is designed to carry her two guns in one turret, the base of the turret being protected by a square armoured box. Both vessels carry an armour belt at the water line, the *Pallas* completely round, but that of the turret-ship to terminate at 25ft. abaft her stem, but running round her stern and protecting her rudder head. At the termination of the belt line, 25ft. from her stem, a 'thwart ship armoured bulkhead will be run across and connect the ends of the belt forward, while at the same time the ship's bows, where there is no belt, will be so subdivided and interlaced that no shot passing through can inflict any serious injury. In fact, they will be much safer without armour at all than if coated with thin plating, such as it is now the custom to plate the bows of our ironclads with. The armour-plating and its backing of the turret-ship are designed to be of equal strength to those of the *Bellerophon*, and her deck will have an underlie of 1in. iron, in lieu of the usual ⅝in. plating beneath her wooden planking. The turret-ship is to be propelled by engines of 600 horse-power—the same power as those of the *Pallas*—and her estimated speed is 13·8 knots. It is not quite certain what rate of estimated speed is given to the *Pallas*. 2,409 tons appears but a small tonnage for a seagoing turret-ship, and it is stated a vessel of one-half more tonnage, with a proportionate increase in her engine power, would carry two turrets, each with two 600-pounder guns, and would attain a speed of 14·3 knots.

Naval Appointments.—The following appointments have taken place since our last:—J. Rollinson, Chief Engineer, to the *Terrible*; W. Lewis, Chief Engineer, to the *Sphinx*; L. Moreton, Engineer to the *Indus*, for the *Clinker*; J. Marsh, Engineer, to the *Terrible*; E. Newman, Engineer, to the *Sphinx*; T. Rose, of the *Gladiator*, promoted to be Engineer; J. T. Robinson, First-class Assist.-Engineer, to the *Terrible*; J. B. Gibson and J. Banuatyne, First-class Assist.-Engineers, to the *Sphinx*; W. M'Intyre and R. Pearce, Second-class Assist.-Engineers, to the *Terrible*; J. Cameron, Second-class Assist.-Engineer, to the *Sphinx*; G. Sullivan, First-class Assist.-Engineer, to the *Cumberland*; F. J. Baron, Acting Second-class Assist.-Engineer, additional, to the *Serpent*; R. S. Lee and G. Fordham, promoted to First-class Assist.-Engineers; J. T. Obrec, Chief Engineer, to the *Cumberland*, for the *Tartar*; W. H. Nicholson, First-class Assist.-Engineer, additional, to the *Caledonia*; G. Ball, Acting Second-class Assist.-Engineer, to the *Caledonia*; J. Darroch, to be Second-class Assist.-Engineer; C. Ford, First-class Assist.-Engineer, additional, to the *Terrible*; J. Shore, Second-class Assist.-Engineer, to the *Terrible*; J. M'Graw, Second-class Assist.-Engineer, to the *St. George*; J. Morris, Chief Engineer, to the *Scout*; R. Taplin, Engineer to the *Cumberland*, for service in the *Pigeon*, *vice* Farrant; N. Farrant, Engineer, to the *Scout*; T. M'Farlane, First-class Assist.-Engineer, to the *Scout*; H. W. Fitzgerald, Second-class Assist.-Engineer, to the *Scout*; W. Glasspole, Chief Engineer, additional, to the *Asia*, in charge of engines of *Geyser*, on that ship being paid for; W. Williams, Inspector of machinery afloat, to the *Edgar*, for temporary service.

MILITARY ENGINEERING.

The Armstrong Guns.—A return has been furnished to Parliament by the Marquis of Hartington, showing that the expenses incurred on all classes of Armstrong guns, their fittings, projectiles, &c., including the 100-pounder smooth bore guns, since the date of the return furnished to Mr. Monsell's committee in May, 1863, amounted to £285,418 0s. 8*d.* The changes and alterations in the same period have cost £15,527 2*s.* 4*d.*, while the extra cost in providing projectiles, &c., in consequence of alterations has been £5,032 4*s.* 2*d.* The return is made up to the date of the last balance-sheet (March 31st, 1864); the expenses incurred during the present year cannot be accurately shown until the next balance-sheet, up to March 31st, 1865, is ready. This may be be expected to be completed about July.

STEAM SHIPPING.

What a Steel Steamer can do.—A letter has recently been received in Liverpool from Havannah from the master of the blockade running paddle steamer *Lark*, which completely justifies the recently adopted practice of building steamers of steel, particularly where strength and speed are required. The *Lark* has made two voyages between Havannah and Galveston, and while at the latter port she was cast ashore, where she lay broadside on for seven days, presenting the appearance, says the writer, "of an old horse, her framework in several places showing through her sides." Her wheels were also much injured, but in spite of this, and after a refit in the Galveston dry dock, she made the run back to Havannah in 70 hours, and this with a foul bottom and a cargo of 793 bales of cotton on board. While in dock at Galveston no less than eight tons of sand were taken out of the *Lark's* bilges, boilers, and condensers. A more satisfactory proof of the superior value of steel over iron and wood for shipbuilding purposes could not be desired, and is a thorough justification for Messrs. Laird Brothers (the builders of the *Lark*), Messrs. Jones, Quiggen, and Co., and other Mersey shipbuilders, who have for some time past so energetically advocated its use, and practically proved its varied advantages over all other materials.

Trial Trip of the S.S. Negapatam.—This vessel recently underwent a trial trip to test the working of her machinery and speed, being fully loaded with coal and iron for that purpose. The *Negapatam* is a fine screw steamer of 347 tons, B.M., with a full poop. Specially adapted for carrying passengers in the tropics. She was built by Messrs. Henderwick and Co., Govan, and fitted with a pair of engines 50 horse-power, by Messrs. James Howden and Co., the contractors for the vessel with the Madras and Colombo steamship Company. After passing down the river, time was marked at the Cloch Lighthouse, and under unfavourable conditions, the distance to Cumbrae Lighthouse was performed in 86 minutes, or at the rate of 9½ knots per hour, being 1 knot per hour above the guaranteed speed. The machinery worked admirably, and without heating, during the whole day—the run from Glasgow and back (about 100 miles) being done at full speed and without a stoppage. The air, feed, and bilge pumps are worked in a very simple manner, patented by Mr. Howden, by which the great number of working parts and complications of the usual lever style are entirely obviated. All the pumps are worked with smoothness from one movement, saving the friction and tear and wear of a great number of joints, and making the pumps at the same time much more accessible.

Steam Shipbuilding on the Clyde.—Messrs. Scott and Co. have launched a screw named the *American*. This vessel is 1,850 tons register, and will be fitted with engines of 200 horse-power, by the Greenock Foundry Company. The steamer is for the West India and Pacific Steam Shipping Company. *The City of Petersburg*, a returned blockade-runner, has left the Clyde for Liverpool, where she has been docked to have her bottom cleaned before being put on the Liverpool and Dublin station. The steamer *Kyles*, intended to be worked in connection with the Wemyss Bay Railway (which has recently been opened for traffic) has made a second trial trip, in which she "ran the lights" at 18½ miles per hour, an increase of 1 mile per hour as compared with her first trip. The contract under which the steamer was built provided for a speed of 19 miles per hour, which may possibly be yet attained. Messrs. Napier have now on hand for the French Compagnie Générale Transatlantique two large screws, which are for the company's New York and Havre line. The *Washington* and *Lafayette*, built a few months since for this company on the Clyde, and also intended for the New York and Havre line, will be applied to the company's Antilles service, on which a lower rate of speed will be deemed sufficient.

The New Saloon Steamer "Alexandra."—This saloon steamer, built by Messrs. Kirkpatrick and M'Intyre, of Port Glasgow, and engined by Messrs. W. Smith and Co., of the Clyde Foundry, Greenock, has been rapidly pushing towards completion, in Victoria Harbour, and her fine lines and general symmetrical appearance have rendered her an object of attraction among the connoisseurs in marine architecture. She was originally intended for a blockade runner, but that trade having ceased, her builders set about converting her into a first-class saloon passenger steamer. She has been purchased by three of the directors of the Saloon Steam Packet Company (Limited), a company which has been formed in London for the purpose of providing a number of iron, swift, elegant, and comfortable steamers to meet the demands of the increasing traffic on the Thames. The *Alexandra* is 240ft. in length, 22ft. 3in. in breadth, and 9ft. in depth. Her engines are 145 horse-power, and as she will be in immediate request by her new owners on the Thames, a very strong effort will be made to get her ready for delivery as soon as possible. This is the first of perhaps a dozen of steamers of the same class, though varying in size, which the new Saloon Steam Packet Company are likely to require.

A Prospectus has been issued of the North German Shipbuilding Company, with a head office at Berlin, and a Board of Direction almost exclusively German. The capital is to be £1,500,000, of which half is to be first subscribed, in shares of £30 each, and the object is to build and repair all classes of vessels and to construct dockyards in the port of Kiel. The company is under the protection of the Royal Prussian Ministry of Marine, who have granted it "the preference for the building and repairing of all their vessels," and have also promised an order for an ironclad frigate. The land purchased has also been approved by these authorities, and is situated near to the Altona and Kiel Railroad, facing the town of Kiel, whence a privilege has been obtained free of charge to reclaim a considerable portion of the contiguous harbour.

Iron Shipbuilding at Southampton.—The largest iron steamship ever built at Southampton was, on the 11th ult., launched from the premises of Messrs. Day and Co., of the Northam ironworks at that port. This vessel has been built for the Hamburg and American Steam Packet Company, and will sail between Hamburg, Southampton, and New York, in conjunction with the *Germania* and other vessels belonging to the company. The following are her dimensions:—Length between perpendiculars, 313ft.; breadth, 40ft. 2½in; depth from base line to spar deck, 35ft. 10in.; tonnage, builders' measurement, 2,484. She has a spar deck flush fore and aft, straight stem, and round stern, and will be brig rigged. Accommodation is provided for 60 first-class, 160 second-class, and 600 emigrant passengers, and she will carry 900 tons of cargo, with 800 tons of coal in her bunkers. Her contract speed, with these weights on board, is 13 knots per hour. This vessel was designed by, and has been built under the superintendence of, Mr. Macormac, the contractor for Messrs. Day, and is a very handsome specimen of nautical architecture. Her engines, of 400 horse-power, nominal, also supplied by the builders, are fitted with horizontal cylinders, surface condensers, steam jackets to the cylinders, and other improvements. She will have four boilers, with superheating apparatus, and an auxiliary boiler for heating the cabins and cooking for the emigrants.

Northfleet Shipbuilding Yard (formerly Pitcher's, and late Mare and Co.)—We have been informed that this property was sold by Messrs. Fuller and Horsey for £65,000; that it was bought by Messrs. Smith, Payne, and Smith, the bankers, who were mortgagees. It is understood that Messrs. Randolph, Elder, and Co., the eminent engineers and iron shipbuilders of the Clyde are about to enter upon the occupation of Northfleet Shipbuilding Yard. It is reported that the representative of a great financial company having been unsuccessful in effecting a combination with an old established firm on the Clyde, sought, when in Glasgow, another firm equally celebrated, and perhaps more enterprising, who are willing to make the necessary fusion for the purpose of forming a Thames and Clyde Shipbuilding and Engineering Company (Limited).

The Humber Iron Works.—We are informed that although the shares in this company are quoted at £11 to £13 discount on £15 paid, it is by no means a fair representation of the actual position and prospects of the concern, as the present panic has been brought about by the bankruptcy of the former proprietors, generally known for some time past as imminent, and from the generally recognized want of experience of the business of such an undertaking amongst the directors of the company.

LAUNCHES.

Launch of the "Aerial."—There was launched on the afternoon of the 2nd ult., from the shipbuilding yard of Messrs. Hedderwicke and Co., a saloon paddle steamer, measuring 120 × 14 × 7. She is to be employed as a pleasure excursion steamer. She has a promenade of about 100 feet long, under which there are large and handsome saloons, where passengers can enjoy the scenery entirely independent of the weather. There are also ladies and gentlemen's cabins, fore and aft, fitted with taste and elegance, and every modern convenience. The engines, which are upon the oscillating principle, are being supplied by Messrs. Jas. Bennie and Co., Caledonian Foundry; and we have no doubt that both boat and engines will do honour to the Clyde.

Launch of the "Waverley," at Pointhouse.—On the 16th ult., there was launched from Messrs. A. and J. Inglis' building yard, Pointhouse, a paddle steamer for the North British Steam Packet Company, called the *Waverley*. She is of the following dimensions, viz., 222ft. keel and forerake, 26½ft. beam, and 14¼ft. deep. Tonnage, 735 B.M. Immediately after the launch she was towed to Finnieston wharf to receive her engines, which are of 300 horse-power, constructed by the builders. This vessel, which will have superior cabin accommodation and great speed, has been built for the Shilloth and Dublin traffic, which it is expected will be greatly augmented this year by the number of visitors to the Dublin Exhibition.

Launch of the Lord Warden.—On the 27th ult. another addition was made to our iron-clad fleet by the launch of the Lord Warden from No. 7 slip in Chatham Dockyard. She is upwards of 4000 tons burden; her timbers are all of a body, consisting of 18 inches of teak; her sides are to be iron armour-plated. The plan of having her timbers placed close together has never been adopted before in that dockyard, and it is said to give additional strength to bear the weight of the iron plating. The Lord Warden is built on the ram system, having what is termed the swan-breasted beak protruding under water. The stern of this portion, which is to resist the first shock, is a gigantic forging of seven tons of brass metal, as is also the stern frame, which is of great power and strength.

The following figures will give some idea of the size of the Lord Warden:—

	ft.	in.
Length between perpendiculars	280	0
Length of keel for tonnage	233	11¾
Breadth, extreme	58	4
Breadth for tonnage	57	2
Breadth, moulded	56	4
Depth in hold	20	9

Burden in tons, 4067 26·49.

As the vessel was brought up opposite to Queen's Stairs to moorings her draught of water was found to be 10 ft. 5 in. forward, and 18 ft. 6 in. aft. Nearly all her planking for her lower decks is fixed. Although the ship has been launched, it will be a long time before she is completely finished.

TELEGRAPHIC ENGINEERING.

Submarine Cables.—Among recent commercial publications has been a statistical paper on "Submarine Telegraph Cables," by Mr. F. Gisborne, showing the results of these enterprises, as regards efficiency, up to the present date, the conclusions arrived at being—1. That no deep sea telegraph of any length has lasted much over two years. 2. That no light cables have, under any circumstances, proved very successful; and 3. That all heavy cables laid in a moderate depth have proved permanently successful.

Telegraph Construction and Maintenance (Limited).—The report of the directors state that the award of Mr. Bidder for the purchase by the company of the buildings, machinery, and plant of Messrs. Glass, Elliot, and Co., at Greenwich, and their leases of the Malta and Alexandria, and Alexandria, Cairo, and Suez Telegraphs, and also for the lands, property, and patents of the Gutta Percha Company, their goodwill and manufactured stock, amounted altogether to £397,672, being considerably less than the amount estimated. The work performed by the company during the year ending the 31st of December last consisted principally of the manufacture of the Atlantic cable, fitting out the *Great Eastern* steamship, and conveying the cable on board preparatory to the laying expedition, which was to start in the month of July next. The profit and loss account for the year included in the gross profit the sums paid for the quantity of Atlantic cable manufactured, viz., 768 miles, at the mileage rate agreed upon, one half in cash, and the remaining half in debentures and shares of the Atlantic Telegraph Company. In addition to the price per mile, this company would be entitled to a large sum in cash and shares upon the successful laying of the cable. The Board had made an arrangement with the directors of the Great Eastern Steamship Company for the payment of the sum agreed upon for the hire of the vessel in shares of the Atlantic Telegraphic Company, but the amount was payable only in the event of the cable being successfully laid. The outlay incurred in fitting out the *Great Eastern* up to the 31st of December last, amounting to £15,714, had been carried to a suspense account until the cable was laid. The accounts for the year showed a gross profit of £148,927, and the expenses £46,627, leaving a net profit of £102,300. The interest on the unpaid purchase-money, £26,777, and the interim dividend on capital, at 5 per cent. per annum, to the 30th of June, 1864, £5,734, together £32,511, being deducted, left a balance of £69,789. From this the directors proposed to write off the whole of the preliminary expenses, £3,174, to pay balance of interest on paid-up capital at 5 per cent. per annum, £5,734; and 10 per cent. to the credit of a reserve fund, £6,088, together £14,996, leaving a balance of £54,793, subject to the realisation of the securities received in part payment of the Atlantic cable, and also subject to the contingent charge. The directors recommended the payment of a dividend to the 31st of December last of 5 per cent., which, with the interest at 5 per cent. per annum, would be equal to 10 per cent. per annum (free of income-tax) on the paid-up share capital, leaving a balance of £13,325.

RAILWAYS.

Inauguration of the Brest Railway.—The Brest Railway, opened for the last two years as far as Guincamp, recently added another length of communication to the lines o Brittany. One of the most important works of this line is the Gouet Viaduct, 249 yards long and 187ft. high, built of semicircular arches, 42ft. 2¾in. in span. The cost did not exceed £120,000, which was defrayed by the State, who undertook the earth works and masonry of the line from Rennes to Brest, leaving the company of L'Ouest to lay the permanent way and build the stations. The immense works of the Port Napoleon, at Brest, are carried on actively, and for which the town has engaged itself to pay to the State the sum of four million francs (£160,000).

Railroad between Vera Cruz and Mexico.—The entire length of the road will be 315 miles, the highest summit level 8,300ft. above the sea, being double the height of any other railroad in the world; it will have an incline of 23 miles and a grade of 212ft. per mile, on which the curves have a radius of 500ft. high. There is one bridge to be built 290ft. high, besides several tunnels, &c.

Peruvian Railways.—The National Bank is authorised to issue 66,800 shares of the Peruvian Railway Company, Limited, of £25 each, representing a first issue of capital aggregating £1,670,000. The Peruvian Government have granted a concession in the shape of a guarantee of seven per cent. per annum on the whole capital, viz., £3,340,000; and a redemption fund is also to be formed from the capital raised, by means of which shares will be periodically drawn after the expiration of twenty years, and paid off at a stipulated premium of 100 per cent. The International Contract Company, Limited, have entered into a contract for the construction of the works.

Indian Railways.—The Governor-General has sanctioned an expenditure of £100,000 to double the line from Luckee Serai up to the Jumna—it may be done at a cost of £1,200 a mile—and has addressed Sir C. Wood on the subject. The through line from Lahore to Mooltan on the Indus was to be formally opened on Monday, the 24th of April. The branch line from the Great Bombay and Calcutta Railway, which pierces the cotton country to Nagpore, is making great progress. The contractors who have got the railway from Lahore or Umritsir to Meerut and Delhi are hard at work. The only break which remains to be considered is that along the desert side of the Indus from Mooltan to Kotree, the terminus of the line from Kurrachee, which will soon have to be filled up by iron links. Then Calcutta will be in direct communication with Kurrachee, 2,000 miles off; with Bombay, 1,600 miles off; and Nagpore, 1,100 miles off, by rail. Whether we look at the magnitude and solidity of the works, or at the distances which they traverse, the railways of India will far surpass those on the North American Continent. They will cover 5,000 miles at a cost of seventy millions sterling, subscribed chiefly in England, and bearing a guaranteed interest of 5 per cent.

Hydraulic Power at the Midland Railway Company's Station.—At the goods station of the Midland Company, Agar Town, the trucks are brought up to the landing-stage by hydraulic machinery, loaded or unloaded when required by hydraulic cranes, and they are shifted from one set of rails to another by means of traverses worked by hydraulic power. Press a lever, and in an instant the loaded truck glides noiselessly away; another lever is pressed, and forthwith a huge bale of goods, or a heavy forging is seen dangling in the air, and is swung round and deposited in the truck or waggon as tenderly as a mother would place her sleeping child in its cradle. The "Railway News" says:—"The machinery by which all this power is made so readily available consists of the water-engines of Sir William Armstrong, situated some hundred yards distant from the place. Every one is familiar with the principle upon which this power is obtained and applied. The effect of a pressure of water from natural sources is got by what are termed "accumulators," which, in this instance, consist of a large reservoir formed of iron plates, add filled with seventy tons of gravel and sand, and its pressure is about equal to that of a head of water 1,500 feet. This force is raised by the hydraulic power, and is ever ready and available for acting on a column of water, and the pressure may be regulated as required over every part of the system. A small steam-engine is employed for pumping the water into the cylinder of the hydraulic press. This hydraulic pressure is obtained at a very small cost. Some engines of this description which are employed at the Newport Docks in Monmouthshire, delivered, last year, 219,000 tons of coal, at a cost of about one farthing per ton for pressure, and about one halfpenny for wages, stores, and repairs; the cost of loading by hand having previously been from 5d. to 7d. per ton.

RAILWAY ACCIDENTS.

Collision on the South-Western Railway.—On the evening of the 13th ult., about half-past five o'clock p.m., a collision occurred at the Nine Elms station of the London and South-Western Railway. It appears that the 4.50 up-passenger train from Twickenham had arrived near the junction of the rails of the goods depôt siding, which branch off from the up Richmond line nearly opposite the gasometers at Nine Elms. A goods train had just been shunted from off the line into the yard, and it is supposed that the points which had been opened to allow this to pass into the depôt had not been properly closed again. The Twickenham train, which was running rather slow, as it had to stop at Vauxhall, instead of continuing on the up-line, turned off into the goods yard, and ran into an engine and trucks, the driver, fireman, and guard of the passenger train being seriously injured, the fireman, who is stated to have been nearly buried in the coals which were thrown out of the tender upon him, having suffered the most. Several of the passengers received injuries.

Accident on the Great Western Railway.—An accident occurred on the Windsor and Slough branch of the Great Western Railway about seven o'clock on the evening of the 22nd ult. It seems that the 6.15 p.m. down train from Paddington slips a carriage at Slough, which is then taken on to Windsor by another engine. This train had passed over the iron bridge across the Thames, and along the high brick viaduct, when, on nearly reaching the "west" signal, the broad guage engine left the rails, and, running along the line for a short distance, partially buried its wheels in the gravel of the permanent way, finally coming to a dead stop.

Railway Collision on the North Seaton Branch.—A collision occurred on the Blyth and Tyne Railway on the morning of the 21st ult., between a passenger train and a train of laden coal waggons. A large coal traffic is carried on by this company on their North Seaton branch, which seems to be a single line. The train which left Bedlington by this branch for North Seaton at a quarter past eight o'clock in the morning, was proceeding to the latter place when the engineman descried a coal train, apparently coming up from the pits. The whistle was blown and the engine reversed, and everything was done to avert an accident, but the trains came into collision. There were only five passengers in the train, of whom, however, two were severely injured.

DOCKS, HARBOURS, BRIDGES.

Opening of Bognor Pier.—The ceremony of opening the pier which has been completed at Bognor has recently taken place. Since its connection with the London, Brighton, and South Coast Railway it has greatly increased in importance. Mr. J. W. Wilson, of London, engineer, devised the form which the pier should take, and the work was placed in the hands of Mr. Dowson. The first pile was fixed in the month of April, 1864. The pier is constructed on the screw principle, and is mainly of iron. It is 1,000ft. long; the head is 40ft. across; and the width of the deck is 18ft., and its height above high-water mark about 12ft.

Extension of the Dockyards.—Papers have been laid before the House of Commons by the Secretary to the Admiralty relating to the proposed extension of basin and dock accommodation in the Royal dockyards. The Director of Works, in a memorandum of the 23rd of January, states that his estimate of the probable expenditure in carrying into effect the recommendation of the select committee of 1864 on dockyards is £6,000,000. But a very considerable saving may be anticipated if convict labour be employed side by side with contract work, and his estimate based on this combination is as follows:—Portsmouth, £1,500,000; Chatham, £1,250,000; Keyham, £750,000; Cork, £150,000; Malta, £500,000; Bermuda, £250,000; advances to companies in aid of the construction of docks to be always available for her Majesty's ships, £250,000; making in all £4,650,000. The director takes fifteen years as the period over which the expenditure would be spread, involving an annual outlay of about £310,000; but so much expenditure on make-shift alterations of works constructed with a view to a former state of things would be saved that the addition to the present annual vote for naval works would probably scarcely average £100,000 a-year. But he considers it desirable that Parliament should so approve the scheme in its entirety as to justify the Government, if the contingency of war should arise, in engaging so large a body of free labour as to secure the more rapid completion of the works, even at the amount of the first estimate, £6,000,000. The director suggests that when once the expenditure has been fixed after deliberate examination and approval of the plans it should be sanctioned, if practicable, by an Act providing for the entire cost, removing the scheme from the influences which so often obstruct and impair the efficient execution of extensive public works. When the Government can enter into no contracts beyond the year, the practical result is that higher prices must be paid, and too often the results for which they have been paid are not obtained. This view is supported by the Admiralty in correspondence with the Treasury relating to the dockyard extensions at Chatham and Portsmouth, the matters were immediately urgent, the Admiralty are anxious to obviate the necessity for a proviso for an allowance to contractors in the event of Parliament thinking fit to refuse or reduce the necessary annual vote, a proviso which inevitably leads to the payment of a higher price, as contractors are unwilling to enter into engagements so fettered, however large the compensation to be paid them in such a contingency. Although the "total estimate for the work" in the first column of the Estimates is generally understood as sanctioned by Parliament when the first vote for the work is passed, yet the director of works has not always felt authorised in cases of considerable amount to propose to pledge the Admiralty to prospective expenditure, and such anticipations of future votes are especially open to objection when the first instalment would be no criterion of the amount of future instalments, or when the first "total estimate" is not based on actual tenders or detailed specifications. The practice does not seem to be guided by any rule, and the Admiralty suggest that it should be considered not merely with reference to the Admiralty, but other departments also. If contracts for these dockyard extensions can be made with firms of the highest position, spreading the payments in fixed instalments over a series of years, great economy will be the result. To this the Treasury can only reply, in their letter of the 26th of April, that so far as concerns these particular works at Chatham and Portsmouth, the Treasury, having regard to the magnitude of the works, would have been inclined to suggest the introduction of a Bill authorising their completion within a definite time out of monies to be voted, thus giving Parliament the opportunity of authorising definitely the proposed scheme. But what the Admiralty desires is to introduce a new system generally with respect to contracts for public works, so as to give the public the advantage possessed by the private trade of certainty in respect of engagements of character. The Treasury feel that they could hardly sanction this course of proceeding without the sanction of Parliament, but they have no objection to the question being submitted for the consideration of the House of Commons.

MINES, METALLURGY, &c.

Action of Sea and other Water on Metals.—From experiments instituted by Messrs. Calvert and Johnson, it appears that steel is the metal which suffers most from sea water; that iron is materially preserved by zinc, as in "galvanized iron;" that iron and oak mutually destroy each other in sea water; that copper is much less injured by sea water than iron, and zinc than copper; and as for lead, there was no trace of the action of sea water at all. This surprised the experimenters, and they tried the effect of different waters on lead with the following result:—Amounts of metals dissolved by 200 litres of the waters upon one square metre of surface during eight weeks:—

	Grammes.
Manchester Corporation water	2·094
Well water	1·477
Distilled water (with air)	110·003
„ „ (without air)	1·829
Sea water	0·038

The Metalliferous Mines Bill.—In the House of Commons Mr. Kinnaird inquired of the Secretary of State for the Home Department what steps had been taken, or proposed to take, to remedy the very serious evils which have been brought to light by the evidence taken by the Royal Commission appointed to inquire into the condition of mines, and which was reported last session. Sir G. Grey replied that the course which had been taken with respect to the report was this:—It had been thought right to confer with the members of that Commission, several of whom were members of that House, on the subject. On many of the questions raised in that report it did not appear possible that any legislation could take place, but there were other points on which it might be expedient to legislate. He had accordingly called a meeting of the Commissioners at the Home Office, where the matter was fully gone into, and it was decided by the majority of members of that Commission that, for the accomplishment of the object they had in view, it was inexpedient that any hasty legislation should take place. It was necessary that the recommendations of the Commissioners with respect to the county of Cornwall specially should be more thoroughly discussed, and the opinions of persons interested in the mines in the locality obtained upon them. That opinion, however, was not shared by his noble friend (Lord Kinnaird) at the head of the Commission, who had proposed a Bill on his own responsibility; but for the reasons he had stated, the Government did not think proper to bring in any Bill upon the subject this session.

Breaking Rocks by Fire.—The ancient method of breaking rocks by fire has lately been revived at the Rammelsberg Mine, in the Hartz Mountains. In a portable furnace about 1½ bushel of coke burns 13 hours, when the furnace is removed, and the rock left to cool, after being sprinkled with water. About noon the face of the rock spontaneously detaches itself, and after that a further portion is broken. The effect of the fire extends to 8in., and with 1½ bushel of coke from 1,600lbs. to 2,400lbs. weight of ore is obtained at half the cost of the gunpowder process.

The Slate Quarries of Wales.—During the last two years the slate trade of the Principality has entered upon quite a new era, and, although the demand is still greatly in excess of the supply, yet the proportion between the yield of the quarries and the requirements of the buyer has been materially reduced. Formerly the slate quarries were entirely in the hands of a few capitalists and some of the wealthy landed proprietors, and the profits derived were unusually large. Once this fact became known to the public there was quite a mania for slate quarry investments, and, as might be naturally expected, disappointment was the result of many of these speculations, and in several instances an enormous capital was spent and no vein of slate discovered after all. Up to the present time out of the 40 quarries opened or recommended during the last two years not more than one-fourth of the number return any profit, and the majority of the remainder are working at a loss. The quarries may be divided under two heads, viz., the true and the bastard, and the great mistake which has been made by speculators, or rather their advisers, is to confound the two descriptions. Bastard slates look well for a time, but they are soon affected by the action of the weather, and a practical eye is able to distinguish them without difficulty.

ACCIDENTS TO MINES, MACHINERY, &c.

Colliery Explosion at Dowlais.—An explosion happened at the Vochriew Pit, the property of the Dowlais Company, on the 10th ult. It appears that a number of colliers had gone down as usual in the morning, and they stood together in a group in some part of the workings for a short time. The fireman, who had been round visiting the workings, placed the usual danger mark outside one heading, in consequence of an escape of gas, but one of the men, with an unaccountable recklessness of his own and others lives, went into the heading, despite the worning posted up. It is said that he commenced brushing the gas out, and the result was a dreadful explosion, which scattered everything within its reach. Seventeen men were more or less injored, and one has died, and four are in a state that gives little hope of their recovery. This is the first explosion that has occurred at the Dowlais Company's collieries within eighteen years.

The Isthmus of Suez Canal.—Mr. Alfred Christian, president of the Chamber of Commerce of Malta, delegated by the Chamber to represent the commercial community of this island at the congress of delegates invited by M. F. de Lesseps to inspect the works of the Isthmus of Suez Canal, has just returned to Malta. The journey through the isthmus occupied about ten days, during which time the delegates had every opportunity of inspecting the works in progress and of conferring with the engineers and other officers belonging to the company. The conclusion Mr. Christian arrives at is that the completion of the ship canal is only a question of time and money, and that in a very few years the communication from sea to sea for vessels of large tonnage will be established, thus uniting the West with the East by an uninterrupted water route and shortening the sea voyage from Europe to India for steamers by fully one-half. It still, of course, remains an open question how far the canal will be useful to our sailing Indiamen, owing to the prevalent winds in the Red Sea. The width of the maritime canal varies at present, according to localities, from about 36 to 58 metres, except in the immediate vicinity of Port Said, where it attains 84 metres. Its average depth at present is not more than from 2 to 3 feet. The depth of the freshwater canal is much the same at present as that of the maritime canal, but, of course, it is deeper during high Nile; its width varies from about 16 to about 25 metres. The company, it is stated, have contracted with various French firms for the completion of the whole of the works from the Mediterranean to the Red Sea by the 1st of July, 1868, at which date the company expect that the canal will be opened to navigation, at a cost to the shareholders not exceeding the subscribed capital of 8,000,000 sterling. On these points, however, Mr. Christian had not sufficient data to enable him to form an accurate opinion.

GAS SUPPLY.

The Arundel Gas Company have reduced the price of gas from 6*s*. 6*d*. to 6*s*. per 1,000ft.

The Framlingham Gaslight Company's Directors have reduced their price of gas from 6*s*. 8*d*. to 6*s*. 3*d*.

The Wigan Gas Company have reduced their price of gas from 4*s*. 2*d*. to 3*s*. 9*d*. to small consumers, and from 3*s*. 9*d*. to 3*s*. 4*d*. to large consumers; in the country district the present prices are 5*s*. 6*d*. and 5*s*., and these will be lowered to 5*s*. and 4*s*. 6*d*.

The Uttoxeter Gas Company have resolved that the price of their gas shall be reduced from 5*s*. 10*d*. to 5*s*. per 1,000ft.; and that the following discounts be allowed:—For all gas burnt in any one year, above 25,000ft. and under 50,000ft., 5 per cent.; above 50,000ft. and under 100,000ft., 10 per cent.; above 100,000ft. and upwards 15 per cent.

The Rotherham Gas Company have declared a dividend of 10 per cent per annum for the last half-year, and 2 per cent. for "arrear" on former years. They state that they cannot further reduce the price of gas at present on account of the great increase of consumption necessitating the laying of larger pipes; and they cannot give their works a finished appearance, as they are looking forward to continual enlargements and additions.

At a Meeting of the Singapore Gas Company, a dividend has been declared at the rate of 7½ per cent. per annum.

The Metropolitan Gas Companies.—The receipts by each company in 1861, 1862, and 1863, from the sale of gas, according to a table in the *Mining Journal*, were as follows:—

Company.	1861.	1862.	1863.
Chartered	£207,661	£222,916	£234,220
City of London	81,277	92,378	94,917
Commercial	94,325	103,554	113,129
Equitable	66,053	69,361	69,627
Great Central	61,883	72,485	73,040
Imperial	356,930	397,947	419,061
Independent	58,361	60,659	59,667
London	127,683	133,776	142,804
Phœnix	127,131	136,812	142,975
Ratcliff	27,477	29,033	29,960
South Metropolitan	57,407	61,168	65,327
Surrey Consumers'	46,410	49,292	51,069
Western	62,134	69,159	77,405
Total	1,374,732	1,498,570	1,573,201

APPLIED CHEMISTRY.

The Estimation of Alumina by Carminic Acid, and the Action of some Reagents on Carminates, by M. C. Luckow.—A solution of cochineal or carminic acid has the property of colouring carmine, a liquid containing alumina; when acidulated, this liquid turns orange. The author has taken advantage of this reaction to make some analytical researches on alumina. The following are the results he has obtained. Carbonate of soda precipitates alumina imperfectly; in the presence of an ammoniacal salt the precipitation is more complete; with bicarbonate of soda instead of soda it is almost perfect. The more slowly the cold precipitation by carbonate of ammonia is effected, the more complete it is. The precipitate obtained with bicarbonate is less bulky than that obtained with neutral carbonates, and is consequently more easily washed. The precipitation of alumina by carbonate of ammonia or ammonia is complete if the liquid is boiled until it returns to its neutral state. The filtered liquid does not give with carminic acid the reaction characteristic of alumina. The cold precipitation by ammonia or by sulphide of ammonium is more complete the longer the time taken to effect it, and the smaller the excess of ammonia and the greater the excess of sulphide the better. By passing a current of carbonic acid into a solution of alkaline alumina, the precipitation of this base is almost perfect. By boiling an alkaline solution of alumina with chloride of ammonium until the reaction is no longer alkaline, the alumina is completely precipitated. Alkaline carminates are soluble in water, very little so in alcohol; their solution is of a red violet colour. Alkaline earthy carminates are almost insoluble; the colour of their solution is carmine red. Carminates are decomposed by acids, giving an orange coloured solution, which does not alter on boiling. The solution of carminate of alumina, such as is obtained by the addition of tincture of cochineal to a neutral solution of alumina, free from iron, has a beautiful carmine colour, which turns to violet by contact with the air, especially when hot: if the solution be acid this change does not take place; when the free acid is tartaric or citric acid a red pulverulent deposit, formed probably of carminate of alumina, is, after a short time, obtained; this deposit is very little soluble in water, insoluble in alcohol, but soluble in acids and in alkalies. Carminates of iron form precipitates of a dark violet (ferrous salts) or brown (ferric salts), slightly soluble in water; strong acids and also concentrated alkalies decompose them. Carminates of zinc, nickel, cobalt, and manganese are almost insoluble; their colour is carmine violet. Salts of lead and copper are insoluble, and dark violet in colour. By adding a solution of cochineal to a stannous salt, a violet colour is obtained, becoming dark carmine if the solution is shaken in the air, or, better still, with chlorine water. Carminate of silver is unstable.

On a Yellow Colouring Matter from Rosaniline, by Max Vogel.—When a strong stream of nitrous acid is passed into an alkaline solution of commercial fuschine or pure rosaniline some magnificent colour phenomena are observed. In a short time the red colour passes to violet, and this to a beautiful blue; by the continued action the blue changes to green. On allowing the green solution to stand for some hours, the green colour changes to a beautiful reddish yellow, but this change may be quickened by continuing to pass the nitrous acid. The colour undergoes no further alteration, and on evaporating this solution on a water bath a reddish brown pasty mass is obtained, which hardens on cooling, and when cold can be reduced to a beautiful cinnabar red powder. The author has made one analysis of this powder, from the results of which he deduces the formula $C_{16}\ H_8\ NO_6$. The new colouring matter behaves as a base and as an acid. It dissolves with some difficulty in dilute, easily in concentrated acids, but more easily in alkalies. Acids separate it from alkaline solutions, the colour floating on such solutions as a flocculent mass. The colour dissolves in alcohol, sulphide of carbon, chloroform, and ether, but is insoluble in water. The author intends to continue the study of this body and to make experiments on the action of nitrous acid on aniline blue, violet, green, &c.

Hydrofluoric Acid for the Detection and Estimation of Silica, by M. Fred. Kuhlmann.—The author proposes to treat silicates at a dull red heat with a current of hydrofluoric acid, and has made a platinum apparatus adapted for this process. It consists of a platinum retort, of which the belly may be of lead; the acid is produced by means of sulphuric acid and white cryolite, or pure fluoride of calcium. The neck of the retort fits tightly into a tube of platinum which contains, in boats of the same metal, the matter to be analysed; this tube, by means of a short adapter, also of platinum, communicates with a condensing or absorbing apparatus; this apparatus may be of vulcanised india-rubber. One hour suffices for the treatment of 10 grammes of matter, but not more than 2 grammes should be employed. By means of this experiment M. Kuhlmann has ascertained the following facts:—Amethyst contains no metallic oxide, but soda and potash, which are observed by means of the spectroscope; emeralds and yellow quartz are decolorised; smoky and yellow diamonds, and rubies do not alter in colour; blue sapphire takes a slightly violet tinge. Blue disthène leaves a ferruginous residue with fluoride of potassium and aluminium; tremoline, pyroxene, quartz, and jaspar give a residue of potash and soda. Finally, red cornelian, which had turned to a dead white under the influence of oxidising and deoxidising gases, and the colour of which seemed consequently due to an organic matter, was found to be ferruginous, which proves that if oxide of iron enters into the colour of cornelian, it is by reason of a molecular arrangement, which disappears by calcination under the influence of reducers or oxidising gases.

The Estimation of Fluorine in Phosphates of Iron and Manganese, by H. Von Kobell.—The method proposed by the author for estimating fluorine in combinations easily attacked by sulphuric acid is as follows:—Cover the platinum capsule in which the decomposition takes place with a funnel, resting with the capsule on a platinum basin, on which it is fastened with wet plaister; ascertain the weight of the funnel and the composition of the glass of which it is made. Heat the whole until most of the sulphuric acid has been expelled; then raise the funnel, wash it carefully, dry and weigh it; the decrease in its weight is owing to a portion of the glass having been attacked; and as its composition was first ascertained, the weight of silica which has been attacked may be calculated from the decrease in weight, and, consequently, the quantity of hydrofluoric acid which has been disengaged. This method has given very satisfactory results with triplite of Limoges, and with zivieselite, and other analogous phosphates of Schlaggenwald. With fluoride of calcium and cryolite too little fluorine is found, because the decomposition of these minerals is complete only when the mixture is properly shaken, which is difficult with the apparatus described above. The same funnel may be used many times, and is even better after it has been corroded; the author has made it in the form of a receiver, that it may better cover the capsule. If the substance to be analysed contains silica, the quantity must be ascertained and added to that of the glass attacked, to obtain the weight of fluorine. The author has experimented by another method. Place the substance to be analysed in a rather deep platinum crucible, and cover it with three or four times its weight of silica; add a few drops of sulphuric acid, and heat gently for half-an-hour; then gradually increase the heat until most of the sulphuric acid is expelled. Then treat the whole with hydrochloric acid, add water, and leave it to deposit; collect the deposit, calcine, and weigh it, and the loss of silica will indicate the amount of fluorine contained in the substance analysed (38 of fluor corresponds to 30 of silica). The author analysed the Limoges triplite by both these methods, and found in them from 6·8 to 7·5 per cent. of fluor. The heterosite of Limoges contains only 0·902 per cent. The qualitative research of fluorine in substances free from silica is easily made, with small quantities of matter, in a platinum crucible furnished with a lid, with a small circular hole pierced in the centre, above which a disc of glass is placed.

Silicate of Methyl and Silicum Methyl.—Friedel and Crafts have announced to the Paris Chemical Society that they have succeeded in forming silicate of methyl by the action of perfectly pure and dry wood spirit on chloride of silicium. By heating together zinc methyl and chloride of silicium they obtained silicium methyl.

Treatment of Auriferous Sulphurs.—Observing that the difference between the assay value of gold ore and the quantity of gold extracted was not accounted for by the gold remaining in the tailings, Messrs. Crosby and Thompson, of California, have conducted a long series of experiments which have demonstrated that gold, if not volatile, is so nearly so that the practical working of it is the same as if it were. No one will deny that the sulphur carries the gold, and it is observed that these sulphates of iron, by some natural system, are nearer the surface the further north they are found, and the nearer the equator the greater the depth before being reached. In Colorado this iron is 30ft. to 100ft. more or less from the surface, elevations and disturbances affecting their locality as a matter of course. In this arrangement the ore, after being crushed into a fine powder or sand (this being done in all systems of working gold), and being generally wet is passed through a drying cylinder, some 10ft. in length and 3ft. in diameter. The latter revolves on a hollow 6in. axle, perforated, through which oxygen can be forced in to perfect disulphurisation, caused by heating the cylinders to about 800°, making them a dull red. The cylinders are slightly inclined, just so that their revolutions will carry the ore through; at the outlet the desulphurised ore falls into a receiver, and the vapour passes out also above it. Passing up it is conducted through spray, where it cools, and the gold becomes metal.

New Experiments with Magnesium.—In experimenting with this new metal Mr. J. N. Hearder, of Plymouth, is said to have discovered some explosive compounds of tremendous power and striking peculiarities. He ignited a small portion (about 20 grains) of one of these compounds during a lecture which he gave at the Plymouth Mechanics' Institute, the instantaneous and dazzling effect of which upon the audience was like that of a flash of lightning. On causing two bars of magnesium to form the terminals of a powerful voltaic battery, a most intense combustion ensued: one of the bars speedily became red hot, entered into ebullition, and then burnt so furiously that it became necessary to plunge it into water to prevent its falling on the platform. In this process portions of the burning metal detached themselves, and floated blazing on the surface of the water, decomposing it after the manner of potassium, and liberating hydrogen, which also burned.

LIST OF APPLICATIONS FOR LETTERS PATENT.

We have adopted a new arrangement of the Provisional Protections applied for by Inventors at the Great Seal Patent Office. If any difficulty should arise with reference to the names, addresses, or titles given in the list, the requisite information will be furnished, free of expense, from the office, by addressing a letter, prepaid, to the Editor of "The Artizan."

Dated April 22nd, 1865.

1126 E. S. Beaux and E. Pannifex—Tanning leather and other skins
1127 J. H. Wilson—Spools or bobbins for preparing fibrous materials for spinning
1128 J. Emary—Capes, paletots, overcoats, and other such like garments
1129 C. J. and J. A. Keenan—Articles of lace or net fabric
1130 A. Grainger and C. M. Girdler—Devices and representations on tombstones
1131 W. Bunger—Permanent way of railways
1132 G. Haseltine—Removing corks from the interior of bottles and other vessels
1133 A. V. Newton—Fitting of steam condenser tubes and the tools to be used therein, and the means of retarding corrosion in steam boilers
1134 J. Howard and E. T. Bousfield—Machinery for cultivating land

Dated April 24th, 1865.

1135 W. Williamson—Portable hot rooms for drying cloths and other articles
1136 P. A. Le Comte de Fontaine-Moreau—Fire arms
1137 H. A. Bouneville—Dissecting maps and charts
1138 R. H. Dart—Propellers
1139 H. C. Butcher—Cigar cutter
1140 W. E. Gedge—Apparatus for administering nourishment to the sick and infirm
1141 W. E. Gedge—Pessary
1142 C. Eastwood—Temples for looms
1143 J. J. Parkes—Communication from one part of a building to another
1144 W. Clark—Washing fibrous materials
1145 A. Atkins—Shoe for facilitating swimming
1146 J. F. C. Carle—Breech loading needle guns
1147 W. E. Newton—Penholders
1148 O. G. Warren—Examination of spirit manifestations

Dated April 25th, 1865.

1149 N. Sibley—Pouring and decanting liquids
1150 T. Walker—Measuring the flow of liquids
1151 G. Davies—Securing buttons to fabrics
1152 R. A. Brooman—Smoke consuming furnaces
1153 J. N. Brown and T. D. Clarke—Manufacture of iron and preparing fuel to be used in the manufacture and melting of iron
1154 J. N. Brown and T. D. Clarke—Paints for preserving metallic and other substances from decay
1155 J. Wilkinson—Printing felts, floor cloths, carpets, and other woven fabrics
1156 C. Jacquelin—Acquiring motive power
1157 W. Elder—Steering ships
1158 J. T. Bucknell—Railway rails and wheels
1159 J. C. Wickham and A. E. Deiss—Waterproof fabrics
1160 W. Oxley—Spinning fibrous substances
1161 W. Clark—Manufacture of soluble and assimilable superphosphates of lime by the application of phosphoric acid and acid phosphates
1162 W. Husband—Fastening wooden planking to iron in ships

Dated April 26th, 1865.

1163 R. Eccles—Railway chairs
1164 T. D. Whitehead—Fire escapes and portable ladders
1165 C. W. Heaven—Fastening for articles of dress
1166 J. and W. Fairweather—Sewing machines
1167 G. Mumby—Machinery for sewing and embroidering
1168 F. D. Pierre Jacques Carasson—Disintegrating vegetable and animal substances
1169 R. A. Brooman—Preparing fibres, threads, and fabrics
1170 J. Cunningham—Construction of fire-proof buildings
1171 J. A. Rowland—Cameras
1172 J. Dodge—File cutting machines
1173 G. T. Bousfield—Gum
1174 W. H. Smith—Photographing on wood

Dated April 27th, 1865.

1175 J. W. Lowther—Lubricating frictional surfaces
1176 J. Tangye—Hydraulic pulling jacks
1177 J. Carr—Fire-arms
1178 H. W. Wood—Reducing friable substances to powder
1179 S. Harvey—Cutting or shaping masts and other beams
1180 A. Francis—Condensing steam
1181 J. F. Feltham—Mallets used in the game of croquet
1182 R. A. Brooman—Charging and closing cartridge cases
1183 W. Balk—Furnaces for smelting
1184 A. Grainger—Photography
1185 W. E. Newton—Artificial arms and hands
1186 D. Simpson—Furnaces

Dated April 28th, 1865.

1187 T. C. March—Arrangement of flowers and leaves
1188 F. Moore—Shirts
1189 A. C. Henderson—Water wheels
1190 E. McNally—Shaping metallic articles
1191 J. Bernard—Blasting rocks
1192 J. Bernard—Raising water
1193 R. Ferris, J. Murray, and A. Wilson—Dyeing yarns

Dated April 29th, 1865.

1194 W. H. Tucker—Locks
1195 A. Wyllie and J. M. Gray—Steam engines
1196 C. Gammon—Instruments to be used when drawing lots or prizes
1197 L. W. Croadwell—Breech-loading guns
1198 T. White—Reburning of animal charcoal
1199 G. A. Huddart—Buttons
1200 G. P. Dodge—Pickers for looms
1201 W. Clark—Locks
1202 P. A. Le Comte de Fontainemoreau—Spinning silk
1203 W. Leathom—Cutting coal
1204 F. Gregory—Apparatus employed in breweries
1205 J. Gutmann—Spectacles

Dated May 1st, 1865.

1206 D. Y. Stewart—Moulds for casting
1207 E. Della-Noce—Fire-arms
1208 H. Bessemer—Manufacture of pig iron and foundry metal
1209 G. Johnson—Iron fortifications
1210 C. E. Herpst—Pumps
1211 J. Blackie—Igniting the fuses of shells
1212 D. Rankin—Marine steam engines
1213 J. C. Davis—Knife-cleaning machines
1214 W. T. W. Jones—Croquet stand
1215 M. W. Ruthven—Propelling vessels
1216 W. E. Wiley—Everpointed pencils
1217 W. Watts and J. J. Cooper—Mangles
1218 W. E. Newton—Manufacture of flock fabrics
1219 Waterproof fabrics
1220 A. H. Emerson and R. Fowler—Vitreous compositions
1221 T. F. Cashin and J. F. Allender—Puddling iron
1222 J. E. Alleuder and T. F. Cashin—Fastenings for driving bands

Dated May 2nd, 1865.

1223 J. H. Johnson—Indicating excessive heat or cold
1224 R. Fenner—Embossing presses
1225 T. H. Campbell—Strengthening shields of iron and steel
1226 T. Russell—Valves for liquids
1227 F. Wise—Obtaining decoctions
1228 W. E. Newton—Folding beds and bedsteads
1229 T. Allcock—Finishing and polishing metal tubes
1230 C. W. Siemens—Regulating the power and velocity of machinery
1231 J. Catillon—Self-supplying pens

Dated May 3rd, 1865.

1232 J. B. Lavanchy—Chair ladder
1233 G. T. Bousfield—Drying and stretching textile fabrics
1234 E. T. Rend & J. B. Fyfe—Receiving the thrust of screw propellers
1235 P. A. Le Comte de Fontainemoreau—Ascertaining the degree of torsion and resistance in the threads of textile substances
1236 M. H. Beguin—Penholders
1237 P. A. Le Comte de Fontainemoreau—Burning petroleum
1238 T. W. Roe—Folding and carding lace or light fabrics
1239 W. Clark—Stretching woven fabrics and other materials
1240 J. H. Johnson—Steam generators
1241 W. E. Gedge—Fan or exhaust for thrashing machines
1242 C. G. Leuk—Purifying water

Dated May 4th, 1865.

1243 G. Josse—Paper hangings
1244 E. G. Smith—Preparing vegetables for culinary purposes
1245 W. F. Stanley—Tools for regulating distances
1246 J. Stalkartt—Ploughs
1247 G. Redrup—Cutting cylindrical or conical articles
1248 F. Caldwell—Winding threads
1249 J. Hampton—Refrigerator
1250 W. Roberts—Links for connecting chain cables and other chains
1251 J. Lilley—Compasses
1252 A. Mackie, H. Garside, and J. Salmon—Distributing printing type
1253 T. Wood—Steam engines

Dated May 5th, 1865.

1254 G. Peel and I. Mason—Compressing cotton and other substances
1255 W. Henderson—Extracting copper
1256 E. Richardson—Producing or effecting fog signals
1257 T. J. Mayall—Stereotype plates
1258 A. H. Brandon—Signals
1259 C. Lamport—Supplying fuel to fire grates
1260 J. Mitchell—Roads and streets
1261 J. Wadsworth, H. Dusset, and J. McMurdo—Indexing machines
1262 J. McGlashan—Preparation of jute
1263 S. Bennett—Production of vinegar

Dated May 6th, 1865.

1264 W. E. Newton—Steam engines
1265 S. Trotman—Communication between passengers and guard
1266 I. Swindells—Manufacture of coal gas
1267 J. Hurt and H. Touge—Grinding corn

Dated May 8th, 1865.

1268 W. C. Cropp—Carriage lamps
1269 P. A. Le Comte de Fontainemoreou—Illuminating
1270 J. Buchanan—Fire-grates
1271 W. Clark—Setting and distributing printing types
1272 J. H. Johnson—Measuring spirits
1273 J. Casey—Window sashes
1274 J. H. Johnson—Safety lamps

Dated May 9th, 1865.

1275 R. B. Cooley—Knitted fabrics
1276 S. Law—Breech-loading fire-arms
1277 P. Welch—Dressing and finishing printers' types
1278 J. C. C. Halkett—Coating iron and other ships and vessels
1279 J. G. Hev and V. Savory—Extinguishing fires
1280 E. T. Bellhouse and W. J. Dorning—Hydraulic presses
1281 J. Gorton—Turkish towelling
1282 R. H. Tweddell—Fixing the ends of boiler and other tubes
1283 T. J. Mayall—Door and other mats
1284 G. Hartley—Fasteners for stays and other articles of dress
1285 S. Hudson—Stirrup for ladies' and gentlemen's riding saddles
1286 J. H. Johnson—Candles
1287 W. Jackson—Mixing gases
1288 C. S. Baker—Paddle wheels
1289 J. C. Conybeare—Breech-loading fire-arms and cartridges

Dated May 10th, 1865.

1290 S. L. Fuller, A. Fuller, and C. Martin—Carriage step
1291 D. Adamson—Drilling boiler and other plates of metal
1292 W. E. Broderick—Churns
1293 P. O'Hagan—Breech-loading fire-arms
1294 H. W. Hart—Buttons
1295 D. Hartley—Moulds for metallic castings having a cylindrical form
1296 E. Myers—Wet gas meters
1297 J. Forbes—Drying grain
1298 J. Melvin—Jacquard machines
1299 P. Brash and L. Irvine—Ornamenting candles
1300 J. J. Revy—Gun cotton cartridges for cannon and small arms
1301 W. J. Rice—Obtaining motive power
1302 R. Hadfield and J. Shipman—Metal ribs for umbrellas
1303 S. Pokutynski and M. Mycielski—Obtaining motive power

Dated May 11th, 1865.

1304 J. Goodwin—Iron girders
1305 J. H. Johnson—Pressure gauge
1306 W. Tijou—Securing the rails of the permanent way of railways
1307 W. Jamieson—Looms for weaving
1308 J. R. Cooper—Breech-loading fire-arms
1309 T. J. Mayall—Flexible tubing
1310 J. Bennett—Steel
1311 G. Mountford and E. Worroll—Smoothing metal pipes
1312 D. Ellis and M. Hillas—Ornamental fabrics
1313 A. Parkes—Collodian

Dated May 12th, 1865.

1314 E. L. Girard—Machinery for fulling fur or felt hats
1315 E. Cordonnier—Tents
1316 T. Smith and H. James—Woven fabric
1317 J. Hesford—Stretching cotton
1318 G. Haseltine—Boots and shoes
1319 H. Ransford—Starch
1320 S. T. Garrett—Stoppers for bottles
1321 R. Winder—Laying single line articulated railways
1322 W. Chubb and S. Fry—Communication between passengers and guard
1323 R. E. Donovan and D. O'Brien—Effecting traction on railways
1324 W. Hewitt—Preventing incrustation in steam boilers
1325 G. Simmons and G. W. Simmons—Producing lithographic impressions
1326 J. Eddy—Ploughs
1327 T. Davis—Vessels for polishing oils

Dated May 13th, 1865.

1328 T. Craig—Breech-loading fire-arms
1329 T. Parkinson and W. Snodgrass—Supports for barrels
1330 A. Weir—Water gauges
1331 J. K. Caird—Sewing machines
1332 W. Spence—Rifling cannon
1333 H. J. Burt—Head dress
1334 W. Clark—Gas burners
1335 W. Clark—Hinges
1336 G. H. Ogston—Animal charcoal
1337 F. Ransome—Slabs
1338 R. Langridge—Fastening the stiffeners or supports of stays
1339 J. P. Cooke—Pocket pencils

Dated May 14th, 1865.

1340 G. Ennis—Saw mills
1341 W. Deakin and J. B. Johnson—Ordnance and gun barrels
1342 C. J. Appleby—Steam cranes
1343 G. Elliott and S. B. Coxon—Spring apparatus to be applied to the bearings of the axles of pulleys or drums used in collieries
1344 R. Harrild and H. Harrild—Printing machines
1345 H. Bealey—Drills
1346 J. Daughlish—Baking bread
1347 J. Tangye—Testing chains
1348 H. A. Bonneville—Flour mills
1349 H. A. Bonneville—Hydrometers
1350 W. Easton, E. Moore, and W. Gilles—Raising liquids

Dated May 16th, 1865.

1351 W. Brown—Clogs
1352 W. Wright—Treating copper ores
1353 M. Defries—Signals
1354 H. E. Dixon—Letter clips
1355 P. C. Lafont—Breech-loading fire-arms
1356 R. A. Brooman—Breech-loading fire-arms and cartridges
1357 R. Leddicoat—Bolts
1358 W. Montgomerie—Locomotive engines
1359 S. Svendson—Receptacles for oil and other liquids
1360 J. Worrall and T. Hughes—Stretching textile fabrics
1361 G. Walton—Distilling hydrocarbons
1362 A. Chavanne—Catching mails or bags withou stopping the train
1363 C. O. Crosby—Rods for spindles

Dated May 17th, 1865.

1364 F. Fletcher—Water closets
1365 W. Haigh—Cutting cardboard

Dated May 18th, 1865.

1366 C. Fischer and J. C. W. Moas—Printing or signing letters
1367 H. Rushton—Goats' hair in imitation of human hair
1368 T. Fancheux—Electric machines
1369 C. S. Billups—Distributing liquids
1370 W. R. Williams—Dry gas meters
1371 W. Manwaring—Reaping machines
1372 T. Molden, J. Newsome, and J. Akeroyd—Furnaces
1373 R. A. Brooman—Securing corks
1374 J. Mitchell and G. Tilfourd—Testing railway springs
1375 R. T. Birt—Traps
1376 S. A. Varley—Insulation of electric telegraph wires
1377 J. Laing—Sewing machines
1378 W. Eassie—Driving piles
1379 C. Copus—Bedsteads

Dated May 19th, 1865.

1380 E. A. Raymond—Atmospheric forging hammers
1381 G. H. Brookes—Sliding gas pendants or chandeliers
1382 S. Ebral—Breech-loading fire-arms
1383 T. Marsden—Spinning cotton
1384 H. de Mornay—Sewing machines
1385 T. Richardson and M. D. Rucker—Obtaining nitrogen
1386 W. Davey—Purifying coal gas
1387 A. V. Newton—Screws
1388 G. Read—Manumotive carriages
1389 W. Clark—Ornamentation of leather

Dated May 20th, 1865.

1390 C. Varley and S. A. Varley—Telegraph supports
1391 C. Bradley—Spinning cotton
1392 W. E. Newton—Raising oil and other liquids from deep wells
1393 J. A. Coffey—Distilling Apparatus
1394 J. Martin—Steering ships
1395 W. Smith and G. B. Smith—Wet gas meters
1396 W. Eddington—Draining land
1397 E. Attenborough, S. Mellor, and G. Mellor—Knitting machines
1398 J. Armstrong—Permanent way and rolling stock of railways

Dated May 22nd, 1865.

1399 J. Wylie and J. Rew—Impressed gold and similar paper hangings
1400 R. Haswell—Invention to supersede the chimney pot now in use
1401 D. Powis and H. Brittain—Wire gauze dish covers
1402 W. E. Gedge—Safety lock
1403 A. G. Bigorie—Casing to protect the lock of fire-arms
1404 J. Shand—Fire-engines
1405 J. H. Johnson—Cooling liquids
1406 W. Hodson—Locks
1407 J. M. Clements—Sewing machines
1408 G. Furness and J. Slater—Cutting off the upper parts of piles
1409 R. Muller, A. T. Weld, and J. Folliott—Substitutes for animal charcoal
1410 P. A. le Comte de Fontainemureau—Lamps for burning mineral oils

Dated May 23rd, 1865.

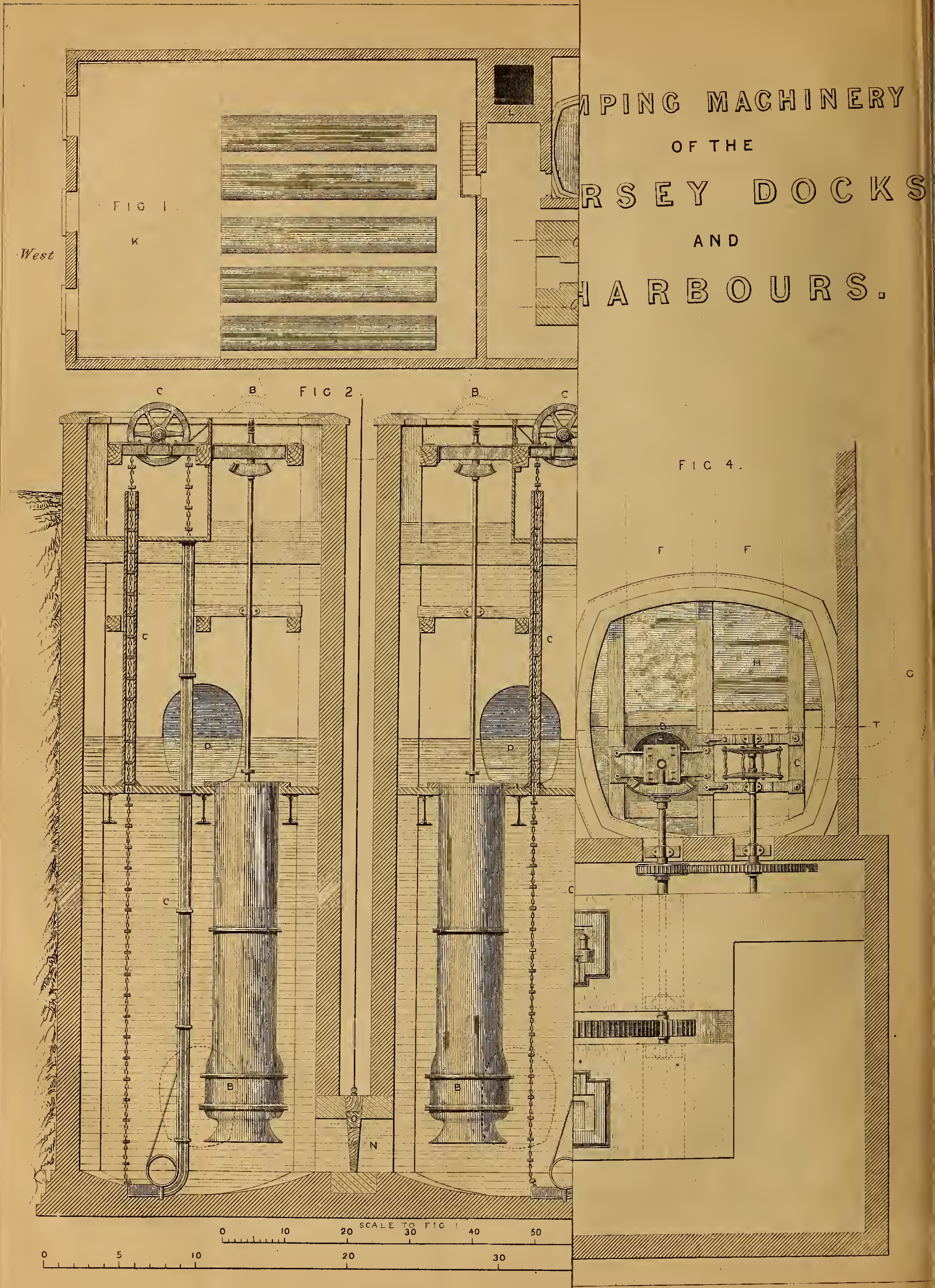
1411 E. McNally—Cutting screws
1412 H. Wilde—Application of electricity
1413 I. Holt, W. Holt, J. Holt, & J. Maude—Dyeing yarns
1414 A. Hett—Ornamenting earthenware
1415 H. Adler—Clocks
1416 H. Gibbs—Envelopes

Dated May 24th, 1865.

1417 T. Calvert and D. Montgomery—Looms for weaving
1418 H. Nunn—Mangles
1419 T. Beanland—Screw gill protector
1420 J. Dale and A. Parat—Calico printing
1421 A. H. Bunnevil e—Cranes
1422 C. T. Moller—Lamps
1423 G. Ashcroft—Pressing cotton

Dated May 25th, 1865.

1424 J. A. Coffee—Retorts
1425 J. Ramsbottom—Hoops and tyres
1426 J. Firth—Railway tyres
1427 D. Welsh—Looms for weaving
1428 R. Maxwell—Applying coal-tar colours to cotton and linen
1429 D. Law—Moulds
1430 R. A. Brooman—Separating fibres
1431 J. X. J. Barbaix—Railway brakes
1432 W. Madders—Embroidery
1433 E. Paton—Fire arms
1434 J. H. Johnson—Making and venting cores
1435 J. Gjers—Kilns
1436 T. Wilson—Breech-loading fire-arms
1437 G. Bray—Gas burner
1438 H. Gibbs—Artificial fuel
1439 W. E. Newton—Preparing cotton
1440 W. E. Newton—Spinning machines
1441 T. H. Hoblyn—Rest for lathes
1442 J. Eustace—Hats
1443 M. Henry—Treating fibrous materials



W. Smith, C.E. direx.

THE ARTIZAN.

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THE QUALIFICATION OF CIVIL ENGINEERS.

A very moderate amount of observation of the principal incidents which have, during the past few years, transpired in connection with the constructive arts can scarcely fail to produce a conviction that it will be found necessary, before the present generation passes away, to institute some criterion or test of the abilities of such as shall in future practise as Civil Engineers. In former times such a system was simply impossible; for when Perry embanked the Thames and Myddelton made the New River the difficulty was to find any engineers who would undertake the responsibility of carrying out works of such magnitude; but in our own time the supply of engineers is in number quite equal to the demand, and vast extension of the works under their control renders their qualification a matter of the utmost importance to the general public.

In the medical profession, practitioners must have diplomas, or undergo the penalties imposed upon quackery, and it is a great question with whom the personal safety of mankind rests in the greater degree, whether with the physician or the engineer; but one point connected with this matter is clear, which is that it is far easier to define the class and amount of knowledge requisite to ensure the competency of the engineer than that which qualifies the physician.

It is not a mere academical system of examination, comprising those branches of scientific research which may be mastered by the acquisition of mathematical knowledge that can be esteemed efficient as a test of the eligibility of engineers, for this could, with a little trouble, be obtained by the aid of tutors and compendious works. But that which is really needed is an enquiry into the practical knowledge of candidates for diplomas.

Formerly the Dutch engineers and their disciples were, after much labour, successful in reclaiming the fens, and converting into fruitful land that which had not only been almost a barren waste, but also the birthplace of those malaria which proved so destructive to life and health. But with all the improvements effected in constructive science, the bursting of the embankment of the Bedford Level was scarcely repaired so expeditiously as might have been expected, for several engineers were called in before one was found who practically overcame the difficulty. We may also quote the Sheffield disaster as an instance of the result of insufficient knowledge or care, for had the works been properly executed, the catastrophy would have been avoided. Many more instances might be cited on this point, but a further extension of argument thereupon is unnecessary.

Of those who enter the profession it is certain that very few ever take positions as engineers—many become merely draughtsmen; but, according to the present system, an accidental occurrence may place one whose experience and abilities are by no means sufficient to qualify him for the post, in charge of works of magnitude and importance. Undoubtedly there are operations connected with the execution of some large works which need only a very limited amount of knowledge and experience on the part of those to whom they may be confided; but matters of great importance may be left in the hands of those who, having acquitted themselves well in the conduct of such matters as suited their capacity, have chosen to style themselves Civil Engineers.

It appears probable that the qualification of engineers in the next generation will consist in passing an examination, and receiving a certificate from a college of engineers; but, whenever the matter may be taken up, it is to be hoped that the form of examination determined upon may be such as cannot be satisfied without a really practical knowledge of the subjects dealt with. Even if such an institution were established without its being made compulsory to pass it previous to practising, it would yet be valuable, inasmuch as the fact of holding a diploma from it would be a guarantee to the public of the ability of members.

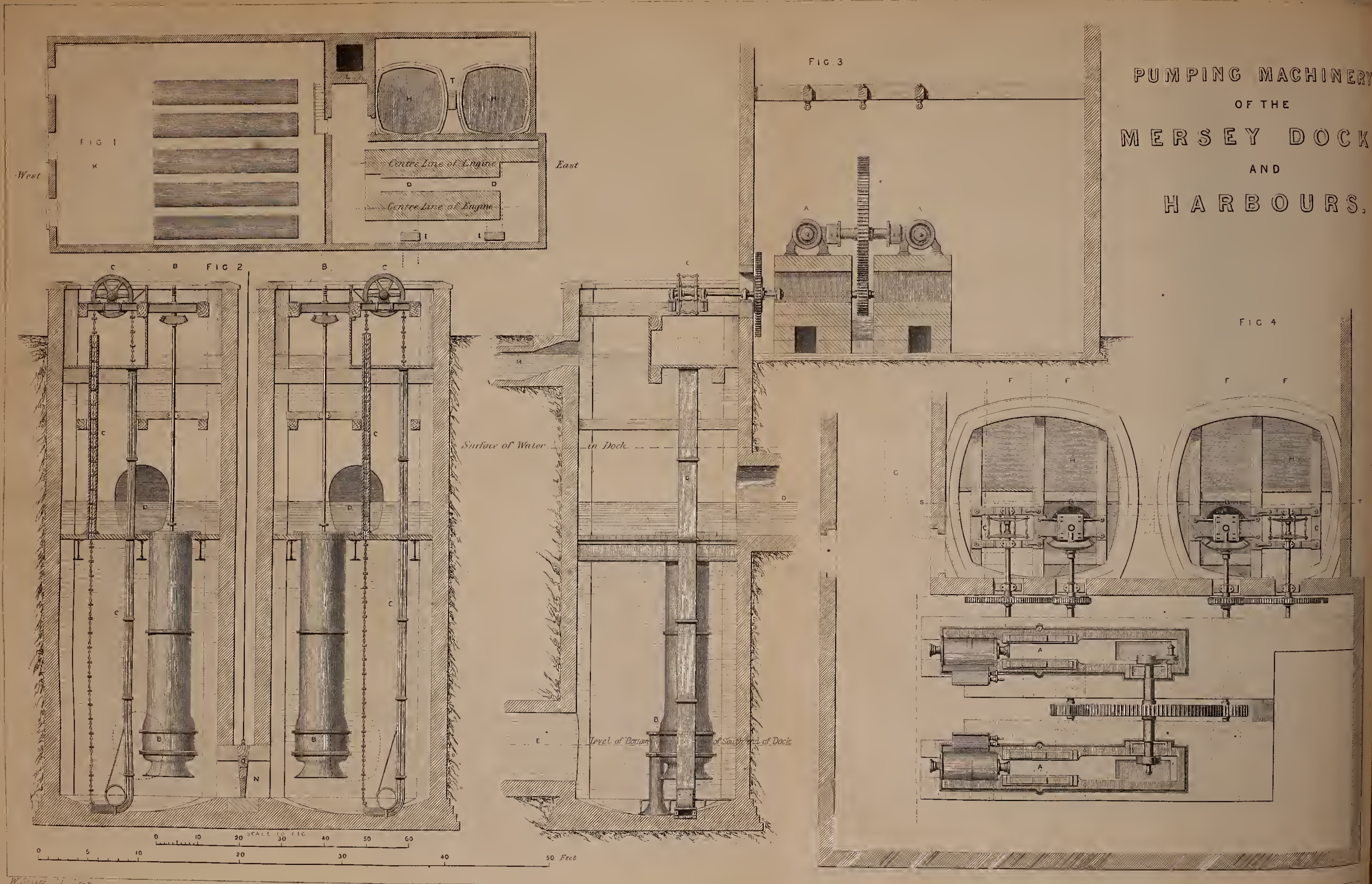
It appears to us not inappropriate to point out a few particulars of those branches of knowledge required by engineers in the various ramifications of the profession; and these may serve to illustrate the necessity of that qualification to which we have alluded, by showing, though very briefly, how numerous are the details which would fall within the comprehension of the civil engineer.

Commencing with hydraulic engineering, it is observed that a geological knowledge is, in the first instance, necessary to those projecting water-works, as, although a professional geologist may before designing the works be called in to report upon the character of the strata underlying the proposed site, yet, throughout the execution of such a project, difficulties constantly arise, which can only be overcome by a practical knowledge of the constitution of the earth's crust. To quote a case in point, we will refer to a locality where the water was obtained from springs issuing from the side of a cliff. These springs deviated, and were for a time lost, and the only way in which they could be recovered was by running adits into the face of the cliff, an operation which required a combination of the greatest care with an accurate understanding of the nature of the soil. The front of the cliff consisted of strong blue clay, similar to that which stretches in a north-east direction through some of the midland counties. Beneath the clay was a species of pulverulent oolite, through the interstices of which water rapidly penetrated. In dealing with these strata it was necessary to observe the greatest caution, in order to prevent the springs, when found, from bringing down a mass of earth on to the works beneath them; and had the engineer in this case been unacquainted with the substrata, it is evident that disastrous results might have ensued. It is also necessary, in dealing with hydraulic works, that dams and embankments be made of the proper solidity by punning the earth in thin layers, as, if this is not strictly enjoined, these works may be erected in the loose style of railway embankments.

Furthermore, some chemical knowledge is necessary to guide the engineer in designing his filtering and purifying apparatus, and, where he has a choice of sources of supply, in selecting that which is most suitable. There are some works constructed on the gravitation principle now in operation in the north of England, in the projection of which three springs were available as sources of supply. One of them yields water of a tolerable quality. This one was not used, the collecting reservoir being at such an elevation, that the water flowed just under the bottom. The springs which actually supply the town derive their water from a shallow surface drainage of peat lands, much frequented by cattle, and occasionally, after heavy rains, containing a little cretaceous matter. The filtering apparatus is quite inefficient, and the water supplied to the town is frequently of a deep straw colour. It appears evident that, in this instance, a very moderate amount of chemical knowledge, properly applied, would have led to a much more judicious and salubrious arrangement.

A great many of the inconveniences arising in connection with the supply of gas may be traced to the want of sufficient attention being paid to the

PUMPING MACHINERY OF THE MERSEY DOCKS AND HARBOURS.



chemical properties of those carbonaceous products from which they are evolved.

On one occasion the lack of a moderate amount of information in mineralogy gave rise to an awkward mistake in ballasting a line of railway. The material used appeared, when laid down, sufficiently sound, but in the course of a short time disintegrated, and presented the appearance of mud.

In the construction of steam machinery very great advantages may constantly be obtained by a correct appreciation of those natural laws upon which its action depends. In this department of the profession, chemical, geological, and mathematical details occur, and the best engines are doubtless those that are made in accordance with the results of the most scientific research, combined with and tested by the most extensive experience. So numerous and varied are the branches of scientific education desirable in those who practise in every part of the profession that it is doubtful if one individual can, except in a few unusual instances, be informed on all points; hence it is probable that certificates or diplomas issued from such a college as has been suggested, would require to be limited to such departments as the various candidates might have specially studied, for there is not one science which the engineer does not in some form or other, call to his aid, and, in addition to the time absorbed in acquiring theoretical knowledge, more must be devoted to practical observation—a process indispensable in the education of those engaged in the constructive arts, and one which cannot be hastened; for, in order that the full benefit of experience may accrue to the observer, the objects observed should be frequently before him, otherwise the impression produced by them is comparatively faint, and their details are not sufficiently studied.

HISTORICAL AND DESCRIPTIVE SKETCH OF THE MERSEY DOCKS AND HARBOUR.

By J. J. Birckel.

(*Illustrated by Plate* 282.)

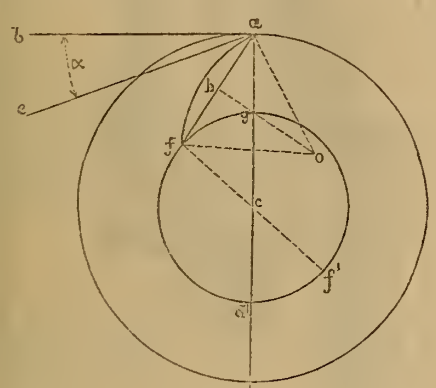
Upon Plate No. 282, we now have illustrated a specimen of pumping machinery such as is found upon the Dock Estate, either in temporary use upon works in course of construction, for the purpose of draining their foundations, or in permanent use for emptying such graving docks or locks as cannot be run altogether dry under the ordinary changes of tidal levels. In the former case, the chain pump is used in preference to any other, because the water which has to be raised is generally very muddy, and any other mechanical contrivance of more accurate construction, and entailing the necessity of mechanically fitting parts, would be absolutely inadmissible for such a purpose. It is doubtful, moreover, whether a much more efficient contrivance for raising water from great depths has been devised than the chain pump, for with it, when it is carefully erected, the losses of power by friction must be considerably less than in a bucket or plunger pump; and if any loss of power does occur through leakage caused by the easy fit of the chain paddles in the ascension shaft, that cannot be larger than the loss which occurs from a somewhat similar cause in an overshot water wheel, or in a high breast wheel; and yet are these machines held in high repute among others of their kind, as to the per centage of power which they yield. If to these considerations we add the paramount advantage just mentioned, which the chain pump possesses of being able to raise water, however thickly charged with sand, silt, or mud, without injury to itself, and remember that its first cost is considerably less than that of any kindred machine of the same power, not excluding the centrifugal pump, it becomes a matter for wonder why it is not used more frequently. This, however, may be accounted for, we think, on the ground of its being out of fashion, and because men would rather run after startling novelties which promise too often impossible results, than cling to that which is known to do its duty well. Upon these works, however, the chain pump is held in great favour still, and is employed under circumstances where even rotary pumps might be used.

The duties of the pumps illustrated here are to empty the graving docks which have been constructed in connection with the Birkenhead Dock scheme; these docks have their sills 7ft. 9in. below the datum of the old dock sill, and, consequently, their bottoms will be about 10ft. below that datum, or at about the lowest level of low water spring tides. And as there is a difference of nearly 10ft. between the levels of low water, spring, and neap tides, it was necessary to supply them with pumping machinery, that they might be emptied whenever that should be required. This provision is not needed in any of the Liverpool Graving Docks, which have their sills mostly at such levels as admit of their being run dry when the tide recedes at almost any period of the tidal cycle, excepting the Canada and the Huskisson Docks, which have their sills at the same level as the Birkenhead Graving Docks, and which, we presume, are furnished with pumps.

The centrifugal pump, which has lately attracted considerable attention, and which, in some of the shapes which it assumes, offers nearly the same simplicity of construction as the chain pump has been adopted here in conjunction with the latter—we presume on account of that very virtue—even under circumstances where the conditions of the problem to be solved prevented its use in that which is its simplest and most advantageous shape, that is, revolving upon a horizontal axis, and acting partly by suction, in order to avoid the necessity of its working under water. The conditions imposed by the dock engineer upon the parties who were invited to send in tenders and designs for these pumps were—that they should be able to raise the water to such a height as would admit of its being discharged into the great float at the level of highest tide, or into the river at a level of 10ft. above Old Dock sill—conditions which we shall see presently are, in the case of the centrifugal pump, altogether at variance with that other condition, always implied if not expressed, that it should perform the highest possible duty under all circumstances. The chain pump, however, was inadmissible in this case, because it would have had to work under conditions similar to those of a water wheel working in back water, and it is attached to the centrifugal pump for the purpose only of raising the lower layers of water, which are too thickly charged with mud to be raised by the former.

We have just said that the centrifugal pumps have attracted great attention of late, and we venture to say, also, that the attention of our readers has been much attracted to a deal of controversial writing, to which the public have been treated ever since the date of the Exhibition of 1862, not so much, we are inclined to think, to do justice to the merits of that mechanical contrivance generally, or to make known the principles which should govern its construction, as to extol the performances of the pumps made by Messrs. Gwynne on the one hand, or of the pumps made by Messrs. Amos on the other, as, though these gentlemen respectively possessed a specific recipe for the construction of pumps of the kind under consideration, which, however, if they do, has been, either wittingly, or else through ignorance, kept from the world; for while Mr. Colburn has pretty successfully endeavoured to show that Mr. D. K. Clarke is not competent to judge of the merits of these pumps, as shown by their performances, himself has not deigned to instruct the world on the subject of that unknown recipe; and, as we are not aware that a theoretical investigation of the action of this mechanical contrivance has been published in any of our engineering contemporaries, believing that many of our readers will welcome its publication, we take this fitting opportunity to lay it before them, as we know it to be propounded by French writers on mechanical subjects.

These pumps generally consist of a number of blades or vanes, sometimes curved and sometimes straight, fixed upon a shaft or spindle with which they revolve, generally at very great speeds, within a casing into which they are fitted very accurately, and which has one or two openings towards the centre for the suction, and one or more towards the circumference for the discharge; their construction in fact is, generally speaking, similar to a fan, as also is their mode of action. The whole of this apparatus may be entirely submerged, as in the case illustrated, or may work by suction and be placed at a limited height above the level of the water; but in either case the action of the centrifugal force impels the water contained within the body of the apparatus towards its outer circumference, and thus causes a partial vacuum towards the centre, which vacuum increases with the velocity of the disc, and into which the water from the reservoir outside is drawn by virtue of the excess of the atmospheric pressure over that in the disc; the water in the stand pipe rises to a height corresponding to the circumferential velocity of the disc. As for the height to which the water will rise into the disc by suction, that is dependent upon the degree of vacuum created, and is limited by the height due to the entire atmospheric pressure (33ft.), which, however, it could never attain. Thus we see that this apparatus is at once a suction and a force pump.



Call V_1 the angular velocity of the revolving disc (*i.e.*, its circumferential velocity measured at a distance of 1ft. from the centre).

R the external radius of the disc.

$M = \frac{W}{32}$ the mass of water raised per second, W being the weight of the same.

The mechanical work *per second* performed by the centrifugal force upon the mass M, which travels from the centre to the circumference in the disc is—

$$\int_0^R M V_1^2 x\, d x = \tfrac{1}{2} M V_1^2 R^2$$

which simply expresses the well-known truth that the quantity of work absorbed by the mass in motion, is equal to one-half its *vis-viva*, and this would give us the expression of the mechanical work required to raise a weight of water, W, to the height, H, if no loss of *vis-viva* occurred during the passage of the water from the lower reservoir into the upper one. Such losses, however, do occur when the water enters the suction pipe, when it reaches the blades at the inner circumference of the disc, and when it leaves them at the outer circumference; there occurs, moreover, a loss by friction of the water in the pipes, and a loss due to the velocity with which the water reaches the level to which it is to be raised. These losses all, according to General Morin's experiments, amount to thirty-five per cent. of the total work expended, so that finally we have

$$M g H = W H = 0{\cdot}65 \frac{M V_1^2 R^2}{2};$$

whence we obtain

$$V_1^2 R^2 = \frac{2 g H}{0{\cdot}65};$$

or, calling V the circumferential velocity due to the height H,

$$V = V_1 R_1 = \frac{\sqrt{2 g H}}{0{\cdot}806} = 1{\cdot}24 \sqrt{2 g H};$$

and for the height corresponding to a circumferential velocity V,

$$H = \frac{V^2}{3{\cdot}075\, g};$$

or, calling N the number of revolutions of the disc per minute, we may put for V,

$$V = \frac{2 \pi R N}{60},$$

when H becomes

$$H = \frac{4 \pi^2 R^2 N^2}{3600 \times 3{\cdot}075 \times g} = 0{\cdot}00073\, R^2 N^2;$$

From which formula, any two of the factors H, R and N being known, the third may be found.

As the velocity of the water increases gradually as it reaches the outer circumference of the disc, the sectional area of the disc, measured upon successive circumferences, should diminish gradually, in order to avoid loss of vis-viva by eddies inside the disc, consequent upon its not being full; and in those pumps experimented upon by General Morin, which gave the best results, the effective area of discharge was 0·75 of that of the inlet pipes; the area of these was exactly one-half the area of the circle of the disc, or

$$\frac{\pi R^2}{2},$$

and as the effective area of discharge is very nearly equal to

$$2 \pi R b \sin \alpha,$$

b being the breadth of the blades of the disc at the outer circumference, and α the angle which the last element of the blades makes with the tangent to the circumference, and which, in the same pumps was about 20°, so that sin α was 0·342, and the relation between the effective area of discharge and the area of the inlet or suction pipes was

$$0{\cdot}75 \frac{\pi R^2}{2} = 2 \pi R b \times 0{\cdot}342;$$

whence we may deduce for the value of b,

$$b = \frac{0{\cdot}75}{1{\cdot}368} R = 0{\cdot}5 R \text{ nearly.}$$

In order now to ascertain the quantity of water which such a pump may discharge, it should be remarked that the whole of the vis-viva communicated to the water is due to the action of the centrifugal force; so that if V_0 be the velocity of exit of the water, we may write

$$M V_0^2 = M V_1^2 R^2;$$

whence

$$V_0 = V_1 R = V.$$

That is to say, the water leaves the blades with a velocity equal to the circumferential velocity of the disc. If, therefore, we call Q the quantity of water in cubic feet discharged by the wheel in one second, we shall have,

$$Q = 2 \pi R b \times 0{\cdot}342 \times V_1 R = 2{\cdot}15\, b\, R^2 V_1;$$

And as we have already put

$$V_1 R = 1{\cdot}24 \sqrt{2 g H},$$

we obtain by substituting

$$Q = 2{\cdot}66\, b\, .\, R \sqrt{2 g H};$$

from which formula either R or b may be found, when the quantity of water and the height to which it has to be raised are given, if either b or R be assumed; and if the proportion $b = 0{\cdot}5$ R be assumed, the radius of the disc will be found, thus,

$$R = \sqrt{\frac{Q}{1{\cdot}33 \sqrt{2 g H}}}$$

In designing a pump of this kind it should be borne in mind that the limit of the velocity with which the water enters into the disc is that due to the atmospheric pressure, and which is equal to

$$8 \sqrt{33} = 46\text{ft. nearly.}$$

when the disc works under water; but if the disc works at a height h above the level of the water that velocity would be equal to

$$8\sqrt{33 - h};$$

and in order to enable the suction pipe to supply the pump it will be necessary to give it an area such that it may answer to the condition

$$m \,.\, A \,.\, 46\text{ft.} > Q,$$

A being the area of the suction pipe, and m = say, 0·75, the co-efficient of contraction; or if the disc be not immersed

$$m \,.\, A \,.\, 8\sqrt{33 - h} > Q;$$

else the pump will not supply water continuously. It is advisable that the product m . A . 46ft. be considerably larger than the quantity Q.

It has already been stated that the angle a of the last element of the blades with the tangent to the circumference should be 20°, but it is necessary now to ascertain the proper angle of the blade with the internal circumference of the disc, and thence to arrive at the shape of the blades. To this effect it should be observed that the velocity of the water due to the action of the centrifugal force when it has reached the internal circumference is $V_1 R_1$ (R_1 being the radius of that circumference), and its direction is radial; on the other hand, the circumferential velocity of the blades at that point is $V_1 R_1$ also, and as the velocity with which the water enters into the disc is the resultant of these two velocities, its direction will lie at an angle of 45° with the tangent to the circumference, and this should be the angle which the blades should make with that tangent in order to avoid shocks; the question therefore resolves itself into this problem of geometry, viz., *To inscribe an arc of a circle between two concentric circumferences, such that it intersect the external one at an angle* a *of* 20°, *and the internal one at an angle* β *of* 45°, which may be solved in the following manner:—At any point a of the external circumference of the disc draw a tangent $a\ b$, and a line $a\ e$, which makes with the former an angle of 20°. From the point a draw a o perpendicular to the line $a\ e$; upon the internal circumference make the arc $d\ g = a + \beta$; produce $a\ g$, and from the point h, middle of the line $a\ f$, draw h o perpendicular upon $a\ f$, and the point o of its intersection with a o is the centre of the arc $a\ f$, which answers to the conditions of the problem.*

Having thus placed before our readers the theoretical considerations by which the construction of these pumps should be governed, it would be interesting to compare the performances of the pumps illustrated with the probable results of pumps constructed on the principles thus laid down; but, in the absence of reliable experimental data, that comparison is impossible, and all that we can do is to point out the results which they ought to yield. It may, however, at once be observed that the height to which the water has to be raised—or the circumferential velocity of the disc—its radius and the breadth of the blade at its external circumference being correlative terms, of which if one changes the others ought to change also if the pump is to continue yielding its maximum useful effect, it can scarcely be expected of those here illustrated that they will give equally satisfactory results throughout, from the period of starting until they have emptied the graving docks; indeed, the range of height is so considerable, that it is scarcely possible to obtain a corresponding variation in the speed of the engines, so that, from the beginning of the operation of emptying the docks until towards the close of that operation, the velocity of the pumps is likely to be too great, and thus will occasion a great loss of power merely in churning the water. We should, therefore, not be surprised to learn that the dock engineer is disappointed in his expectations of their performance.

¶ The range of speed, as indicated on the enlarged section and plan of the disc and casing in the accompanying woodcuts, Figs. 1 and 2, is from 170 to 290 revolutions, which latter corresponds to a circumferential velocity due to a head of 36ft. 6in., very nearly, as calculated by the formula given above; and if the quantity of water which *one* of the pumps should discharge when working at a mean velocity of 230 revolutions be calculated on the assumption that it is constructed in conformity with the principles above enunciated, it is found that it should discharge about 13½ million gallons of water in twelve hours; and as the capacity of one of the docks is rather better than 14 million gallons, one

FIG. 1.

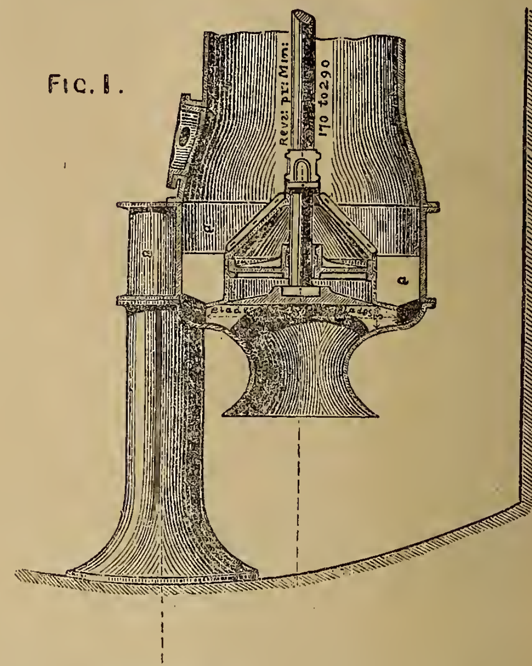
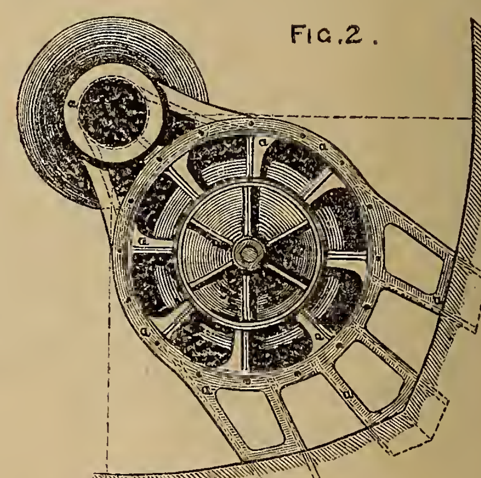


FIG. 2.

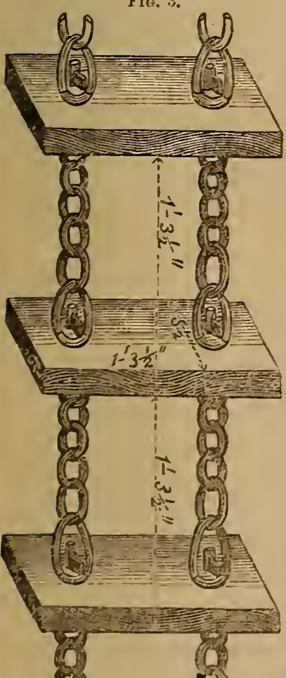


* The following will demonstrate the correctness of this construction:—The angle $c\ a\ o = \alpha$, and if we call c the angle $c\ a\ f$ then $a\ o\ f = c + \alpha$, and as in the triangle $a\ o\ f$, $a\ o = f\ o$, the angle $o\ f\ a = o\ a\ f = c + \alpha$, but the line $o\ f$ being perpendicular to the arc $a\ f$ at the point f, and the line $c\ f$ being perpendicular to the internal circumference at the same point, it follows that the angle $c\ f\ o$ is equal to that which the arc makes with the circumference at the point f, and therefore $c\ f\ o = \beta$; consequently angle $a\ f\ c = c + \alpha + \beta$, and $a\ f\ c - c\ a\ f = a + \beta$. The problem now resolves itself into the following:—To construct a triangle $c\ a\ f$ of which the two sides $c\ a$ and $c\ f$ are known, and of which the two angles $c\ a\ f$ and $c\ f\ a$ shall differ by a quantity $a + \beta$; but the angle $a\ f\ c = 180° - c\ f\ g = 180° \frac{g\ d_1}{2} - \frac{d_1 f_1}{2}$ also angle $c\ a\ f = \frac{g\ d_1}{2} - \frac{f\ d}{2}$; and as $f\ d = d_1 f_1$, it follows that $a\ f\ c - c\ a\ f = 180° - g\ d_1$; but again $180° - g\ d_1 = d\ g$, therefore, $a\ f\ c - c\ a\ f = a + \beta = d\ g$, which gives the direction of the secant $a\ g$, and consequently the point f.

of these pumps should nearly empty it in a working day of twelve hours.

The engines are horizontal, and have cylinders of 24in. diameter × 4ft. stroke, working expansively by means of a cut off slide valve, and the maximum rate of expansion is about from $\frac{1}{4}$ of the stroke; they make from 30 to 50 revolutions. There are two wells, each of them, we presume, connected with its own dock, since each of them contains both a rotary and chain pump; each of these may be thrown out of gear when the other one is working, or both pumps may be thrown out of gear at the same time, so that the engine may only work one or both the pumps of one well. The wells are connected by the passage N, provided with sluice valve O. The drum of the chain pumps is 3ft. 6in. diameter, and makes about 100 revolutions per minute; a detail of the chain is shown in the woodcut, Fig. 3.

FIG. 3.



In the accompanying plate, Fig. 1 is a general plan of the engine and boiler house; Fig. 2 is a section on the line S T of the plan, Fig. 4, taken through the two pumping wells, showing the pumps and gearing, &c.; Fig. 3 is a section taken on the line U V of the plan; Fig. 4, of the engine and pumping house. In these several views A A are the engines; B B, the bevil gearing for working the centrifugal pumps; C C, the chain pumps, fittings, and connections; D D, discharge culvert to sewer, leading into river; E, let in culvert from sewers, leading from docks to pump well; F F F F, discharge culvert, leading to large float; G, discharge culvert from chain pumps; H H, the wells; I I I, the "cloughs;" K, the coal space in boiler house; L, the chimney shaft; M, culvert leading into great float; N, passage between the two wells; O, sluice valve in the same.

The boilers are five in number—34ft. long, and 5ft. 6in. diameter, with a single flue 3ft. 2in. diameter. Each of these may be termed a 30ft. horse boiler, but should be able to supply steam for at least indicated horse; and as the highest duty that one of the rotary pumps can do is to raise 3,650 cubic feet of water 36½ft. in one minute, which represents a work of 250 indicated horse, there should be no lack of steam power. The engines themselves, we are inclined to think, might with advantage have been a little heavier, to enable them to do this work without throwing considerable strains upon their working parts.

The cost of this machinery was, we understand, about £7,000.

(*To be continued.*)

ON WORK AND VIS-VIVA.

By J. W. NYSTROM, Acting Chief Engineer, U.S.N.

(From the Journal of the Franklin Institute.)

In a previous article on Physical Work, a continuance of the same subject was promised, extending to the combined action of gravity and mechanical force, the manuscript of which has since been lying on the shelf, awaiting some criticisms on the part already published.

In the great confusion which now involves the subject, it was deemed necessary to advance cautiously, having each step of progress thoroughly discussed as far as it went; for experience admonishes us, that any reform, however simple or important, cannot be introduced and accepted without due deliberation.

The liberal criticisms of Professor De Volson Wood, of C.E. University of Michigan, however much at variance in doctrine with my own, were perused with unaffected satisfaction, and should the interest in the subject evinced by him be followed by others, we might hope that valuable light would ultimately be shed upon it.

The greater part of his criticism is derived from misconception of the meaning of the letter V. In work (W = F V T), V means the velocity of the force F; or if F and V either, or both, are variable, then they can only signify the mean force, and mean velocity in the time T. In the member M V^2, V means the uniform velocity of the moving body M, after the force has ceased to act upon it; or the final velocity imported to the body M by the force F at the time T.

Professor Wood says,—"The member F V T does not express the work which the force F does upon a body free to move, in producing the velocity A in time T; but when the body is free to move, as here supposed, it equals one-half the work." In this he is in error. F V T equals twice the work when V means the final velocity of the constant force F at the time T, because the final velocity of the force F is just twice its mean velocity in the time T, as will be proved hereafter.

Professor Wood says,—"If still further we admit that F T = S and $V^2 = 2\,g\,S$, we have, by substitution and reduction, F = 2 W, which cannot be true." This is most probably a misprint, and Professor Wood means F V = S, in which case V must be the mean or uniform velocity in the space S; but in the formula $V^2 = 2\,g\,S$, V means the final velocity in the space S, which reduces F = W, which is true. Professor Wood by W means weight. He says,—"We see, then, that the equation F V T = M V^2 reduces to an absurdity under every hypothesis except the first, and, in that, it simply gives a true equation without expressing the value of work." Is it possible that the formula can be a true equation of work without expressing the value of work? It gives precisely the same value of work as vis-viva; still he says,—"We see, then, that it never expresses the true relation between work and vis-viva." I contend that it does, and shall proceed to prove it in this article.

If I am not very much mistaken, Professor Wood is confused in his conception of force, power, and work. He says that "work was called by Smeaton mechanical power, and by Monge and others dynamic effect." I understand those authors to mean F V for mechanical power and dynamic effect, and not F S, which is work, and regret that I have not succeeded in making Professor Wood understand the difference between power and work, and that F V T is work. He admits that S = V T, when V is constant; he also admits that work is F S; will he then not allow us to insert V T for S in work, which will make F V T? Professor Wood further says,—"Now the work alone in the space is the same, whether it be done in one hour, day, or week; it is independent of the time." Then he confounds horse-power with work, in which he says time is included. This radical error has been persistently maintained in antagonism to me by professors and engineers, from a date long antecedent to my article on Work as published in this journal; and Professor Wood will have no difficulty in finding supporters in that doctrine, for, as accepted by him, it is taught in schools and colleges. I have in the last eight months had frequent occasion to discuss the subject with engineers, some of whom were apparently fresh from college, and have studied, Wiesbach's, Bartlett's and Moseley's "Mechanics," and who not only differ with me on the subject, but also disagree amongst themselves. They all seem to agree that time is not included in work, and the few who acknowledge the existence of power as a different quantity from work, also agree that time is included in power, but not in work. They argue that "the unit of power is 33,000 lbs. lifted 1ft. per minute, whilst work is 1lb. lifted 1ft. independently of the time." They also assert that space is a simple element, and that velocity is a compound result of time and space.

My argument, on the contrary, is this: that the space 1ft. is the product of time and velocity, and when we say per time, in the unit of power, we divide the space by the time, and the remainder is only pounds and velocity. Therefore, in the ordinary conception of work F S, the time and velocity are included in the space S.

Let F = weight or force in pounds; v = velocity in feet per second of the force F, t = time in seconds; F and V being constant or the mean in the time t, S = space in feet traversed by the force F; P = power expressed in foot-pounds of power; W = work in foot-pounds of work.

The popular expression of power is—

$$P = \frac{F\,S}{T}, \text{ but when } S = v\,t,$$

$$\text{we have } P = \frac{F\,v\,t}{t} = F\,v, \text{ the primitive for power.}$$

The popular expression of work is

$$W = F\,S, \text{ but when } S = v\,t,$$

$$\text{we have } W = F\,v\,t, \text{ the primitive formula for work.}$$

These are the fundamental formulas throughout the science of dynamics. They include the whole conglomeration of vis-viva, the different momentum and quantities of motion, activity, inertia, energy, dynamic effects, as shall hereafter be proved.

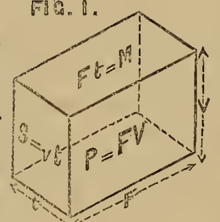
It is perfectly absurd to say, with Professor Wood and others, "that work is independent of time." If that were so, why then is time such an important item in contracts for work? and why do we so often fail to accomplish a contracted work in a specified time? In digging a canal, the power in operation, $P = F v$, is represented by the number of labourers, and the quantity of work accomplished will be direct as the time. Professor Wood may do a work in one minute, in one day, or in any time he pleases—the work accomplished will, in all cases, be $F v t$, and nothing else. For a given quantity of work, time can vary only at the expense of power. On Professor Wood's reasoning we can say that work is independent of force, because a force of 1lb. can accomplish as much work as a force of 100lbs., but at an expense of time and velocity only. Cannot the Professor understand and admit that space cannot be accomplished without time and velocity? He may easily satisfy himself in simple experiments by drawing chalk lines on the black board.

Professor W. maintains that the English unit of work is 33,000lbs. raised 1ft. per minute. This is the English unit for power, and not, as he erroneously assumes, for work.

Power is the rate at which work is executed.
Power is working or labour, and the result of labour is work.
Power is the differential of work.
Work is the integral of power.

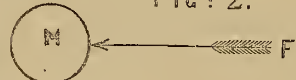
The subject may be better illustrated as follows:—

FIG. 1.



The three dimensions, length, breadth, and thickness in this parallelopipedon, may be assumed to represent the elements Force F, Velocity v, and Time t. The area of the side elevation $F v$ therefore represents the power; the area of the end elevation $v t$ represents the space; the area of the base $F t$ the momentum; and the cubic contents $F v t = F S = P t$ represents the work, provided that the force F and velocity V are constant in the time T. But when F and v are either or both variable, they will generate and be represented by various other figures. In the case of a constant force F acting on a mass free to move, the velocity will be variable with a uniform acceleratrix, then the work done will be represented by a wedge.

FIG: 2.



Let a constant force F, Fig. 2, act on a mass or body M, in the direction of the arrow, F and M being expressed by the same unit of weight, say pounds, and no other force acting on M; then we know, from the law of gravity, that the acceleratrix of the force F will be

$$G = \frac{g F}{M}.$$

Let the force F act on for any length of time T, then we know, from the law of gravity, that the final velocity attained will be,

$$V = G T.$$

Let v denote the velocity at any time t, both less than V and T, then the power in operation will be,

$$P = F v,$$

and the differential work will be,

$$d W = F v \, dt,$$

but $v = G t$ and

$$d W = F G t \, dt,$$

when

$$W = \int_{t=0}^{t=T} F G t \, dt.$$

$$W = \overset{1}{\frac{G F T^2}{2}} = \overset{2}{\frac{F V T}{2}} = \overset{3}{\frac{F V^2}{2 g}}$$

which are the three forms of work accomplished by the constant force F acting on the body M in the time T.

We know that $F = \frac{G M}{g}$ which, inserted in the above members, will give

$$W = \overset{4}{\frac{G^2 M T^2}{2 g}} = \overset{5}{\frac{G M V T}{2 g}} = \overset{6}{\frac{M V^2}{2 g}}.$$

These are the three forms of work concentrated in the moving body M. Comparing the 2nd and 6th members we have,

$$\frac{F V T}{2} = \frac{M V^2}{2 g}; \text{ or, } F V T = \frac{M V^2}{g} = 2 W, \text{ which was to be proved.}$$

When M denotes the mass of the body we have,

$$F V T = M V^2.$$

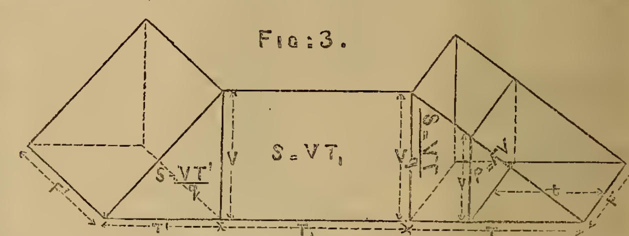
This is the equation which Professor Wood, in his criticism, proved to be an absurdity under every hypothesis. I cannot omit to state that his reasoning must be very elastic.

The member $M V^2$ is the mysterious quantity *vis-viva*, which I shall here endeavour to bring bodily to sight.

The velocity V in the preceding formulæ does not signify the mean velocity of the force F, but the final velocity imparted by the force F to the body M, in the time T; or the uniform velocity of the body M after the force F has ceased to act upon it. This final velocity at the time T is just twice the mean velocity of F in the time T, when F and the acceleration G are constant, as here supposed.

An illustration may form a clearer conception of the nature of the preceding formulæ.

Let the line F, Fig. 3, represent the magnitude of a constant force acting on a body free to move in the direction t, the line T to represent time; any ordinate v to represent the velocity of the force F at any corresponding time t, until F ceases to act, when the final velocity V will be constant. The hypothenuse for the catheters T and V will become a straight line when the acceleration of F is constant. Then the area of the cross



section $P = F v$ represents the power in operation at the time t; the area of the triangular side represents the space $S = \frac{v t}{2}$, passed through by the force F; the work done in the time t is represented by the cubic contents of the wedge $\frac{F v t}{2}$ or for whole time T.

When the force F ceases to act at the end of the time T, the body will continue with a uniform velocity V, and pass through the space $S = V T_1$, with its concentrated work $W = \frac{F V T}{2}$ until we will suppose some force F' is applied to stop it.

The linear space S which the body passes through in the time T_1 is on the figure represented by the rectangular area $V T_1$, constituting the elements of space.

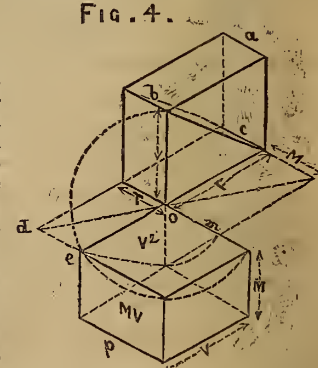
The body will come to rest when the work of the opposing force F' is equal to the work accomplished by the force F, or when $\frac{1}{2} F' V' T' = \frac{1}{2} F V T$. Let the common factor $\frac{1}{2} V$ be eliminated, and the momentums $F' T' = F T$ when the body comes to rest.

It has before been proved that

$$2 W = F V T = M V^2$$

and the momentum $F T = M V$.

FIG. 4.



Now let the parallelopipedon $a b T c$, Fig 4, represent $F V T$, which, as before shown, is double the work, when V = final velocity; then the base will represent the momentum $F T$. Continue the line F from o to e; make $o e = V$; complete the rectangle $T d e$, draw the diagonal $d o$ continued to M, c and M being in a straight line; then M represents the magnitude of a mass in which is accumulated the work $\frac{1}{2} F V T$. Complete the square V^2, and draw on it the figures $m e p V M$, which then represent the so-called *vis-viva* $M V^2$, in a moving mass, of which only one-half, or the wedge $m n r$, is realised as substance, while the other half, or the wedge $n r p$ remains in mystery.

Vis-viva is the most unfortunate term in dynamics, inasmuch as it does not express what it means, neither in substance nor in quantity. There is no more *vis-viva* in a moving mass than in one at rest. It requires F v t and nothing else to set a mass in motion; it requires F v t and nothing else to bring a moving body to rest; and it is F v t, and nothing else, that can change the motion of a body.

The sooner the term *vis-viva* is rejected in its present acceptation, the sooner will the science of dynamics be cleared up. Whatever name may be selected for the work concentrated in a moving mass, it ought to express the fundamental elements F V and T. I would propose to call it energy, but even if the term *vis-viva* is maintained, it ought to mean the true work $\frac{1}{2}$ M V^2 and not M V^2.

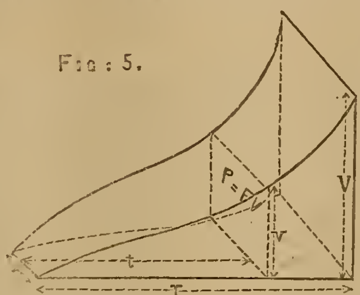


Fig. 5.

A parallelopipedon constructed on the mean velocity will represent the true work F v t.

When the force F is variable, as represented by Fig. 5, the hypothenuse of the catheters F and V will be a curved line, the form of which depends on the nature of variation of F, but the work will still be

$$W = \int F\,G\,t\,dt, \text{ as before.}$$

Momentum, $\quad M\,V = \int F\,dt.$

Velocity, $\quad V = \frac{1}{M}\int F\,dt.$

Space, $\quad S = \int d\,v \int F\,dt$

Power, $\quad P = \frac{F}{M}\int F\,dt$

Work, $\quad W = \int P\,dt = \Sigma\,F\,v\,t = \frac{M\,V}{2\,g},$

which will represent the work under all circumstances.

The form of the figure of work depends on the nature of variation of F and v.

In the case of a body moving through a fluid, as a vessel through the the water, a bomb through the air, where the resistance is as the square of the velocity, the figure of work will be a pyramid.

Comparing the members 1 and 5 we have,

$$\overset{1}{\frac{G\,F\,T}{2}} = \overset{5}{\frac{G\,M\,V\,T}{2\,g}},$$

or the momentum,

$$F\,T = \frac{M\,V}{g},$$

For circular motion we have the velocity,

$$\overset{11}{V = \frac{2\,\pi\,R\,n}{60}}$$

which insertion in the member 10, will be

$$\overset{12}{FT = \frac{M\,2\,\pi\,R\,n}{60\,g}},$$

in which R = radius of gyration of the rotating body, and n = number of revolutions per minute.

A force multiplied by the lever it acts upon is called static momentum; which is analogous to the force of inertia multiplied by the radius of gyration MR, which seems to have a claim to be called moment of inertia.

The square of the member 11, inserted in the member 6, will represent the work concentrated in a revolving mass, or

$$W = \frac{M\,4\,\pi^2\,R^2\,n^2}{3600 \times 2g} = \frac{M\,R^2\,n^2}{5866{\cdot}8},$$

of which the part MR^2 has been denominated moment of inertia.

I was in error in my statement that "Moseley called moment of inertia, work." I ought to have said that the substance of the so-called moment of inertia MR^2, is work when n is constant.

Professor Wood refers to his two articles on *vis-viva*, published in the November number, 1862, and in the February number, 1864, of the "Journal of the Franklin Institute." I beg leave to state that the confusion existing in those articles was one of the many reasons why I undertook to write on the subject, which was stated in the Franklin Institute; for in both those articles, as well as in the general criticism on mine, force, power, and work, are confounded with each other.

The article in the November number, 1862, page, 315, commences in this way:—"When we consider that eminent scholars have taken different views upon the measure of the force in a moving body, it is not strange that students, while yet in the elements of mechanical science, should be at a loss to know whether the force varies as the velocity or as the square of the velocity." Here the professor confounds force with work and momentum. The force of inertia in a moving mass is equal to what external force is applied to change its motion. The different views taken by eminent scholars and students are, whether power or work is as the velocity or as the square of the velocity. The professor continues, "They do not see why the momentum does not express the force as well as the *vis-viva*; or they fail to distinguish between the two forces." Force is neither momentum nor *vis-viva*. Force is, as far as we yet know, a simple element; whilst momentum is a compound of two elements, and *vis-viva* a compound of three elements. The momentum in question is derived from the analogy

$$F : M = V; \text{ or } F : FT = MV.$$

The momentum FT is equal to the momentum MV. It is the momentum MV which the professor calls one kind of force as different from MV^2, another kind of force. The momentum MV is substantially the same as the product obtained by multiplying six horses by four bushels of barley; it must be multiplied or divided by some element before it can be recognised as a physical quantity; if we multiply MV by V, the product will work; multiply MV by $\frac{G}{g}$, the product will be power; divide it by T and it will be force; divide it by F and it becomes time. If six horses can eat three bushels of barley, how many horses can eat four bushels? Here we multiply six horses by four bushels of barley, which will only be a momentum to be divided by three bushels of barley, when the result will be eight horse. On the same page, 251, Professor Wood says, "The force which is stored in a moving body, is a force of inertia; hence it is equivalent to the force which would cause the body to move from a state of rest to a velocity V, when free to move without any resistance."

It is most difficult in this case to distinguish if the professor means force or work. The force of inertia in a body free to move is equal to any external force applied to change its motion; but the force which has set the body in motion has no necessary relation with the force which may bring it to rest, except with consideration of time, as in case of gravity acting on a pendulum; but the work expended in setting a body in motion is equal to the work required to bring it to rest.

On the next page, 352, Professor Wood gives an example of momentum by multiplying the weight of a moving mass 200lbs. by its velocity 2ft., and calls the product 400lbs. feet, but does not state what kind of foot-pounds. Can this momentum lift 400lbs. one foot high in a unit of time or independently of time? Next the Professor gives an example of *vis viva*, by multiplying the same mass 200lbs. by the square of its velocity $200 \times 2^2 = 800$, but does not state what kind of substance this 800 is. From the commencement of his article we are led to suppose it to be force. The fact is that the *vis-viva* 800 is in substance foot-pounds of work; while the momentum 400 multiplied by $\frac{G}{g}$ will be in substance foot-pounds of power. The Professor, however, admits that his example may appear paradoxical. The difference between foot-pounds of power and foot-pounds of work is the same as the difference between square feet and cubic feet. Professor Wood thinks that "the reason why much obscurity has hung over the subject is principally on account of brevity of treatment by most authors." I do not believe that such is the case, but is owing rather to a want of a clear conception on the subject, which all our treatises testify by their unnecessary complication and confusion. Professor Wood gives me credit for the definition of power, to be "force multiplied by velocity." I learned that at the Royal Technological Institute in Stockholm, when I was a boy, and it is so used by all practical steam engineers throughout the world, for calculating the power of steam engines. The force on the steam piston multiplied by its velocity is the power of the engine. The definitions of force, power, and work, are intended only to hold good in the science of dynamics. I will not undertake to define those terms as they are used in popular language. The only new term I proposed in my article was Workmandays.

In the first formula for work under action of gravity, page 321, last volume, the number 2 is left out in the denominator. It should read,

$$W = \frac{M\,V^2}{2\,g\,550 \times 3600}$$

ROYAL INSTITUTION OF GREAT BRITAIN.

ON THE CHEMICAL CIRCULATION IN THE BODY.

By Henry Bence Jones, M.A., M.D., F.R.S., Hon. Sec. R.I.

All our knowledge usually passes through three stages as it advances to perfection. First, a stage in which we think we know everything: then a stage in which we find we know nothing; and, finally, a stage in which we rapidly obtain those clear and connected ideas in which all sound knowledge consists.

As regards the absorbent system of animals and the mode of action of remedies, we have long been in the first or second stage, and this evening I hope to show you that there is reason for believing that in regard to these subjects we are about to enter on the third stage; for that, in addition to the circulation of the blood, there is the dawn of another or chemical circulation, dependent in part on the mechanical circulation, but carried on mostly by diffusion from the blood into the textures, and from the textures into the absorbents, which thus become necessary agents for promoting those actions of oxidation and nutrition on which, in great part, animal life depends.

Mr. Huggins, in his discourse last week, showed us how the spectrum-analysis can determine the chemical composition and the physical constitution even of substances outside those circulating bodies that constitute our solar system. And as the nebulæ and fixed stars are beginning to be analysed, so in the microcosm of our own bodies substances that are outside the circulating system of the blood can (by the peculiar light they give when burnt) be analysed with such delicacy that elements can now be therein discovered which all other modes of analysis would entirely overlook.

The human body, in this discourse, may be regarded as consisting of four parts—a funnel, a circle, an envelope, and a drain.

The laws of diffusion modified by pressure determine the passage of all substances from the funnel into the circulation, from the circle into the envelope, and from the envelope or circle to the drains. To Mr. Graham we owe the investigation of the laws of diffusion of gases and liquids, and the division of substances into crystalloids and colloids. One or two experiments, and for them I am indebted to Mr. Ansell and to Mr. Graham, will make the meaning of these terms more clear to you. Inside and outside this porous cell there is at present atmospheric air. There is no passage of the outer air into the inside of the cell, nor of the inside air to the outside of the cell; but if hydrogen is put outside, being lighter than common air, it rapidly passes into the inside of the cell, whilst the heavier air inside more slowly passes out, and thus pressure is produced inside the cell, and the index shows how much pressure exists. So also with this india-rubber ball. When the gases inside and out differ, the lighter gas will pass rapidly in, and such an alteration of form will occur that a spring will be liberated, and this bell will say that light gas has passed through the india-rubber ball. Mr. Ansell has invented this test for the explosive gas in coal mines, that it may ring its own alarm. In these beautiful illustrations of Mr. Anderson's the same excess of diffusion of the lighter over the heavier gas is shown more slowly. Originally over both jars the india-rubber was flat. But through this concave india-rubber the hydrogen has more rapidly passed out than the air has passed in; and through the convex rubber the hydrogen has more rapidly passed in than the atmospheric air has passed out.

So with these liquids, for which I am indebted to Mr. Graham. Here is a very diffusable crystalloid substance, acetate of rosaniline, or magenta; and in this other vessel there is a much less diffusible or colloid substance, cochineal. In half-an-hour the crystalloid will pass through the membrane, whilst the colloid will show no signs of passage.

Here is another semisolid contrast. In the one jar there is bichromate of potash in gelatine above, with pure gelatine below; and in the other cochineal in gelatine above, and pure gelatine below; the bichromate diffuses whilst the cochineal is unmoved.

The same laws of diffusion modified by pressure determine in the body the passage of substances from the funnel into the circulation, from the circulation into the tissues or ducts, and from the tissues back through the absorbents to the circulation.

The circulation must not be regarded as the stem of a tree curled round on itself, but rather as a series of circles formed by each terminal branch twig joining a terminal twig of the root. The enormous number of these terminal circles may be seen in any injected preparation of any part of the body. The whole substance seems to consist of these vessels alone. The walls of these vessels are of the finest membrane, through which diffusion takes place with the greatest rapidity into the tissues beyond the circulation. These tissues constitute the different organs of the body—nerves, muscles, glands, ligaments, bones, &c. Each particle of each nerve, muscle, or gland, is encompassed by blood-vessels on which its growth and its action depend; but there are some few spots in the body where blood-vessels would be dangerous to the function of the part. These parts may be called the fixed stars of our microcosm; they seem outside the circulating system which binds together the rest of the body.

The most numerous of these fixed stars are the cartilages of the joints; and at a far greater distance may be placed the most remarkable twin stars of our body, the crystalline lenses, which, without any circulation of their own, are separated from all circulation by an aqueous and glassy fluid, which themselves also have no circulation. The lenses might well be thought to be altogether free from all the multitude of disturbing substances that enter through the funnel into the circulation of man. By this model, perhaps, you will best realise the distance of the lens from the circulation of the blood.

The lenses, the humours of the eye, and the cartilages of the joints, thus constitute the parts of the envelope most distant from the vessels, whilst the proper tissues of the various organs of the body constitute the parts of the envelope most immediately touching the circulation. The absorbent system and the ducts of glands constitute the drains by which substances that have passed out of the circle into the envelope are taken up into the circulation again or pass out of the body.

It has long been known that bile would diffuse into every texture; that madder would diffuse into the bones and into the fœtus, and urate of soda into the joints; carbazotic or picric acid into the skin; mercury into the gums; lead into the gums and muscles, and silver into the skin; and it has long been known that multitudes of substances would run through the funnel into the circulation and out through the envelope into some of the drains. Esther, asparagus, turpentine, and many other such substances, require no mention here.

It occurred to me that both in animals and in plants* the spectrum-analysis ought to determine with certainty where diffusing substances go to; how long they are in going out of the circle into the envelope; how long they stay in the envelope, and how quickly they cease to appear in the drain; and with Dr. Dupre's help a long investigation into the rate of passage of crystalloids into and out of the textures of the body was undertaken. The delicacy of the spectrum-analysis may be seen in this table:—

Chlorate of soda	$\frac{1}{195}$	millionth of a grain.
Carbonate of lithia	$\frac{1}{8}$	„
Chloride of strontium	1	„
Chloride of barium	1	„
Chlorate of potass	$\frac{1}{65}$	thousandth of a grain.
Chloride of lithium	$\frac{1}{12}$	millionth of a grain.
Chloride of rubidium	$\frac{1}{16}$	thousandth of a grain.
Chloride of cæsium	$\frac{1}{125}$	„

Soda exists everywhere, and in everything we eat and drink, so there was no use in looking for soda in the circulation and envelope, for it was sure to be there.

Lithia exists in many vegetable and animal substances, according to the soil on which they grow or live. Here is a table of substances which we examined for lithia:—

In potatoes—seldom found	In tea—slight traces
apples—sometimes	coffee—slight traces
bread—traces	ale—slight traces
cabbage—distinctly	porter—slight traces
Rhine wines—always	mutton—none
French wines—distinctly	beef—none
Sherry—distinctly	milk—none
Port—distinctly	

It had already been found—

In sea water
kelp
spring water sometimes
ashes of wood grown in the Odenwald
Russian and other potashes
tobacco
vine leaves and grapes
ashes of the produce of the fields in the Palatinate
milk of animals eating the produce
ash of human blood and muscle
meteoric stones
all the drinking waters of London.

The spectrum of lithium is very characteristic and very perceptible, and some approximation to a quantitive determination may be arrived at by observing the amount of substance that requires to be burnt to obtain the reaction, and by the necessity, in some cases, for the removal of interfering substances previous to combustion. Thus three degrees may readily be observed. The highest amount of lithia is present when each particle of the substance when introduced into the flame gives the lithia reaction; and a smaller amount of lithia is present when the whole of a lens or of an organ must be extracted with water to remove the lithia previous to combustion; and the smallest trace is present when the substance has to be incinerated, the ash treated with sulphuric acid, the excess of acid driven off, the dry residue extracted with absolute alcohol, the alcohol evaporated, and the dry residue tested. These three quantities may be designated as the slightest trace, a trace, and plenty.

As soon as experiments on man and animals showed that the infinitesimal quantities taken in with the food were rarely to be perceived in the envelope, experiments were made to determine how quickly the lithium diffused from the funnel into the blood circulation, and from the circulation into the envelope, and whether it was to be found in those distant parts of the envelope where no circulation existed, and especially in the lens of the eye.

The following table gives the experiments made when lithia in small quantity was poured into the funnel on the rate of its passage not only into the circulation, but out of the circulation into the envelope of a guinea-pig.

* Cress sown on paper, when 1in. high had the paper moistened with water containing a little chloride of lithium, in ten minutes and twelve minutes the lithium was detected in the leaves.

The rate at which chloride of lithium passes into the textures throngh tbe stomach :—

1½ grain	iu 3 days	plenty fouud everywhere.	
3 "	15 minutes	everywhere except iu the lens.	
"	30 "	"	"
"	30 "	"	traces in the lens.
"	30 "	"	outer part of the lens.
"	60 "	"	"
"	60 "	"	except in the lens.
"	in 2¼ hours	"	and throughout the leus.
"	4 "	"	"
"	8 "	"	"
"	24 "	"	"
"	26 "	"	"
¼ "	5¼ "	"	except iu the lens.

It follows from these experimeuts that three grains of chloride of lithinm given on an empty stomach, may diffuse into the cartillage of the hip-joint and the aqueous humour of the eye in a quarter of au hour. In very young aud very small pigs, the same quantity of lithium may in 30 or 32 minutes be found in the lens of the eye, but iu au old pig in this time the lithium will have got no farther than the humour of the eye. If the stomach was empty when the chloride of lithium was takeu, in oue hour the lithium may be very evident iu the onter part of the lens and very faintly in the inner part; hut if the stomach be full of food the lithinm does uot iu an hour reach the lens. Even in two hours and a half the lithium may be more marked in the outer than in the inner part of the lens. Iu fonr hours the lithium will be in every part of the lens, but it will still be more evident in the humours than in the lens. Even in eight the centre of the lens may show less than the outer part. The lithium will be found in as great quantity in the outside after twenty-six hours.

When instead of being put in by the funnel, the lithia was injected into the skin: three grains of chloride of lithia in 24 minutes showed the lithium iu the lens and in every texture; in 10 minutes slightly iu the lens, but plenty everywhere else; in 4 minutes no lithium was in the leus but plenty iu the aqueous humonr of the eye and in the bile; one and a half grain in five minutes showed no lithium iu the lens but plenty in the aqueous humour and iu the bile.

Having thus shown that lithium will pass everywhere into the textures in between 4 and 15 minutes, when injected into the circulation, and between 15 minutes and 26 hours when taken iu by the funnel, some experiments were made to determine after how many days the lithium ceased to be detected in the envelope after it had been taken. Usually three pigs were taken; to one no lithium was given, the second was killed in a few hours after a dose of lithium, and the third was given the same dose and killed after mauy days.

The following table shows the rate at which chloride of lithium passes out of the textures :—

2 grs. in 6 hours gave plenty everywhere.	Iu 6 days gave no trace in the alcoholic extract of the kidneys, livers, or leuses.
" — "	" " "
" — "	" 4 days gave none in the lens.
1 gr. in 5½ honrs showed partly in the lens.	" 3 days gave faint traces in the lens.

It follows from these and other experiments that twice in six days and once in four days two grains of chloride of lithium, which in six hours gave lithium everywhere, in six days ceased to be detectable in the lens, and that even in the three days the lithium is most probably diminishing in the lens.

Having thus gained a clear knowledge of the time it takes for a small quantity of lithia to pass in and out of the envelope of an animal, I proceed, through the kindness of my friends Mr. Bowman and Mr. Critchett, to trace tho passage of lithium into that part of the envelope which is most distant from the blood circulation in man. Lithia water is by means an unpleasant driuk, and a few minutes, or a few hours, or a few days before the operation for cataract, twenty grains of carbonate of lithia dissolved in water was taken.

No less than seven cataracts were previously examined with the greatest care, to determine whether lithia was usually absent, and in only one instance was the very faintest trace of lithium detectable.

The following table shows the rate of passage of carbonate of lithia into and out of cataracts :—

20 grains of carbonate of lithia were taken

25 minutes		before the operation	—No trace of lithium was found in the cataract.
2½ hours		"	—Lithium in the watery extract of the cataract.
2½ "		"	—Lithium in each particle.
4 "		"	" "
4½ "		"	" "
4½ "		"	" "
5 "	(old man)	"	" "
5 "		"	" "
7 "		"	" "
4 days	{spontaneous soft cataract, 25 to 30}	"	—Traces in alcoholic solution of ash.
7 "		"	—In alcoholic extract not the slightest trace of lithium.
7 "	5 hours	"	" "
7 "		"	—Slightest trace in the alcoholic extract.

It follows from these experiments, that in the human body twenty grains of carbonate of lithia poured into the fuunel in two and a half hours will have partly passed into every particle of the envelope and beyond the blood circulation even into the most distant parts, and in three and a half hours it will be more distinctly present in each particle of the lens.

In four days it will still be distinctly preseut iu each particle of the lens.

In five days it will have begun most clearly to pass out of the leus, and in seven days scarcely the smallest trace will be detectable there. The most striking experiment was in the case of a youug girl with two soft cataracts. She took twenty grains of carbouate of lithia, aud in seven hours one lens was removed, and the smallest particle of the lens showed the presence of lithium. The other cataract was not removed for seven days after the first operation; then not the slightest trace of lithium could be found iu the lens.

A long series of experiments on the passage of lithium out by a drain. after it had been taken in by the funnel, showed nearly the same fact—namely, that after a dose of twenty grains, the lithium was not entirely throwu out of the body under six, seven, or eight days.

Thus, then, both in animal and man the same law obtains. A single dose of lithium in a few minutes passes through the circulation into all the ducts and into every particle of the body, and eveu into the parts most distant from the blood-circulatiou.* There it remains for a much longer time than it took to get into the textures, probably for three or four days, varying with the quantity with the quantity taken; then it dimiuishes; and finally, iu six, seven, or eight days, the whole quantity is thrown out of the body.

In auimals it is very difficult accurately to determine the time when a single dose is remoued, for a portion passes out in the perspiration and gets into the hair, and the animal then re-doses itself with the lithium which had already passed through the blood-circulation into the envelope and out by the skin drain, aud this re-dosing may be continued over and over again, so that eveu for thirty or forty days, after a dose of three grains, some lithium may be detected in guinea pigs still passiug out of the body.

Having thus traced the lithium iu and out of the envelope the questiou of far greater importance remains—What does the lithium or other alkaliue salt do whilst it is in the envelope; in other words, what is the actiou of alkalies in the system? What is the action of carbonated alkali at a temperature of 38 C. (100 Fahr.) wheu oxygen at the same time is present—ou 1st, organic acids; 2nd, neutral hydro-carbons; 3rd, fatty matter; and, 4th, albumiuous substances.

The most remarkable instance of the action of alkali wheu organic acid and oxygeu are in contact is in the decomposition of pyrogallic acid. In this vessel I have oxygen and pyrogallic acid in contact, and no action takes place and none would take place if alkali were not added; but immediately on the addition of potass action begins, the pyrogallic acid is unable to keep its composition, and is burut by the oxygen aided by the alkali. More stable acids of lower composition are produced, and these combine with the alkali and liberate carbonic acid. If carbonated instead of caustic alkali be used, the action is not nearly so rapid or complete as with caustic alkali.

The best example of the destructiou of a neutral hydrocarhon by oxygen aided by alkali is in the reduction of oxide of copper hy sngar. The metallic oxide furnishes the oxygen, the alkali assists the formation of acid in the sngar, and draws it out of the sugar destroying the neutral compound.

In fatty matters the alkali splits the fat into fatty acid and glycerine, and forms a soap with the acid. Oil of bitter almonds exposed to common oxygen or ozonised oxygen absorbed in two hours two cubic centimetres of oxygen; with carbonate of soda it absorbed in the same time ·2,75 CC. When mixed with an alcoholic solutiou of potash, and heated benzoic acid combines with the potash, and the whole contents of the tube solidify, the alkali causes the oxidatiou of the oil, and by extreme oxidation carbouic acid aud water would be the final results.

The action of alkali and oxygen on albuminous substances at low or moderate temperatures, 100 Fahr., has not been yet studied. At high temperatnres with alkali the entire decomposition of the substance with the production of carbonic acid and ammonia, and a multitude of less perfect products of oxidation have long heen known; the same suhstances oxidised at a higher temperature without the presence of alkali give rise to fewer intermediate products, and to a greater amount of the ultimate products of oxidation, viz., water, carbonic acid, and ammonia, out of which the albumen was originally formed.

M Béchamp stated that by the oxidation of albumen by manganic acid urea was produced, but this proved to be benzoic acid; and probably kreatin, uric acid, urea, and other products will not be obtained from albuminous substances until we follow the method of oxidation that occurs in the body, viz., a temperature of 38 C. (100 Fahr.) a moderately strong solution of carbouate of soda and basic phosphate of soda, and the action of oxygen, possibly in an ozonised state.

Von Gorup Basanez (Liebig's "Annalen," vol. cx. p. 86, and cxxv. p. 207) has traced the action of ozone at ordinary temperatures on a multitude of animal and vegetable substances, but of these my time allows me to mention only one or two striking examples.

Cane or grape sugar when in contact with ozone undergoes no change; but where grape sugar is exposed to ozone with potass, soda, or carbonate of soda, it is entirely oxidised, and carbonic and formic acids only result. When no alkali is present no action occurs. Cane sugar oxidises with alkali and ozone much slower than grape sugar.

Olein is quite inactive when exposed to ozone, but with potass or carbonate of soda the olein is immediately oxidised. The olein is saponified and the glycerine is oxidised into acrolein, and ultimately into carbonic, formic, and propionic acids. The oleic acid is much more slowly oxidised into formic and carbonic acid.

Hence the action of alkalies out of the body on the different classes of substances of which we are built up is sufficiently clear. The alkali disturbs the equilibrium of the elements in the organic body by its affinity for acids. Aided by oxygen and heat, more or less complex acids are formed from the neutral substances, and if the action of the alkali is sufficiently continued, carbonic acid water and ammonia alone remain.

The progress of therapeutics probably depends on the application of our knowledge of the action out of the body of different medicines on the different

* When seven grains of carbonate of lithia were given eight hours before delivery, the lithium was detected in each particle of the umbilical cord.

chemical constituents of the body, to the explanation of the action of the same substances on the components of the textures in the body.

I have shown you how alkali out of the body promotes oxidation. The chemist can have no doubt that the same action takes place in each particle of the textures to which the alkali is carried. Thus carbonate of lithia, soda, and potass, lime, magnesia, rubidium, cæsium, are indirectly oxidising agents, increasing chemical action in the different substances of which the textures are composed, according to the amount of the different alkalies that can diffuse into the textures, according to the different properties of the substances capable of oxidation that happen to be in the textures, and according to the amount and active state of the oxygen present and the amount of heat that assists the action, and according to the facilities for the removal of the products of the combustion.

Chloride of rubidium and cæsium we have proved to follow the same law as chloride of lithium, in that these substances pass into the crystalline lens, and can be detected there; but the evidence is much less distinct than in the case of lithium, so that the rate of the passage of these substances in and out of the textures cannot so easily be determined. Twenty grains of chloride of rubidium, and the same quantity of chloride of cæsium were necessary to give traces of the spectrum reaction for these substances in the lenses of guinea pigs.

There can be no reasonable doubt that as alkalies pass in, so we shall prove that vegetable acids, if not stopped by the alkaline fluid that is contained in the circulation, will pass into every particle of the textures, aud, when there, these acids must have exactly the reverse action to alkalies. By lessening the alkalescence of the tissues, vegetable acids must tend to stop the oxidising process.

As starch, sugar, and alcohol may be looked upon as becoming in the body vegetable acids, there is here a vast field for research, for there can be no doubt that the sugar and alcohol of our food pass at least as quickly as alkalies into the vascular and non-vascular textures of our bodies.

How far mineral acids can penetrate into the textures cannot be determined, and it may well be doubted if they reach the textures at all, although, by rendering the blood less alkaline, they must indirectly render the diffusing fluid in the textures less alkaline also.

Alkaloids we hope to detect diffusing into the textures in the same way, if not at the same rate, as alkalies. How they act on the different components of the textures of the body, chemistry at present has not determined. The action of alkaloids on sugars, fatty matters, and albumen at first sight appears altogether unproved. There exists in the brain and nerves a substance discovered by Dr. Oscar Liebriech, and named by him protagon ($\overline{C}_{116} H_{241} N_4 O_2 P$). It gives rise to neurin ($\overline{C}_5 H_{13} N$), glycerin-phosphoric acid, and a fatty acid, when treated with alkali; and this substance, of which $\frac{1}{10000}$ forms a strong jelly with water, may be acted ou by the alkaloid, and thus form a nerve substance, having very different physical and chemical properties from the protagon in its unaltered state.

Even the action of ammonia in the different tissues of the body is not yet made out. In the "Phil. Trans.," Part II., 1851, p. 409, I have shown that in passing through the stomach into the blood, or when in the blood, ammonia is partially oxidised, and that the same oxidation happens when urea is taken, and probably when caffein and the alkaloids pass into the blood, but the action that occurs as soon as ammonia, urea, or alkaloids come into contact with the different substances in the different textures, and the rate at which these alkaloids are ultimately oxidised in the textures, has yet to be determined. The first effect of alkaloids is to increase chemical action; but the resulting chemical combinations that take place, and the alterations in the textures that are produced by ammonia, urea, and alkaloids are at present undetermined. Moreover, the alterations these substances occasion in the products of decomposition of the tissues, whilst being themselves finally decomposed and removed from the body, are still entirely unknown.

Judging from the actiou of alkalies, there can be little doubt that alkaloids in a few minutes diffuse into every texture, and act according to their powers on the different substances with which they come into contact. If our means of analysis were sufficient, they would be found probably for three or four or more days in the textures, generally much longer than the symptoms, which depend upon contrast, would lead us to expect.

Lastly, we have proved that some salts of the metals diffuse like chloride of lithium into every texture of the body. Three grains of sulphate of thallium we have followed in twenty-two hours into the crystalline lens, and into the cartilages, the nerves, the liver, and the kidneys. It may be doubted, perhaps, whether the thallium is a metal; but the same fact we have also determined to be true of sulphato of silver by a very delicate galvanic arrangement.

In twelve days a grain aud a quarter of sulphate of silver was given to a guinea pig. The ashes of the liver, kidney, aud stomach showed silver fairly. The ash of the bile showed it rather less distinctly. The ash of the lenses showed ouly very bright traces of silver, but silver was there. The ash of the brain showed no silver.

And here again a vast field for inquiry is opened. What is the action of the metallic salts on the water, salts, hydrocarbous, fats, albuminous substauces of which each tissue is built up? How do metallic salts influence the oxidation and nutrition going on in the textures? The power of the salts of silver, lead, and mercury, &c., to form insoluble or soluble compounds with albumen out of the body seems to indicate the action of these substauces on the albuminous matter in the body. A compound with the albumen may be formed which may check the action of the organ or tho metal may be reduced or form a sulphuret, as with silver salts, and may bo deposited in the textures and there remain, rendering the organ useless, as with lead salts; or the metallic salt may set up a more active chemical change in the albuminous textures or substances with which it is brought into direct coutact, and this chemical action may rise to that degree which is known as inflammation; and the salts of mercury may he takeu as examples of substances possessing this action.

From this view of the rapid passage of crystalloid substances into the vascular and non-vascular textures of our bodies, there arises a feeling of surprise that under such constantly varying conditions, the different functions of the different parts can be carried on. There is, however, from these experiments, but little room to doubt that substances like water, alcohol, salt, and sugar, assisted by the mechanical circulation of the blood, can in a few minutes pass by diffusion into each particle of our textures; and if in them these substances must take part in the changes of matter and force that are proceeding there, according to the chemical properties that the substance possesses, and according to the conditions and times during which the action proceeds.

Thus, this circulation of diffusion rises even to an equal if not to a greater importance than that other more mechanical circulation of the blood, which indeed, in two out of the four grand divisions of animals, is almost absent, and during the early weeks of our own fœtal life is entirely wanting; and in this chemical circulation we recognise a link between the lowest vegetable and the highest animal creation, since this diffusion is a necessary condition on which the chemical actions in both kingdoms of nature depend.

To sum up, then, I have tried to show you that there are good grounds for believing that there exists within us, in addition to the mechanical or animal circulation of the blood, another, and a greater and a more strictly chemical circulation, closely resembling, if not identical with, that which obtains in the lower divisions of animals and in vegetables. A circulation in which substances continually pass from the outside of the body into the blood, and through the blood into the textures, and from the textures either into the ducts, by which they again pass back again into the blood, or are thrown out of the body; or into the absorbents, by which they are again taken back into the blood, again to pass from it into the textures.

This chemical circulation leads directly to two most importaut inquiries:—First, whether substances that diffuse into this larger circulation act as they would do out of the body under somewhat similar circumstances upon the different substances with which they come into contact in the different textures; either promoting the formation of new compounds, or giving rise to decompositions in the substances that are at present in the tissues.

And, secondly, whether the chemical force, which may have been latent for ages in the mineral and vegetable substances that can enter by our vegetable and mineral food and medicine into this larger circulation, may be so given out in the textures as to increase or diminish those actions of oxidation, motion, sensation, and growth, which almost, although not altogether, constitute that assemblage of correlatied actions which we sum up in two words—Animal Life.

ON THE FOOD OF MAN IN RELATION TO HIS USEFUL WORK.

By Lyon Playfair, C.B., F.R.S.

This discourse was in three divisions. The first division treated of the amount of food required for mere subsistence; then for the full health of the non-labouring adult; and lastly, of the quantity necessary for an active labourer. The second division of the discourse discussed the question whether there was sufficient poteutial energy in the nitrogenous tissues, and in the oxygen required for their transformation, to account for the dynamical actions within or without the body. The question as to whether the fatty and anylaceous ingredients of the food co-operated in this work was brought under review. The third division of the discourse treated of the secretions *per vesicam* and *per anum* as measures of work.

In the first division of the discourse a number of subsistence and low dietaries were recorded, and, as a general average, the following diets were given in ounces of 437½ grains :—

	Subsistence Diet, oz.	Diet in Quietude, oz.
Flesh formers	2·0	2·5
Fat	0·5	1·0
Starch, &c.	12·0	12·0
Starch equivalent to heat given	13·2	14·4
Carbon in the food	6·7	7·4

The speaker then examined the food of soldiers during peace as giving a fair average of food required by adult men, of soldiers engaged in work like the Royal Engineers, and of those exposed to the fatigues of war as giving diets necessary for labourers. The following averages were given in ounces :—

	Soldiers during peace.	Royal Engineers.	Soldiers during war.	Active labourers.
Flesh formers	4·2	5·1	5·4	5·6
Fat	1·4	2·9	2·4	2·3
Starch, &c.	18·7	22·2	17·9	20·4
Starch equivalent	22·4	29·4	23·5	25·9
Total carbon	11·6	14·8	12·7	13·9

Active labour was defined to consist of work which would enable a man to walk twenty miles every day throughout the year, except on Sundays. The labour during war is much the same, for soldiers marching fourteen miles daily, with 60lbs. of accontrements, exercise labour amounting to 776,160 foot pounds, while the pedestrian walking twenty miles exerts a force of 792,000 foot pounds.

In the second division of the discourse, the speaker showed that the common experience of mankind is in favour of the nitrogenous ingredients of food being the source of dynamical work. Horses aud men, when labouring, are provided with food rich in such substances, and their labour was shown by numerical data to be proportional to the amount of the former. Thus the work of a horse, divided by the work of an ox, gives the ratio 1 : 1·43, while the plastic food of these animals, treated in the same way, yields 1 : 1·44. In the same way the work of a horse is eight times greater thau that of a man, and the plastic food used for the external dynamical labour of each is nearly in the same proportion. The equation of decomposition used by the author is the following one:—

Albumen.		Urea or amido-carbonic Acid.		Carbonic Acid.		Water.

$$C_{24}\,H_{38}\,N_6\,O_{16} + 100\,O = 3\,(CO_2\,(NH_2)_2) + 21\,CO_4 + 13\,(H_2\,O_2)$$

In this equation, the small quantity of sulphur in albumen is viewed as oxygen. The simplicity of the equation is remarkable; for of the two forms of carbonic acid produced, the one, amido-carbonic acid, passes away *per vesicam*, and gaseous carbonic acid *per halitem*. Seven times as much carbon should appear in the latter as in the former secretion, and this is exactly what has been found in the case of dogs fed with flesh free from fat. Using Andrew's units of heat and the above equation, one ounce of transformed tissue (28·35 grammes) would raise 126·5 kilogrammes of water, 1° C., or converted into its mechanical equivalent by Joule's number 425, would raise 53,762 kilogrammes one metre high.* These numbers are easily applied. Soldiers during peace are well exercised by a march of seven miles daily. Their useful external work is therefore 38,333 kilogrammètres; while the potential energy in the 3·94oz. of flesh-formers (remaining after deducting the amount in the alvine evacuations) is 211,822 kilogrammètres. But the internal dynamical work of the heart, respiratory and other movements, require 107,524 kilogrammètres, so that the residue of 104,298 kilogrammètres represents nearly three times as much potential energy as useful work. The same method of calculation being applied to a labourer, shows that the 3·5oz. of flesh formers applied to external dynamical work, would, after deduction, yield 172,125 kilogrammètres, the useful work of the labourer being 109,496 kilogrammètres.

The speaker then showed that the fat contained in the muscles was quite insufficient to account for the useful work done. While the wasted muscles of a non-labouring man would yield 506 kilogramme units of heat, the fat resident in them would give only 87 kilogramme units.

The third division of the discourse treated of the secretions as measures of work. A man living on a subsistence diet should excrete 267 grs. of urea daily, and we find that 264 grs. have been actually found under such circumstances. Soldiers on the diet of peace should have from 560 to 580 grains of urea in their excretions, and the mean of Haughton of 575 grs. represents this quantity. An active labourer ought to have 735 grs. of urea in the urine, and forgemen in engineering works were found to have 740 grains, while active pedestrians were found to have as much as 800 to 850 grs. The same people on days of rest, as on Sundays, had only 500 grs.

The amount of nitrogen secreted *per anum* was viewed as the measure of digestive or assimilative work. One-twelfth of the flesh formers consumed in food pass away in a state of health in the alvine evacuations as exhausted digestive ferments. These, the speaker contended, were merely slightly oxidized flesh formers, ready for assimilation and secreted to prepare the food for absorption into the blood. A small portion of them were exhausted in the act, and were then excreted *per anum*, but much the largest portion was reabsorbed into the blood, and was used in the formation of tissues.

In bad digestion, or with excess of food more than one-twelfth of the flesh formers is necessarily found in the alvine evacuations.

* In this estimation the carbon in urea is supposed to be oxidised into carbonic oxide; but it would be still more in favour of the view if urea were taken as the residue, and six atoms more of hydrogen were oxidised.

SCOTTISH SHIPBUILDERS' ASSOCIATION.

IRON SHIPS.—BUILDER'S MEASURE *versus* REGISTER TONNAGE.

By Mr. Robert Duncan.

The term "tonnage" originated in the scale of weight, and had reference, not to the size or dimensions of the ship, but to the weight carried by it. The necessities of revenue and other purposes required a standard of value or size by which imposts on shipping might be regulated. It was desirable that this standard should be the fairest possible, therefore the standard of weight. As it was not desirable to wait till vessels were tested by load before determining their tonnage, a caculation based on existing proportions and carrying abilities was legalised in 1773 to determine the weight or tonnage burden—commonly now called the old law or builder's measure. This calculation being a constant of length and breadth, with which form and depth had nothing to do, evasion became possible. Morally no one objects to make the best bargain possible with taxation. We all approve of free trade as regards ourselves, though possibly nor always admiring the "wholesome competition" which may be equally free to out neighbours. Nevertheless, as shipowners, we are bound to have and to build ships which carry the largest cargoes with the smallest disbursements. Great difference of opinion exists as to the most suitable depths and forms. It becomes, therefore, a question of great importance to builders and owners how certain depths and forms may pay to build and to sail. It is obvious that under the old law the shortest, deepest vessel suitable for each trade became the rule. The maximum depth being reached, experience did the rest for the builder, and like sizes like prices became a law unto themselves. I need not again go over the processes which wrought a cure of this system as regards the taxation part of it, having already treated of that in a previous paper to this association. I should like to look now at the subject from the builder's side as to cost, and the owner's as to profit.

The tonnage law of 1854 has been in operation for ten years, and by this time shipbuilders and shipowners may be supposed to have an ordinarily correct conception of its value as a mode of measuring and rating shipping. The tonnage of the kingdom, particularly in iron shipping, has multiplied itself repeatedly since the introduction of the present system, which, having now been fairly tried, may safely be said to have come through its infancy very creditably to Mr. Moorsom and the gentlemen who assisted him by advice and information to mature it. Had there been any serious defects in the mode of measurement these would have been developed to the utmost, and the forms of our ships would have manifested its imperfections exaggerated to deformity, as under the former law. Any defects of the present rule are simply in the application and not in the principle, and the rule as applied for the measurement of the hull may be considered as nearly perfect as scientific principle can make it. As a mode of comparison the late rule of 1835 has passed utterly and unregretted out of use but its predecessor, the old law of 1773, under the style of "Builder's Measure," still exercises a very important influence on the shipping of the kingdom. Use and prejudice—an affectionate regard for a simple old servant which has served our fathers and ourselves for ninety years, possibly not always well, but at any rate not materially worse than its successor, which was introduced to supersede it—has induced a conservatism as regards the old law which, notwithstanding the beauty and correctness of the present law, operates prejudicially on our shipping against the interests of all parties concerned.

Rather more than ten years ago, when Mr. Moorsom published his system of measurement, which immediately afterwards became law, he remarks respecting the old, and the then existing, law—"That the evil of such loose and imperfect measurement does not rest here. If it were limited simply to depriving us of a just conception of the relative magnitude of vessels, no very serious harm or inconvenience might arise from such deficiency; but when we consider . . . . that vessels are built, bought, and sold . . . . . all in proportion to the same standard . . . . . the importance of the highest degree of truth and perfection is manifest; and therefore the apathy which has been evinced on this cardinal point by many of our intelligent shipowners, and more particularly by our merchant shipbuilders, is truly astonishing, and not to be accounted for in the way in which we are generally accustomed to solve such problems."

I believe Mr. Moorsom's latter reflections are nearly as applicable at the present time as they were at the time of publication.

One way of accounting for this seeming apathy is, that each alteration of the law of tonnage has been based upon the old law, so as to make as little alteration as possible in statistics of existing tonnage, and "to produce the same general result as the old law." So far shipowners and shipbuilders may be excused for not immediately perceiving the difference between apparently six and half-a-dozen. The Act of 1835 had been notoriously not much of a change for the better, and looking to the immediate result contemplated by the second change, namely the maintenance of statistical tonnage, the one law doubtless appeared to the majority of both interests as good as the other. The minority, with Mr. Moorsom, looked not alone to the immediate maintenance of existing statistics, but to the prospective benefit to the whole maritime interests of the kingdom. And they were right; a very great improvement has taken place, irrespective of the apathy of the majority, and all will yet see, as he and many like him saw, "the importance of the highest degree of truth and perfection in the standard of tonnage measurement for building, selling, buying, and working shipping."

Shipbuilders being producers, are of course influenced in their productions by the requirements of their customers, who in their turn are influenced by the measure by which shipbuilders sell. As shipbuilders chose to adhere to the old law as their working standard, the term "old law" naturally became transmuted into "builders' tonnage;" and this being the rule by which even yet the majority of builders build and sell, shipowners are naturally compelled to study the relationship of the builders' and register tonnage, as it affects their interests, first, as to the requirements of their trade, and secondly, as to the value of the builders' standard. I do not under-estimate the intelligence of our shipbuilders when I say that many of our most intelligent shipowners understand the entire value of the relationship between the two rules. It is not difficult to perceive that a rule which ignores the depth in estimating the tonnage can never at best give more than a very imperfect estimate of the capacity of a ship, while the new rule, which not only takes account of the principal dimensions, depth included, but, on purely scientific principles, calculates the actual capacity of every modification of form, can at all times be relied on to give an accurate basis of value for taxation in proportion to capacity or register tonnage, and to bring returns wherewith to pay their taxes in cubic feet of measurement and deadweight cargo in exact proportion to that register tonnage; therefore—and the conclusion is the most natural possible—if the requirements of the owner's trade will permit, the largest register tonnage that can be got from the builder on the smallest builder's tonnage, which is assumed to be the basis of payment, is the best bargain for the owner. Possibly it may be said, reverse the case and the converse holds. If a shipowner does not see the full relationship of the laws, and wishes a form of ship which produces a small register in proportion to builders' tonnage, the builder has the best of the bargain, and accounts are squared. I will not do either party the injustice to suppose that this "diamond ent diamond" system is an agreeable one, or possibly understood to its full extent, as I am sure that it is not a profitable one for either party when carried to its full extent; but of this I am sure, that dimensions, form, and construction are all influenced prejudicially by the maintenance of the old law, as Lloyd's register and other statistics of tonnage very plainly show.

As the builder's measure is a very full standard, vessels built to register in excess of builder's measure must either be extravagant as to form or have large erections above the main or upper deck. Only vessels of large dimensions which can stand a greater proportion of depth, such as $\frac{7}{10}$ of the beam and upwards, can have a register under the upper deck greater than the builder's tonnage, and when such vessels can carry a poop and deckhouses in addition, the difference may be very great; but taking statistics of tonnage of all sizes, the greater number of vessels are less register than B.M. The cost of production being actually in propertion to the register, the average cost per B.M. is of course reduced, and the cases in which the register is high, or in excess, very generally a wrong balance for the builder, till experience teaches the necessity of supplementing the B.M. by some more accurate calculation in self-defence. Many builders do not possibly rate by the old law, even though making it the standard of tender. Many of our own members, perhaps all of us, have other methods by which to estimate cost. Some assume a ratio of cost to the multiplied dimensions, with some fixed divisor; others assume ratios of displacement of the forms they prefer; others merely take the cost of already constructed type ships—the latter by far the safer rule. But almost all are generally reduced to B.M., or a sum, before tendering, and the owner having but one standard before him, very likely only B.M. tonnage, irrespective of dimensions and form, and not being influenced, or probably aware, of the modes by which the cost has been deduced, has the dimensions, model, and form made to suit his ideas, and the builder is obliged to conform, often against his convictions and frequently against his interest. In order to satisfy myself of the extent to which the old law is still the builder's standard, and influences the forms of our ships, I have abstracted the iron sailing ships in Lloyd's register from the beginning of 1860 till June this year, and I find that of 157 iron ships above 500 tons register, 85—or more than one-half—are greater register than B.M. That the excess would be even more than this I have no reason to doubt, as the register is the tonnage given in the book, and I have calculated the B.M. from the register length, which is generally 3ft. to 10ft. longer than the length between perpendiculars, my calculated B.M. may safely be assumed greater than the actual B.M., and thus the number of vessels of larger register than B.M. should have been in excess of what I have stated. But withal the fact stands, that fully half of all the iron ships above 500 tons classed at Lloyd's are greater register than B.M. Two-thirds of the ships built on the Thames and the Mersey are greater register, while Sunderland and the east coast are nearly half, and the Clyde rather less than one-third in excess.

The liability to excess is greater with sailing vessels than with steamers, in consequence of the greater depth to which sailing vessels are usually built; hence the fact is more easily deduced from them, if other proof were wanting, that builders' tonnage is still the regulating standard. If a ship of 1,000 tons B.M. can be, and frequently is, built to measure 1,100 and upwards, we cannot wonder that some builders should find it necessary to charge higher figures for deeper ships, and stand for equality of tonnages. It requires a considerable advance in price to produce 10 per cent. additional tonnage, particularly when that excess is the actual extra capacity for which material has to be provided, and on which extra workmanship has to be expended to produce this enlarged capacity.

Large vessels which can be built deep, and carry poop, forecastle, and deckhouses, often of considerable tonnage, are all rated by the same standard as ships which have none of these. Small vessels which are built shallow are also rated by the same standard, but experience has proved that they can be built very much cheaper in proportion to B.M., hence they are more cheaply rated per B.M. All practical men know that it is impossible to work light material as cheaply as heavier. We know that vessels of 1 to 500 tons are relatively dearer to build than vessels of 800 to 2,000 tons, for material and work are comparatively dearer the smaller they become. Therefore it appears to me that the actual measure and weight of material in each case is the only true standard of cost. This it is nearly impracticable to obtain without a standard of construction; some fixed, recognised, or legal scale of weight or scantling requires to be assumed, such as Lloyd's rules, as a base for weight. The measure by which this scantling is to be determined must be fixed. To give the scale a definite value, the truest measure must certainly be that which most truly defines the form, capacity, or enclosed space, in a word, tonnage, and the proportion of scantling be so determined as to apportion weight to that tonnage in nearly equal ratio to all sizes. The correctness, therefore, of the standard of weight or material is of the first importance, and the correctness of the standard of measure next, each indispensable to the other. Many builders do not estimate quantities directly, but according to some indirect measure of dimensions, most frequently builders' tonnage. Allowances may be made for differences of depth or erections above deck, but allowances made without a definite rule are apt to be occasionally wide on either side.

The most correct standard of measure, in my opinion, is the new tonnage measure, and the most correct standard of weight is Lloyd's rules. Properly speaking, shipbuilders have no others from which they have so great an amount of reliable data; each builder can certify the accuracy of both standards by his own experience. I have collected, during the last ten years, since the introduction of both rules, an amount of data, which satisfies myself that the relation between the tonnage N.M., and the weight according to Lloyd's rules, has been throughout nearly a perfect ratio, each verifying the other so beautifully and so exactly, that the material used in construction is nearly uniformly a constant of the tonnage, irrespective of the dimensions and form. I daresay many of our members are not prepared to endorse my remarks as yet; I must, therefore, support myself by proof.

As a standard of form and capacity, it is not now necessary to prove the correctness of the new tonnage law, it is practically perfect. The question, therefore, is solely its relation to the standard of weight—to show, in fact, what proportion a ton weight of iron and other material generally used for building ships bears to a ton measurement of space according to the present mode of measuring ships.

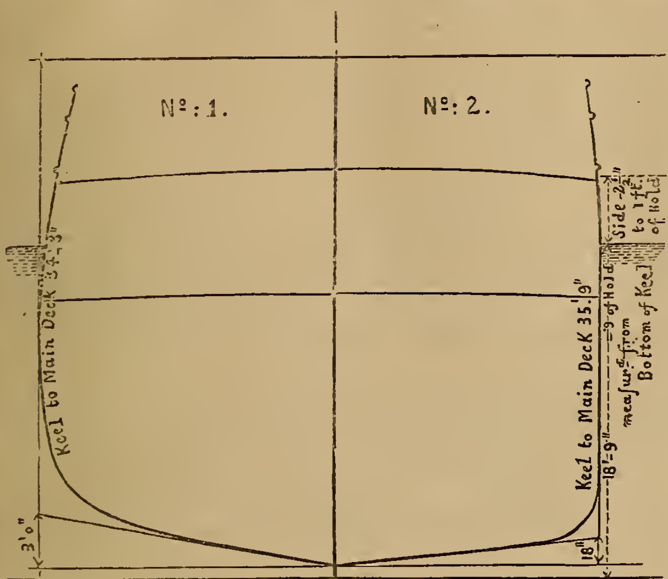
Uniformity of material has more nearly equalised the weight of scantling for iron ships per standard measures, feet, inches, and fractions, and Lloyd's rules have produced greater uniformity of scantlings to tonnage. There ought, therefore, to be much less relative difference in the value of iron vessels built to Lloyd's rules—weight for weight. But whether built to Lloyd's rules or not, weight for weight is nearly the correct standard, if we can get it. We may safely assume that the scantlings of most vessels, whether classed or not, are based on Lloyd's rules, as affording the best guarantee for sufficiency, and as Lloyd's rules for iron ships came into operation nearly simultaneously with the new tonnage law for measurement, we cannot possibly have or get any other standard of weight from which we have so great an amount of reliable data. Those rules have been altered several times, but a comparison on the same scale of any date will safely ensure similar results. The question of weight to measurement is a question purely of experience. We cannot think that the gentleman who arranged the scantlings of Lloyd's rules had the least idea of determining with mathematical accuracy the relation of scantling and weight to tonnage. Perhaps they could not readily have given a reason for choosing tonnage rather than dimensions, or preferring one tonnage to another, old or new, except that the new was the legal standard. Lloyd's committee have generally acted on the liberal principle of a minimum scale for the smallest tonnage, thereby giving the owner, the ship, and the builder the benefit of any doubt as to correct standard for weight. Of late, dimensions have been imported into the regulating scale and are principally the regulating scale of the Liverpool registry. This will militate to a certain extent against the accuracy of the scale to tonnage—to what extent we have not yet sufficient data to furnish proof. It certainly will operate against fine ships of large dimensions and small tonnage N.M., but as the Liverpool rule has been framed principally for ships of small dimensions and large tonnage N.M., it may have been judicious to adopt dimensions as their standard for that style of ships, and reasonably so, for Lloyds, in the case of steamers, to give sufficient midship strength to carry long fine ends. The accuracy of the scale of weight to tonnage in the latter case might be advantageously maintained by an increase of the spacing of the frames toward the ends, the weight so removed to be distributed amidships, as compensation for increased dimensions. Leaving this latter case for the consideration of the gentlemen most interested, it gives me great pleasure to be able to state that, so far as experience can be taken as a guide, my experience of the relationship of Lloyd's Rules to New Measurement Tonnage, beginning with the introduction of both in 1854 as standards of measurement and construction, and compared by a great number of vessels of all sizes and forms, has satisfied me that both have been, and are now, as nearly perfect in their relation to each other as the weight of the volume of water displaced is to the bulk of the displacing body to the water level, whether that bulk be a solid or a shell enclosing a certain space in cubic feet or cubic tons of 100 cubic feet—say a ship, irrespective of the form and dimensions of the solid or bulk immersed.

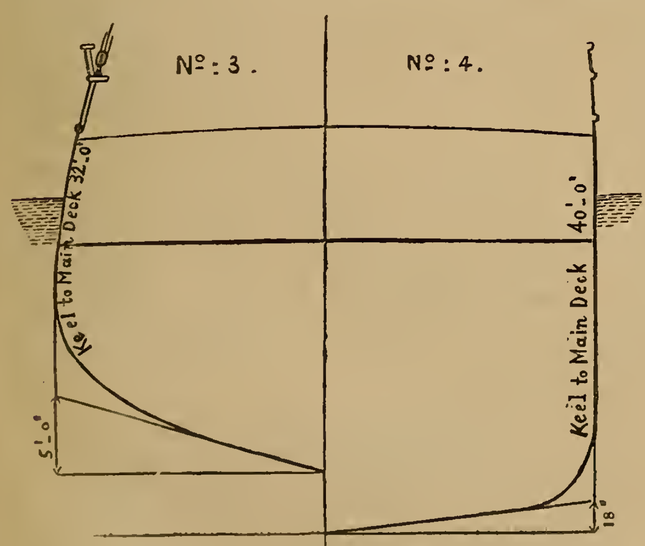
I am quite aware that exception will be taken theoretically to this absolute relation of the space enclosed to the weight of the surface, or shell, or hull, enclosing that space. I am not sorry that, as regards weight of hull to tonnage or space enclosed in ships, theory is at fault, or the difference is so small as to be practically imperceptible. I did not begin my comparisons ten years ago with a theory, as there was no data to start with, and theory would have stopped me at the outset. I did not even look for coincidences. I dealt only with facts, and my conclusions are results, not demonstrations.

I have no doubt it will be more satisfactory to our members to compare my statements and results by the facts of their own experience. Meantime I shall illustrate by a few facts from my own and other experience. Last year, at the meeting of the Institution of Mechanical Engineers in Birmingham, Mr. Vernon, of Liverpool, read an excellent paper on the Construction of Iron Ships, in which he stated, among other subjects—and I believe expresses pretty nearly the received opinion—that the weight of an iron ship of the highest class at Lloyd's is about 15 cwt. to the ton, builders' measure. The dimensions of the vessel quoted in illustration were 205′ × 34½′ × 23′ = 1,166 B.M. The weight of iron in the hull is stated at 612 tons, and the finished weight of the vessel, complete in hull and full East India outfit = 901 tons. Displacement on 20ft. load draft, 2,703 tons. The register tonnage is not given, but the particulars correspond nearly with the following vessel which passed through my hands:—208 × 34½ × 23 = 1,186 B.M. Tonnage under main deck, 1,121; ditto, poop, 77; gross register, 1,198 tons. Displacement on 20ft. (on frames), 2,725 tons. This vessel was built to class 12 years A 1 at Lloyd's, and 20 years Liverpool register. The weight of iron ordered and received per invoice was 715 tons; the finished weight of ship complete, 928 tons. As both vessels are so nearly the same displacement on the same draft of water, and the dimensions so nearly alike, the tonnage under main deck must have been very nearly the same, 1,120 tons, the displacement being an exact measure of the form and capacity. The difference of the finished weights, 901 to 928, might be accounted for, but the weight of iron, 612 tons against 715, is not exactly explained, except by assuming a certain per centage of ordered or invoiced iron deducted for scrap, and the balance considered the finished weight of iron in the hull.

Lloyd's rules do not admit of less quantities being used in similar ships. Mr. Vernon must, therefore, have ordered and received about 700 tons iron, and deducting $\frac{1}{7}$th for scrap, &c., leaves 612 or thereby for finished iron in the hull. The latter quantity I do not intend to discuss, as it is indefinite. The invoiced quantity is easily obtained from the books. The finished weight is also easily obtained from the displacement scale, if the latter be correct, and the register tonnage is also easily obtained from the plan of the ship. Comparison of these quantities can, therefore, be easily made by any person, without the necessity for reductions and allowances, which can never be uniform.

We have built several vessels of 200 × 34½ × 21 = 1,135 B.M. register tonnage under deck, 942; poop, 56; gross, 998. Class 12 years Lloyd's, and 20 years Liverpool registry. If the builder's tonnage were the regulating standard, our weights ought to agree very nearly with the preceding ships, but the registers differ by 200 tons, and the weights differ in the same proportion.





	B.M.	N.M.	Iron.	N.M. Ratio.	B.M. Ratio.	Finished Weight.	N.M. Ratio.	B.M. Ratio.
First	1166	Say 1198	{612 / 700}	·590	·60	901	Say ·75	·773
Second	1186	„ 1198	715	·597	·60	928	„ ·775	·782
Third	1135	„ 998	589	·590	·52	744	„ ·775	·682

In these vessels the material bears no regular proportion to B.M., but it does bear a regular proportion to N.M.; the comparison of the two last, of which I am certain, being as follows, the ratios of weight to tonnage being as above:—

B.M.	N.M.	Iron.	Total.
1186	1198	715	928
1135	998	589	774
Difference, 51	200	126	154

If a shipowner pays for 1135 tons B.M. with the register and quantities as stated, at the same rate as he pays for 1186 tons B.M., with the register and quantities thereto, he must have a poor bargain of the former, or a good bargain of the latter, and so should the shipbuilder by reversing cases. But it appears to me no easy matter, with no better standard than B.M. to assume a rate or a margin that would admit of giving 150 tons weight of extra material at a cost of £22 to £24 per ton. Yet the practice is not unusual, apparently from Lloyd's register, numbers of vessels of the same nominal B.M. varying as much as 200 tons in their registers.

On ships about this size a very great difference can be made in the register tonnage and cost, which if estimated as usual by the B.M. tonnage should show no difference. For example, a vessel of the dimensions quoted, 205 × 34½ = 1166 B.M., can be made to vary as much as 500 tons register, say from 780 to 1280 under main deck, by simply varying the form and the depth from 20ft. to 24ft. depth of hold. On any one depth alone it is easy to vary the tonnage nearly 300 tons, by simply altering the form between fine and full, within the limits of merchant ship forms, as that an unpractised observer, and possibly some who fancy themselves excellent judges, could have no idea of the amount of difference from the appearance of the models or vessels. The difference in the weight of these vessels, built to A 1 at Lloyds, will be as 75 per cent. of register tonnage; so that 200 tons difference of tonnage will give 150 tons difference of weight, and 400 tons difference of tonnage will give 300 of weight. The smaller vessel will cost less than the larger in the same proportion; each ship will be fitted out for her register tonnage, or at least according to specification for a particular trade, the cost of which is easily obtained. All those varying tonnages will, if well formed, carry equal dead-weight cargoes in proportion to their tonnage—say a regular load of one and a half their register dead-weight on draft of water in equal ratio to the depth of hold—say ·9 from bottom of keel.

The mode of calculating register tonnage by ratios is exceedingly simple. The useful limit of ratios for merchant vessels is from ·55 to ·75 of the parallelopiped of dimensions, every decimal to three or four places, and any degree of fineness or fulness, as required either for high speed or low speed. Multiply the length between perpendiculars (including the rake of sternpost to main deck), the breadth extreme and the depth of hold together, and the sum by the ratio of fineness desired, divided by 100, the result will be the tonnage under deck (main or spar deck, as may be) which may be easily produced on plan by decimal sections designed to the ratio of form required.

Thus for the dimensions already quoted, 205 × 34·5 = 1166 B.M. on any depth, the register calculated for 20ft. depth by ratio ·6 is as follows:—

$$205 \times 34{\cdot}5 \times 20 = 848\tfrac{70}{100} \text{ tons under main deck.}$$

```
  205
 34·5
-----
7072·5
   20
------
141450
    ·6
------
÷ 100 ) 848·70
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The following figures will explain how the same dimensions can be made to vary about 300 tons, as previously stated, on the same depth, and nearly 500 tons between 20ft. and 24ft. hold: 205 × 34½ = 1166 B.M. any depth.

By ratio	·55	·6	·65	·7	·75;
On 20ft. hold	778	849	919	990	1061 tons.
On 24ft. hold	934	1018	1103	1188	1263 „

The difference between 778 and 1061 being 283 tons, and the difference between 934 and 1,273 being 339 tons on the same depth and varying ratios, and the difference between 778 and 1,273 being 495 tons on extreme of depths and extreme of ratios, the B.M. tonnage being unvarying throughout.

All those tonnages from 778 to 1,061 on the same depth, or from 778 to 1,273 on the varying depths, can be modified to ten tons or one ton by using the ratios from two to four decimal places. There is no doubt about the varying weights also, as the smallest tonnage can be built on the 700 ton scale, even with a poop, while the largest and fullest must be built on the 1,200 ton scale, if built to class, and experience on all the ratios has proved them correct weight to tonnage on any form.

Referring to diagrams 1, 2, 3, 4, which represent midship sections of sailing vessels—3 and 4 show the difference of midship form of the limits ·55 and ·75 on the same length, breadth, and B.M. (the ratio of middle section below load line being as ratio of displacement + ·25; thus ratio—tonnage, ·65; displacement, ·61 + ·25—·86 ratio of middle section); but with the depth 20ft. in the one and 24ft. in the other, the circumference of half frame in the small vessel is 32ft., and in the large vessel 40ft. to main deck; of course the plating and other details of the hull are in the same proportion, scantlings varying as the tonnage. Sections 1 and 2 show the difference of form and ratios for the same tonnage. No. 1 is 200 × 34½ × 21 = 1,135 B.M., ratio ·65 = 945 N.M. under deck, and with poop 1,000 tons gross register. No. 2 is 200 × 31 × 21 = 927 B.M. ratio ·725 = 945 N.M., under deck and with poop 1,000 tons gross register. Both vessels are the same length and depth and register tonnage: they differ by 3½ft. beam and 208 tons B.M. They must be built on the same line to class, and the narrow vessel has 1ft. 6in. longer midship frame than the broad vessel, 1ft. 6in. more circumference for plating, &c., and the vessels take precisely the same quantities of iron, wood, and other material. Yet many builders would have no objection to build the latter at an ordinary rate per B.M. and give over 70 tons register in addition, while very few would be willing to build the former at any less rate per B.M. with register 135 tons less. I would prefer the register in both cases, and the former or broad ship for for choice, as a very superior ship to build and to our own.

The following table of eight sailing ships of 1,000 to 1,500 tons intermediate sizes and ratios of tonnage from ·65 to ·74 is a sample of the relation of the constant of weight to register tonnage, the vessels having been built by four different builders and all different models. I give the weights as I got them:—

Length.	Breadth.	Depth of Hold.	B.M.	Register N.M.			Ratio of Form under Deck.	Class.	Tons of Iron Invoiced.	Constant to Gross Reg.	Weight complete for Sea.	Constant Complete to Reg.
				Under Deck.	Above Deck.	Gross.						
190	33·5	21·5	1,014	952	42	994	·695	12 A 1	553	·55	771	·775
195	34·5	21·25	1,104	961	33	994	·672	„	588	·59	771	·775
200	32	21·5	985	958	36	994	·696	„	597	·6	774	·777
200	34·5	21	1,135	943	56	999	·65	„	590	·59	775	·775
200*	33·7	22·5	1,090	1,111	60	1,171	·732	„	784	·67	975	·833
208	34·5	23	1,186	1,121	77	1,198	·681	„	715	·595	928	·775
								New Rules.				
205	35	22·5	1,198	1,142	82	1,224	·707	AA 1	681	·557	924	·735
224	37·5	24·75	1,507	1,462	63	1,525	·707	„	910	·6	1,120	·735

* The fullest vessel is extravagantly heavy, being nearly 100 tons in excess of all classes in iron and other material.

That the constants apply to steamers as well as sailing vessels is shown by the following table of eight screw steamers, from 100 to 1500 tons, built, between 1855 and 1862, during several changes of Lloyd's rules :—

Length.	Breadth.	Depth of Hold.	B.M.	Register N.M.			Ratio under Deck.	Class.	Tons of Iron Invoiced.	Constant to Gross Reg.	Weight complete.	Constant Complete.
				Under Deck.	Above Deck.	Gross.						
120	18·5	9·5	200	133	5	138	·63	9 years	81	·59	96	·7
145	22	12	339	260	3	263	·68	„	152	·58	179	·68
160	24	12	446	325	19	333	·705	„	193	·58	226	·68
180	26	13	591	362	42	404	·60	„	242	·60	303*	·75
214	28	16	822	604	91	695	·63	12 „	430	·62	500	·72
220	26	17	734	660 {	55 House 30 „	} 745	·678	9 „	Hull and Poop. 400	·58	491	·66
250	30	21	1,110	1,059 {	66 „ 44 „	} 1,170	·666	„ (1855)	661	·6	795	·68
255	36	22	1,600	1,384	39	1,423	·685	12 years	853	·6	995	·7

* Extra for cattle trade.

The variation in constants is due entirely to extras in construction and equipment, the class being true constant. The iron columns in these tables must be understood to mean only the hull iron proper, including masts of iron, but exclusive of smith work, bolts, and nails.

As a further illustration of the accuracy of the constants of weight, irrespective of dimensions, the following details of two vessels will show—the one a screw steamer ten beams length, the other a sailing ship of less than six beams length :—

S.S. 340 × 34 × 24. Gross, 2,100 N.M.

Register under deck, 1,890.

Keel, stern, sternpost, and rudder		24
Angle iron	355 tons.	
Beams	62 „	
Floors, stringers, ties, keelsons, &c., plates	177 „	
		594
Hull plates		450
		1,068

Ship 200 × 34·5 × 21. Gross, 1,000 N.M.

Register under deck, 943.

Keel, stern, sternpost, and rudder		11
Angle iron	149 tons.	
Beams	41 „	
Floors, &c.	102 „	
		292
Hull plates		215
		518

I purposely omit the small details of straps, slips, rivets, &c., and the materia exclusively pertaining to steam vessels and arrangements for machinery. The latter, with additional bulkheads, usually increase the iron work of steamers 4 per cent. of tonnage over sailing vessels. Each item in these quantities is not necessarily in exact ratio; it is only in the sum totals, and justly so, that the equality of the ratio of weight to tonnage is apparent. My object in the foregoing comparison of weight and length being to show that in all the material dependent on length, form, and tonnage for classification, Lloyd's rules are nearly uniformly constant to register tonnage, independently of dimensions, from 100 to 2,000 tons.

NOTE.—Since reading this paper, I have been favoured by Messrs. Gourlay Brothers, Dundee, with particulars of a few of their vessels built to class, which further prove the constants correct. Here is the table:—

Length.	Breadth.	Depth of hold.	B.M.	Register N.M. Under Deck.	Register N.M. Above Deck.	Register N.M. Gross.	Ratio under Deck.	Class.	Tons of Iron invoiced.	Constant to Gross Reg.	Weight Complete.	Constant to Gross Reg.
S.S. 230	29	16·40	950	685·30	96·12	781·42	·626	Aᴀ 1	469	·6	539	·69
„ 216	28	16·25	830	601·78	90·59	692·37	·612	„	407	·59	477	·69
„ 208	28	16·45	797	569·90	94·48	664·38	·595	12 A 1	396	·6	478	·72
„ 216	27	15·45	774	531·02	78·62	609·64	·588	9 A 1	360	·59	414	·68
„ 144	20·75	9·46	301	186·42	20·3	216·72	·66	„	127	·61	150	·72
Shp 170	28	18·8	639	603·8	...	603·8	·675	12 A 1	350	·58	470	·778

These weights do not include forgings, but they include masts and deck-house framing.

It will be apparent from the tables and foregoing remarks that the constants of weight are very nearly as follows:—

Class. Late Rule.	Gross Reg.	Iron.	Finished Weight of Ship.
Sailing ships, 12 years	1·000	·59	·775
„ Aᴀ 1	1·000	·55	·735

If built to Liverpool rule 20 years, in addition to Lloyd's, the increase of material in very full vessels of large tonnage and small dimensions is slight, from 1 to 2 per cent. in excess of Lloyd's; but in the case of fine vessels of large dimensions to tonnage the increase of material is very important, amounting in several vessels we have lately built to about 3 per cent. of tonnage. As this involves an increase of cost from 5*s.* to 10*s.* per ton, it is virtually a tax on fine forms, not only to what they cost in construction, but to what they are obliged to carry of unnecessary weight. The Liverpool rules do not acknowledge the value of thickness of outside plating over ⅝, stringers and keelsons being of the first importance. Lloyd's rules consider plating of the first importance, and the conflicting interests with owners who require both, necessarily increase the expense of construction.

Screw steamers' constants on the late rules were—

Class.	Gross Reg.	Iron.	Finished Weight.
12 Years	1·000	·62	·72
9 „	1·000	·58	·68
6 „	1·000	·54	·64

Under the new rules Aᴀ and Aʙ the constants are nearly the same as 9 and 6 years for minimum dimensions, say, length = 10 depths, &c., increasing by easy per centages to 12 and 9 years constants, at extreme dimensions, say, length = 20 depths. This, it must be understood, arises solely from extra material, as a vessel of 20 depths long is not per rule heavier than a vessel of 10 depths of the same tonnage.

I trust that the foregoing explanations and tables illustrate as clearly as I would desire, that the material used in construction, or the weight of hull, is nearly constant ratio to N.M. tonnage, irrespective of dimensions, form, or builder's measure. The ratio of displacement I have stated, and shown to be also in relation to the ratio of tonnage; but as the displacement ratio is not a constant necessarily of the tonnage, being entirely dependent on the form immersed, it is quite possible that the carrying abilities and other qualities of vessels of the same dimensions and N.M. tonnage may vary to a very great extent. The weight of the vessel I have shown to be invariably a constant of the tonnage, and as this weight has in every case to be deducted from the total displacement, the remainder only is cargo power. It follows that form and the balance of ratios must, therefore, always enter into the calculation, for economy and utility, ability, stability, &c., for sailing vessels, and also for power and speed in steam vessels. All those elements are in every case practicable, and may be made constants on any tonnage N.M., the dimensions and ratios being merely modes of varying the solid of capacity or tonnage for the purposes of any particular trade. The question of tonnage, therefore, resolves itself into the best dimensions and form for each particular trade. "Builder's measure" considers length and breadth the only necessary elements in the calculation. Experience in the matter of material and wages proves that builder's measure is a false guide. Register tonnage is never at fault in quantities, and an ordinary attention to adjustment of ratios may make all the elements which enter into the builder's and the owner's calculations fit into each other as constants to produce the best vessel for both.

There are certain general questions belonging chiefly to proportions, on which opinions differ. B.M. tonnage being based on length and breadth, vessels contracted for by B.M. are generally narrow in proportion to their depth. Experience distinctly says that a narrow ship, requiring ballast, is at all times an unsafe and unprofitable vessel. For a steady dead-weight trade both ways, sure cargoes and quick despatch, narrow ships may suit, but these are exceptional trades, which only verify the rule; for we find invariably that ships of good beam in proportion to depth, which require little or no ballast, are preferred. Owners' interests certainly lie in ships which can carry nothing but cargo; that can wait, or shift, with a clean hold if necessary, while the narrow tender ship must frequently disburse a large portion of her earnings in ballast and charges incidental thereto. The fact that Lloyd's register shows the interests so nearly balanced, that half the ships are less and half more register than B.M., even while the cost is nearly uniformly rated by the latter, proves the owner's interest to lie in ships of which the profit is consequent upon a superior economical form, apart from the consideration of first cost. Deep ships—or more properly speaking, narrow ships—are said to be easier on themselves than broad ships. This, I believe, to be simply a question of loading. No nation has such narrow square ships in proportion to depth as ours. No nation better understood the science of ship sailing than the Americans, and their vessels were uniformly much broader than ours, their laws favoured that proportion, and they studied to work it, and so successfully, that for a long time their shipping was the fastest and most economically worked marine in the world, while ours was the slowest. We have, to a certain extent, improved on them since the introduction of our new and better mode of measurement. But the question of the easiest ship is simply a question of a little better experience of broad ships of large tonnage. All our small vessels are of great beam in proportion to depth, for the purely economical reason that they are safer and cheaper not to carry ballast. Yet dead weight is the principal item in our coasting trade. Our most distant commerce is essentially light freight, full cargoes out and home, and vessels which can carry the largest cargoes of bulk or bale goods out and home without ballast, will certainly be easier in the long run on both themselves and their owners, if properly loaded and properly sailed. Our shipping was spoiled by our former modes of measurement, and now since the measurement has been rectified, it is to a great extent spoiled by our adherence to the oldest standard. Owners and builders accustomed to look upon breadth as the base for all measurement of shipping, and paying—perhaps nominally—only by that standard have looked, not unnaturally, on all depth which is not the greatest usual, or safe, in proportion to breadth, as so much depth and cargo lost or thrown away. The standard which the new mode of measurement renders practicable and most advantageous is depth. This is the only true and suitable base for proportioning ships. The breadth should be entirely subordinate to the requirements of the intended trade. The register tonnage defines the form in relation to the depth, and the form defines the tonnage in ratio to the dimensions for any purpose—the weight of vessel being uniform, and the displacement and weight of cargo are easily made uniform constants of the tonnage and its ratio. Depth is already the standard for draught of water, though the exact proportion which the draught should bear to the depth is not so clearly defined. As the draught is not subject to legislation except by the Association of Underwriters, and even they are not all agreed, vessels are more frequently loaded at discretion than by rule; hence the only correct comparison is by the displacement scale. But, given, depth of hold and the tonnage under main deck as the standard for comparison, with the side above water at the deepest draught allowed by the Underwriters equal to 2½in. to the foot of hold; or more simply, its exact equivalent, $\frac{9}{10}$ths of the depth of hold from bottom of keel—all well-formed iron vessels of the highest class should carry once and half their tonnage of dead weight cargo. As a matter of course, the greater the amount of tonnage above the main deck the less the cargo, as poops and houses add weight and tonnage without giving equivalent draught of water. The ratio of displacement at that draught, ex keel, to the ratio of tonnage should not have a greater difference than four per cent. with a good form. Thus a vessel with a tonnage ratio of ·64 will have a displacement ratio of ·60, and the proportion may be constantly relied on, if carefully designed, as safely as the constant of weight. Hence the difference of ratios of tonnage and displacement may, with equal propriety, be called the constant of displacement. The advantage of those constants in the case of steam vessels requiring a fixed draught with a stated cargo cannot be over-estimated, as by comparison of ratios and constants the smallest vessel which can carry a stated cargo at a fixed draught, horse-power, and speed, can be determined from the N.M. tonnage with almost mathematical precision and no trouble, while the abilities of Sir Isaac Newton would be nonplussed to determine any one of those elements from the builder's measure.

RIFLED SMALL ARMS.

(*Continued from page* 136.)

A modification was introduced by M. Bruncel, which rendered evident the fact that, by flattening spherical bullets, the stability of their axes of rotation, and consequently their accuracy, is augmented, a result quite in accordance with theory. Subsequently, new experiments were instituted in 1833, and other forms adopted successively in 1837, 1840, and 1842. In 1844, M. Minié proposed to use conical bullets in place of spherical ones, and his endeavours, in combination with M. Thouvenin, led to the adoption of a rifle with which were used oblong projectiles having three chamferings (1846). In 1849, M. Minié constructed his bullet with shot bottom, to be forced by the action of the ignited powder, so as to expand the bullet into the grooves. Further trials led to the hollow ball of the Guard (1854), and M. Nessler's (1856). The principal improvements that have been realised since belong to M. Nessler, who has been appointed Principal of the Ecole du Tir of Vincennes. The experiments of 1833 and 1834 established the following general principles:—

1st. The rotary of the projectile on an axis corresponding with the line of direction of its motion is essential to accuracy of firing.

2nd. The charge of rifled, which is smaller than that of smooth arms, may be varied only in very narrow limits.

3rd. The length of the bore should be less in rifled than in smooth arms.

4th. The obliquity of the grooves may vary considerably without affecting the accuracy of the firing.

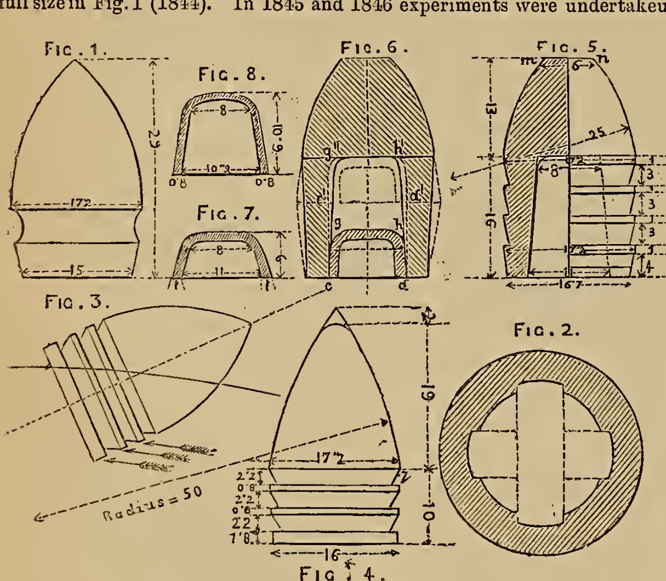
5th. The accuracy varies to a certain extent in inverse ratio with the number of grooves.

Some imporant results were also arrived at with reference to the flat and spherical balls:—

1st. They should be made to revolve round their minor axes, being those of the greatest momentum of inertia.

2nd. For such balls the less obliquity of the grooves is preferable.

Rifled arms with chambers were subject to the drawback of requiring special cartridges, difficult to make, and easily damaged, wherefore Thouvenin and Minié's system was adopted, with the form of ball shown full size in Fig. 1 (1844). In 1845 and 1846 experiments were undertaken



to determine the best form of grooves. It was found that guns rifled from right to left produced deviation to the left, and *vice versâ*. A pitch of 5·56ft. received preference. The grooves were helicoidal, and turned from left to right, wide and shallow, with sharp corners, and the bottom concentric with the sides of the arm. The grooves were four in number, in width equal to one-eighth the interior of the periphery, with a depth of ·01968in., or ·5 millimetres.*

An investigation into the influence of the new form on the progress of the projectile resulted in the following conclusions:—

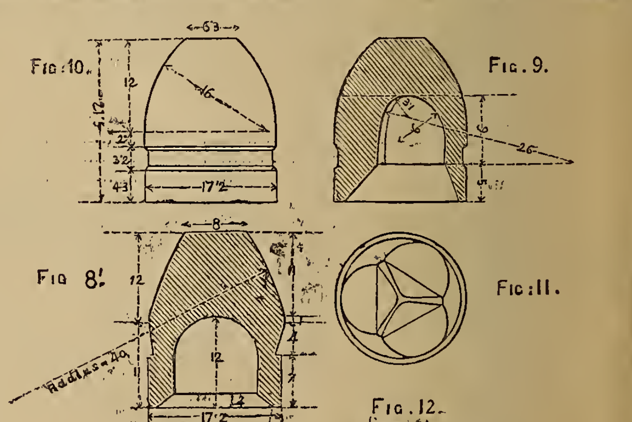
1st. The rotatory speed of the projectile should increase in direct ratio to its length, and the pitch of the helix should vary inversely with this length.

2nd. The chargo (4·50 grammes = 2·54 drams) is smaller than that for unrifled arms. Further, M. Tamisier found that the stability of the axis of rotation for lengthened projectiles depends on the position of the point of application of the resultant of the external resistances on the axis of the bullet, with reference to its centre of gravity. If the former point lies behind the latter, the equilibrium will be stable, and *vice versâ*. The centre of resistance is thrown backward by forming the projectile with chamfers, as shown in fig. 3.

Finally, the experiments lead to the adoption of the oblong chamfered bullet, as shown in fig. 4.

The committee appointed in 1845-6 investigated the phenomena of the deviation of the projectile arising from the slanting of the grooves; and M. Tamisier found that lengthened bullets deviate in reference to the vertical position of the mark in a direction corresponding to that of the rotation of the grooves. More recent researches have, however, shown that this is not the case, and that, in a gun rifled from left to right, oblong projectiles will deviate to the right if the centre of resistance lies before the centre of gravity, and to the left if it lies behind. In a gun of which the grooves form a helix sinistrostrum, the reverse takes place. In order to reduce the deviation arising from the slanting of the grooves, the centre of resistance of the air should be brought as close as possible to the centre of gravity of the projectile, so as to reduce the momentum of the latter from the speed of rotation it imparts. In addition, the momentum of inertia of the projectile, whereby the resistance of the air is counterbalanced, must be increased by increasing the angular speed of rotation of the bullet. From this point of view, it appears that rifled arms with ramrods possess real advantages, but their cleaning is difficult, and the forcing of the fall irregular.

As we have already observed, M. Minié proposed, in 1849, his ball with a shot bottom to obviate the above inconveniences. It is illustrated in figs. 5 to 8. Fig. 5 represents this projectile half in section and half in elevation, which was modified after the trials of 1851-2. Fig. 6 shows the bullet with the shot bottom; fig. 7, the shot bottom in its first shape; fig. 8, the same improved. Fig. 6 shows the widening action of the shot bottom, *c g h d*, in being driven to the bottom of the hollow, *c′ g′ h′ d′*, by the force of the ignited powder. The use of this projectile was attended with a disadvantage—that the ball may be broken, or become hollow or torn. The combination of ball and shot bottom was difficult and costly, on which account expansive projectiles, as shown in fig. 8′, without shot bottoms, were proposed by M. Minié in 1854. The trials at Vincennes



showed that, of the two, the balls with the shot bottoms fired most accurately, but the others proved less liable to rupture, and needed no chamferings. The external and internal outlines of the projectiles were carefully examined, and the following three forms proposed by M Nessler:—

* In the illustrations the dimensions are marked in millimetres. 1 millimetre = 0·03937in.

1st. The forms shown in figs. 9 to 11, where the cavity consists of a spherical part and a truncated cone, was called the *balle modèle* of 1857.

2nd. In 1859 this bullet was substituted by one illustrated in figs. 12 and 13, in which the cavity is pyramidal with triangular base, the edges being either left sharp or truncated. It is stated to be superior to the former.

3rd. In 1863 Colonel Nessler adopted a form having a pyramidal hollow, with a quadrangular base. Its weight is 1·27 oz. *adp.*, or 36 grammes, and it may be considered a remarkable improvement on its predecessors. These results are certainly due to the perseverance of Colonel Nessler, yet many essential improvements are urgently called for in the construction of the French small arms. The composition of the powder tends to corrode the interior of the gun, to obviate which, recourse is had to the inconvenient process of greasing the cartridges, and, finally, in the author's opinion, the calibre of the arms is not proportionate to their weight, and to that which may be assumed for cartridges, and in its reduction consists the only means of remedying all these inconveniences.

Erratum.—In our last number, page 136, column 2, line 16 from top, read 3 : 2 for 3·2.

MANCHESTER ASSOCIATION FOR THE PREVENTION OF STEAM BOILER EXPLOSIONS.

The ordinary monthly meeting of this Association was held on May 30th, when the chief engineer presented his report, of which the following is an abstract:—

"During the last month 191 engines have been examined, and 388 boilers, 12 of the latter being examined specially, and 2 of them tested with hydraulic pressure. Of the boiler examinations, 262 have been external, 8 internal, and 118 thorough or entire. The following defects and omissions have been found in the boilers examined:—Furnaces out of shape, 4; fractures, 10; blistered plates, 6; internal corrosions 4 (1 dangerous); external corrosion, 24 (4 dangerous); internal grooving, 8; external grooving, 2; feed apparatus out of order, 2; water gauges ditto, 14; fusible plugs ditto, 3; safety valves ditto, 2; pressure gauges ditto, 18; boilers without safety valves, 3; without glass water gauges, 2; without pressure gauges, 14; without blow-out apparatus, 14; without feed back-pressure valves, 44.

"The defects in the condition of the boilers examined during the past month do not call for any special remark, but the construction of some of the boilers lately enrolled in the Association has been found to be very imperfect. Three of them have proved to be as much as a foot oval in the furnace flues, and six inches in the shell, the major axis being horizontal. This is a very imperfect arrangement. Both the shells and internal flues of boilers, unless mainly or entirely dependent on stays, should be made truly circular, since a slight departure from this shape materially weakens them; and although, when oval, they may be able for a time to withstand the pressure, yet a change of form takes place in them whenever the steam is got up or let down, which has a very weakening effect, and soon wears out the plates. This, in locomotive boilers, leads to internal grooving, which is so fruitful a cause of their explosion. Three other boilers, which were of the hot water circulating description, for the purpose of heating and ventilating, although of a large size, were not fitted with any safety-valves; while the inlet and outlet pipes could both be closed at the same time, so that the pressure could be bottled up inside the boiler while the fire was in action. Under these circumstances, with anything like a brisk fire, explosion would in a very short space of time be clearly inevitable.

"Explosions.

"Six explosions have occurred during the last month, by which seven persons have been killed, and thirteen others injured. The scene of one of these explosions has been personally visited, and the cause investigated, while particulars of most of the others have been obtained, and will be given at the earliest opportunity.

"Tabular Statement of Explosions from April 22nd, 1865, to May 26th, 1865, inclusive.

Progressive No. for 1865	Date.	General Description of Boiler.	Persons Killed.	Persons Injured.	Total.
20	April 24.	Plain Cylindrical. Externally-fired	1	4	5
21	May 1.	Plain Cylindrical egg-ended Externally-fired	4	5	9
22	May 7.	Plain Cylindrical egg-ended Externally-fired	0	0	0
23	May 9.	Plain Cylindrical egg-ended Externally-fired	1	0	1
24	May 20.	Particulars not yet fully ascertained	0	3	3
25	May 26.	Locomotive	1	1	2
		Total	7	13	20

"In No. 20 Explosion one person was killed and four others injured. This explosion is the second that occurred within one fortnight at the same colliery. Particulars of the first of these were given in last month's report, under the head of No. 18 Explosion, while the second, now under consideration, viz., No. 20, occurred on April 24th.

"The boiler, which was one of two ranged side by side and working together, was externally-fired, of plain cylindrical construction, and set on two side walls, so that the fire passed underneath in the first instance and then encircled it, returning first on one side, and then on the other. It was about 25ft. long and 5ft. in diameter, the thickness of the plates being ⅜ of an inch, and the pressure of the steam from 50lb. to 60lb.

"The shell rent longitudinally from one end to the other below water-mark, and near to the bottom of the boiler, somewhat to the left hand side of the centre line, and was thrown to a distance of about 50 yards from its original seating, and the feed-valve box upwards of 200, while the sister boiler was also dislodged from its place. The fireman, who happened to be on the boiler at the time, was blown to a distance of about 100 yards, while the key of the feed-valve, which appears to have been in his hand at the time, fell to the ground about six yards from his body.

"The explosion was attributed to the neglect of the deceased boiler attendant —an inexperienced lad of nineteen years of age—who it was stated had in the first instance allowed the water supply to run low, and then let in the feed to supply the deficiency, when the explosion immediately occurred. This view was thought to be corroborated by the fact that the feed-valve was found to be just opened one or two threads of the screw, and the key picked up within a few yards of the body of the poor lad, just as if he had been standing on the top of the boiler with the key in his hand, and in the act of opening the feed-valve at the very moment of explosion. The jury returned a verdict of 'Accidental Death, arising from the absence of a competent person to inspect the boilers, and from want of judgment or negligence of the deceased,' adding that they hoped that some means would be taken by the proprietor to prevent occurrences of a similar nature.

"The assumption of shortness of water, and then of the sudden re-admission of the feed through the negligence of boiler attendants, forms a ready-made and stereotyped explanation of nearly every explosion that occurs, and although so widely circulated and received is yet seldom correct, while it too frequently damages unfairly the character of boiler attendants, and conceals the true cause of many explosions. Such is the case in the present instance. The boiler attendant was the victim of the explosion, not its cause, and it is unfair to blame him for the bursting of a dilapidated boiler which was older than himself, and by which he lost his life. This will be apparent from the following:—

"On examining the fragments of the exploded boiler I found that the primary rent had occurred just where the plates had rested on the brickwork seating, and where they had been so reduced by corrosion for a considerable length as to be as thin as a sheet of paper, so that it was a matter of great surprise that the boiler had not exploded long before. The boiler showed signs of great neglect throughout, the plates being also materially corroded where they had rested on the other side wall. It was difficult to ascertain precisely the age of the boiler, but it was an old one, and reported to have been down not less than twenty years. It had been seldom, if ever, inspected; indeed, the external flues were so contracted that the attendant stated he was unable to get up them to make any examination, so that the boiler had just been allowed to work on until it burst, and the one alongside, which was uncovered by the explosion, seemed to be rapidly approaching the same state, being seriously eaten away where it had been in contact with the brickwork, at which part the plates were shaling off, and were of a bright red colour from the active corrosion going on.

"There can be no question, therefore, that the explosion was due to the dilapidated condition of the boiler through neglect."

CORRESPONDENCE.

We cannot hold ourselves responsible for the opinions of our Correspondents.

LAKE'S DIFFERENTIAL ENGINE.

To the Editor of The Artizan.

Sir,—Will you allow me a few lines to reply to Mr. Maw's letter in your impression of June. His multiplication of examples, though useful to tyros, scarcely needs an equally voluminous reply, but two or three points demand comment on my part. Mr. Maw is wrong as to the quantity of steam lost in the curved passages—probably on account of his going on his own data, as I gave none. The interior of each cylinder would not in practice be exposed to the open air—the mode of protecting them seemed too obvious to need illustration in the sketch.

Mr. Maw's remark about the doubtfulness of the exhaust valve is merely an opinion, and if he will see the pumping engines at the East London or Kent Waterworks, he will find that a tappet motion, even when complicated (which that in the differential engine would not be) may be worked without any noise at all. Granting that the direction in which a *single* engine starts is dependent upon its position when the steam is turned on, this would not be the only engine which sometimes needs to be turned before it can be started.

I am, sir, yours, &c.,

Westminster, June, 1865. FRANCIS CAMPIN.

[This discussion has already extended over so much space that we must decline inserting any further letters on the subject.—Ed. "Artizan."]

REVIEWS AND NOTICES OF NEW BOOKS.

The Life, Time, and Scientific Labours of Edward Somerset, second Marquis of Worcester. To which is added a reprint of the "Century of Inventions," with a commentary thereon. By Henry Dircks, Esq., C.E. London: B. Quaritch. [Second Notice.]

After a lapse of two hundred years it has fallen to the lot of Mr. Dircks to write the first regular biographical memoir of the great Marquis of Worcester, who, born during the latter part of the reign of Queen Elizabeth, died in 1667, being seven years after the restoration of Charles II. to the throne. No period of our history is more interesting than that comprised in the present volume, or any subject calculated to be much more attractive to all classes of readers, from the scholar to the artizan.

Mr. Dircks's first chapter opens with an animated account of the marriage of Henry, first Marquis of Worcester, father of the subject of the memoir, and the last occupant of the strong fortress of Raglan Castle, distinguished in modern times only as a stately ruin. There was a grand masque on the occasion, honoured with the presence of the Queen, who, after dancing, was sumptuously entertained. For the first time we learn the births of both father and son; the former living until 70 years of age, and not until from 80 to 85, as currently asserted by all other authorities; while the son would be but 66 years of age at his decease, a fact hitherto unknown. Mr. Dircks likewise carefully traces and satisfactorily proves the decease of Elizabeth, the Marquis's first wife (mother of Henry, created Duke of Beaufort by Charles II.) which happened in 1635, and not in 1655, as declared by Sandford, Collins, and other genealogists. The settlement of this error was of the utmost importance, as we find the Marquis married a second time in 1639, four years after the decease of his first wife. Many interesting, and not a few amusing, family particulars are recorded, which incidentally illustrate the manners and customs of the period, and the disasters consequent on the great civil war which commenced in 1641.

The life of the Marquis is minutely traced to ascertain his studies, travels, and pursuits. His military character was one forced on him by the necessities of the war, and by no means congenial to a man of his philosophical temperament. We follow him through various vicissitudes of fortune, to find him at last driven to the sad necessity of making his escape from Ireland to France, where, with others of the Royalist party, he resided at the Court of the exiled King. Returning to England in 1652, he was imprisoned in the Tower, and when released, he wrote, in 1665, his famous "Century of Inventions," but which was not printed until 1663, three years after the restoration of the monarchy. Four years later he died, his decease having been preceded by plague and the Great Fire of London, either or both of which may have conspired to promote his premature departure. It is certain he never fulfilled his intention of leaving a larger work than his "Century," with complete descriptions and engravings of his hundred inventions. In this portion of his work Mr. Dircks does ample justice to the memory of the noble inventor's memory, plainly exposing the ignorance, if not malice, of Walpole, the recklessness of the censure of Hume, and the general weakness of critics who pretend to judge of a work like the "Century" without any previous intelligence respecting the state of scientific knowledge and scientific literature of the age in which the Marquis flourished. Mr. Dircks heaps authority upon authority to clear the Marquis's production of such charges as that it contains only "chimeras, lies, and impossibilities." In this respect the commentary is highly amusing and instructive. A library of old scientific literature is spread before us, and we all but see the Marquis once more in his tower, probably the Closet Tower, the library of Raglan Castle. In addition to this course of investigation, the biographer adds his own efforts to reproduce several of the inventions, as in the one-line cypher, balance water-work, bucket-fountain, double-drawing engine, to and fro lever, easy level draught, water flowing and ebbing motion, engine to raise weights, &c., all entirely original illustrations, with suitable engraved diagrams. Mr. Dircks has also discovered a key to the Marquis's cypher letter in the Bodleian Library, given at page 553. And not the least curious point in this portion of his investigation is the way in which he clears up six of the most paradoxical articles—that is, paradoxical, if viewed in any other light than as early experimental applications of steam; so that the Marquis must have been well acquainted with condensation and with the employment of a piston.

The author throughout displays a thorough appreciation of the great engineer's merits as a mathematician and mechanician, aided by a wonderfully fertile and inventive genius. No effort has been wanting to supply materials for forming a just estimate of the Marquis's character, either in a political or scientific point of view; but it is made evident that he was essentially rather the philosopher than the statesman or the warrior. In happier times he would have been appreciated and esteemed, but political dissensions and civil war, together with the fact of his siding with the Royal cause, rendered his very loyalty obnoxious to the dominant party. The Commonwealth tolerated his return to London, while Cromwell condescended to allow him a weekly pension of three pounds! His debts did not arise from personal extravagance, but from his unbounded loyalty, and liberality to his sovereign. Charles II. seems to have dreaded making him any adequate advances, or even countenancing him in bringing out his inventions. He sued in vain for Royal favour, the monarch preferring the gaieties of a loose Court to the profound subtleties of an euridite philosopher, and so lost what might have been the crowning glory of his reign—the early introduction of the steam engine at the hands of its inventor. Mr. Dircks has brought together some astounding facts and dates to show the too great probability that Savery's was no other than a resuscitation of the Marquis's own engine, the infant which has since grown to such gigantic proportions through years of successive improvements. The Marquis was the first inventor who brought steam into active employment with practical results, as also with a lively impression of its vast capabilities and possible mighty consequences. For this extraordinary prescience he has been charged by incompetent critics with egotism, enthusiasm, and eccentricity! Such has been the fate, hitherto, of this great mechanical genius, examined only by the light of classical learning. The life before us shows the deep injustice that has been inflicted on his labours and character by incompetent critics; and if Mr. Dircks had done no more than clear up the accumulated inconsistencies of former writers touching this subject, his work would have effected an important purpose; as it is, however, he has amassed in this biography more documentary evidence than it was, perhaps, ever supposed it would be possible to find in the archives of our public offices, colleges, and museums; but these—as here collected, arranged, and faithfully referred to, by catalogues and indexes—renders the present memoir a valuable contribution, not only in this respect particularly, but likewise generally to our scientific literature.

The Practical Millwrights' and Engineers' Ready Reckoner. By Thomas Dixon. 93 pp. London: E. and F. N. Spon. 1865.

This work, consisting of tables of diameters and power of wheels and shafts, multipliers for determining the effects of steam used expansively, speeds of governors and other matters constantly requiring the millwrights' and engineers' attention, deserves the consideration of all practical men. The tables and explanatory text are exceedingly well arranged, and afford a great amount of information in a small compass, and the value of the volume, as a handybook, is enhanced by the insertion of blank forms for memoranda in each division. We can confidently recommend this work to all practical engineers.

BOOKS RECEIVED.

"Wines and other Fermented Liquors." By J. R. Sheen. London: R. Hardwicke, Piccadilly. 1865.

"Public and Middle Class School Education—What it is and What it should be." By A Practical Man. London: Virtue Brothers. 1865.

NOTICES TO CORRESPONDENTS.

Mechanic.—The size and weight of fly-wheels are usually determined from practical experience. There is given an elaborate theory of the fly-wheel in Moseley's "Mechanical Principles of Architecture and Engineering," but the formulæ deduced are very intricate. The diameter of the mainshaft of a steam engine may be determined by the following formula:—

$$d = \sqrt[3]{\frac{320 \text{ H.P.}}{\text{R}}}$$

where d = diameter in inches, R = revolutions per minute, and H.P. the horse-power.

Surface Condenser.—There is a surface condenser applied to a pumping engine at Scarborough. It has horizontal tubes, and also admits of being used as ordinary condenser. One with vertical tubes is working at the Kent Water Works, Lewisham; all the water passing to the main pump is drawn over the condenser, so that an efficient vacuum is maintained.

C. E.—We are informed that whatever railway bills have not time to pass the present parliament will, in the next session, be taken at the stage they reach in this.

C. F. G. (Greenwich).—Howson's long tube barometer may answer your purpose. Within the mercurial column is a hollow glass stalk, which rises and falls with it, and by reducing its gross weight, causes the rise or fall for any given increment or decrement of atmospheric pressure to be greater than in the ordinary instrument.

Electrician.—A current of electricity of unit strength will decompose ·02 grains of water per second, or ·0103lbs, per hour, consuming ·0728 grains zinc per second, or ·03744lbs. per hour. The following formula will give the strength of any current in terms of the above unit:—

$$S = \frac{w}{\cdot 03744}$$

where S = the strength of the current, and w = the pounds of zinc consumed per hour.

PRICES CURRENT OF THE LONDON METAL MARKET.

	June 3. £	s.	d.	June 10. £	s.	d.	June 17. £	s.	d.	June 24. £	s.	d.
COPPER.												
Best, selected, per ton	92	0	0	90	0	0	90	0	0	90	0	0
Tough cake, do.	91	0	0	87	0	0	87	0	0	87	0	0
Copper wire, per lb.	0	1	0	0	1	0	0	1	0	0	1	0
„ tubes, do.	0	1	1	0	1	1	0	1	1	0	1	1
Sheathing, per ton	93	0	0	93	0	0	92	0	0	92	0	0
Bottoms, do.	100	0	0	98	0	0	98	0	0	98	0	0
IRON.												
Bars, Welsh, in London, per ton	7	12	6	7	15	0	7	15	0	8	0	0
Nail rods, do.	8	10	0	8	10	0	8	10	0	8	10	0
„ Stafford in London, do.	8	15	0	8	15	0	8	15	0	8	15	0
Bars, do.	8	15	0	8	15	0	8	15	0	8	15	0
Hoops, do.	9	15	0	9	15	0	9	15	0	9	15	0
Sheets, single, do.	10	7	6	10	7	6	10	7	6	10	7	6
Pig, No. 1, in Wales, do.	4	10	0	4	10	0	4	10	0	4	10	0
„ in Clyde, do.	2	14	9	2	14	9	2	15	0	2	15	6
LEAD.												
English pig, ord. soft, per ton	19	10	0	19	15	0	19	15	0	19	5	0
„ sheet, do.	20	5	0	20	5	0	20	5	0	20	5	0
„ red lead, do.	22	0	0	22	0	0	22	0	0	22	0	0
„ white, do.	26	0	0	26	0	0	26	0	0	26	0	0
Spanish, do.	19	0	0	19	0	0	19	0	0	19	0	0
BRASS.												
Sheets, per lb.	0	0	9½	0	0	9½	0	0	9½	0	0	9½
Wire, do.	0	0	9	0	0	9	0	0	9	0	0	9
Tubes, do.	0	0	9¾	0	0	9¾	0	0	9¾	0	0	9¾
FOREIGN STEEL.												
Swedish, in kegs (rolled)	13	5	0	13	0	0	13	0	0	13	0	0
„ (hammered)	14	15	0	14	15	0	14	15	0	14	15	0
English, Spring	18	0	0	18	0	0	18	0	0	18	0	0
Quicksilver, per bottle	8	0	0	8	0	0	8	0	0	8	0	0
TIN PLATES.												
IC Charcoal, 1st qu., per box	1	8	0	1	8	0	1	8	0	1	8	0
IX „ „ „	1	14	0	1	14	0	1	14	0	1	14	0
IC „ 2nd qua., „	1	6	6	1	6	6	1	6	6	1	6	6
IC Coke, per box	1	2	6	1	3	0	1	3	0	1	3	0
IX „ „	1	8	0.	1	9	0	1	9	0	1	9	0

ON UNSINKABLE OR RAFT SHIPPING.

By CHARLES ATHERTON, late Chief Engineer Royal Dockyard, Woolwich.

A paper has been recently read by Mr. Atherton at the Royal United Service Institution on the subject of Unsinkable or Raft Shipping, wherein the author sets forth the qualifications of vessels which, instead of possessing their buoyancy by reason of their hollow form, owe their floating capabilities to their being constructed chiefly of materials of less specific gravity than water. He proposes to construct the vessels so that, with the exception of cavities for the reception of machinery and coals, they will be solid up to a level somewhat above the logged water line, the materials used being so combined as to give the requisite strength with sufficient buoyancy. Thus, layers of 10in. of cork might be alternated with others of iron ·08in., or oak 1·05in., as bonding.

Mr. Atherton's object was to show the suitability of vessels of this class for the purposes of war, as, however much riddled with shot they may be, they cannot sink, but will still afford some refuge for those on board who, in the case of the sinking of ships of the ordinary construction used in naval warfare, would have but a comparatively small chance of being saved.

IMPORTANT INVENTION.—The *Western Morning News* states that Mr. Gale, electrician, of Plymouth, has discovered a process by which powder can be rendered non-explosive, and its combustible properties restored when required. The discovery possesses every element of an important and practical invention. The process is simple and effective. It cannot injure the powder. The cost is very small, and it has the advantage of being readily applied. In five minutes a barrel of powder can be made non-explosive, and in another five minutes it can be restored to its original condition. We have seen gunpowder subjected to this process and stirred with a red-hot poker without an explosion. If a shell burst in a store filled with the prepared powder, it would not fire it. The process can be readily applied to the largest or the smallest quantities, and it does not require any cumbersome apparatus. The invention will solve the serious difficulty which has been felt as to the storage of powder in time of peace, and in war it will avert the danger which now arises from the necessity of fighting in the neighbourhood of an explosive material.

RECENT LEGAL DECISIONS

AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

UNDER this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least—less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

CROOK v. JOSSE.—This was an action of trover, tried in the Court of Exchequer, for certain iron castings. The plaintiff is an ironfounder at Bolton, Lancashire, and in 1863 had contracted with a firm of Ellis and Co. to send a quantity of iron curbs, which were required for the construction of a railway, to Spain. Ellis and Co., who had been paid by the plaintiff, subsequently employed the defendant, who was a shipping agent, to transmit the goods for them. After the arrival of the curbs in Spain, Ellis and Co. became insolvent, and the defendant thereupon claimed to hold the goods for the amount due for their carriage. After the case had been opened, Mr. Williams said he felt that there was no substantial defence to the action, and would, therefore, consent to a verdict for the plaintiff. Damages, £333 11*s.* 8*d.*

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

POLLUTION OF RIVERS.—Instructions have been issued from the Home-office to the commissioners appointed to inquire into the pollution of rivers directing them to take selected river basins, illustrating different classes of employment and population, with a view to ascertain whether a measure absolutely prohibiting the discharge of the refuse of mines and manufactories into rivers, or absolutely compelling town authorities to carry town sewage on to the lands, might not be remedying one evil at the cost of an evil still more serious in the shape of injury to health and damage to manufactures. The Secretary of State suggests that the following river basins might be taken:—1st, the Thames Valley, both as example of an agricultural river basin, with many navigation works, such as locks and weirs, and mills affecting the flow of water, and many towns and some manufactories discharging their sewage and refuse into the stream from which is mainly derived the water supply of the metropolis. 2nd, the Mersey Valley, including its feeders, particularly the Irwell, as an example of the river basin, most extensively polluted by all forms of manufacturing refuse, particularly that arising from the cotton manufacture, and processes connected therewith. 3rd, the Aire and Calder Basin, as an additional example of the same class, particularly in connection with the woollen and iron manufactories. 4th, the Severn Basin, for the same reason, but in particular connection with the great seats of the iron trade. 5th, the Tall Valley, in connection with mining and industry applied to metals; and 6th, a river basin, comprising the mining districts in Cornwall.

PATENT PNEUMATIC LOOM COMPANY.—A prospectus has been issued of the Patent Pneumatic Loom Company, with a capital of £250,000, in shares of £10. The company was originally incorporated in October, 1863, with a nominal capital of £100,000, and its proposed extension to £250,000 is consequent upon arrangements for purchasing the Continental as well as the English patents. The leading principle of the invention consists in the direct action of compressed air in throwing the shuttle in lieu of pickers, shafts, &c., ordinarily employed. The works are at Salford, Manchester, and supposing the calculations in the prospectus as to the saving in power to be correct, the undertaking should be of vital interest to the trade of the country and profitable to all concerned. The true test of the practical opinions entertained on this point must be looked for in the degree of readiness with which the wealthy millowners of Lancashire may be disposed to subscribe the required capital.

IN PARIS THE IRONWORKS have still a vast number of orders on hand. One establishment is constructing thirty locomotives, of which ten are to have eight wheels, for one of the central lines, and several screw steamboats of 50 horse-power for the navigation of the lower Seine. An iron lighthouse of the largest size is likewise being constructed in Paris for the Government of the Argentine Republic. It is to be placed at the confluence of the Uruguay and the Parana, where the junction forms the Rio de Plata.

TRADE OF THE SOUTH WALES PORTS.—During the month of May 20,422 tons of coal were exported from Newport, against 21,607 tons in April, and 16,133 tons in the corresponding month of last year. Coastwise the shipments reached 57,831 tons, as compared with 48,517 tons in the previous month, and 57,548 tons in May, 1864. The satisfactory increase in the export trade shows that the port is gradually recovering its old position, and when the new railways and docks in contemplation are completed there is no doubt but that a still further increase will take place. Swansea exported 40,120 tons, against 47,668 tons in April, and 44,381 tons in the corresponding month of last year, and the shipments coastwise were 26,696 tons, as compared with 24,171 tons in the previous month, and 26,427 tons in May, 1864. The exports from Llanelly reached 16,113 tons, against 18,320 tons in April, and 15,255 tons in the corresponding month; and the coasting shipments were 26,816 tons, as compared with 24,812 tons in the previous month, and 25,810 tons in May, 1864. Swansea also exported 6,097 tons of patent fuel, and 100 tons of iron. The iron exports from Newport reached 11,066 tons, against 6,619 tons in the previous month. This large increase was brought about mainly by the opening of the Baltic trade, and there was a slight revival in the American trade as well.

OUR GREAT PORTS.—The amount estimated to be required for the Customs' service at the port of London for 1865-6 is £250,959, as compared with £252,024 in the corresponding period of 1864-5. The Customs' service of the port of Liverpool will absorb this year £104,915, as compared with £105,000 in 1864-5; of the port of Bristol, £16,400; of the port of Dublin, £19,150; of the port of Glasgow, £15,600; of the port of Greenock, £11,650; of the port of Hull, £18,490; of the port of Leith, £11,950; and of the port of Southampton, £11,030.

COSTS OF PRIVATE BILLS.—The Act (28th of Victoria, cap. 27) for awarding costs in certain cases of Private Bills has just been printed. Both Houses of Parliament are empowered on Private Bills to award costs in certain cases. When a committee report a "preamble not proved," the opponents are to be entitled to recover costs, and when a committee report unanimously "opposition unfounded," the promoters are to be entitled to costs. The costs are to be taxed, and afterwards to be recovered in one of the courts of law on the certificate given, with costs of the action. On filing a declaration and an affidavit of demand, the plaintiff is to be at liberty to sign judgment and to take out execution. The validity of the certificate for costs is not to be called in question in any court. Persons paying costs may recover a proportion from other persons liable. When a commitee report "preamble not proved," the promoters are to pay costs out of deposits. The Act is not to take effect before the 1st of November next.

BOILERS UNDER THE HOUSES OF PARLIAMENT.—There are several boilers for the purpose of heating and ventilating the Houses of Lords and Commons, as well as the committee rooms, placed in the basement of the building. It was reported some time since that these boilers were in an unsafe condition, and questions with regard to them were put by members in the House. All these boilers have recently been placed under the charge of the Manchester Association for the Prevention of Steam Boiler Explosions, and the chief engineer to the association, Mr. L. E. Fletcher, has lately made an examination of the boilers, with a view to putting them on a safe footing.

BORING OIL WELLS.—In boring a well a correct journal is kept, showing the different kinds of rock and earth passed through, and the exact points where water-courses, gas, or shows of oil are found. If a large vein of oil is struck, the well is immediately tubed with a 2in. or 2½in. iron pipe, put together in sections. The water from water-courses and the surface water is prevented from flooding the well by means of a leathern bag, called a seed bag, filled with flax seed, which is placed on the outside of the tubing and within the earth chamber below the water-courses. When the flax seed becomes saturated with water it swells, and completely shuts off all communication with the bottom of the well on the outside of the tubing.

CAUTION AS TO THE CONSTRUCTION OF "LIFTS."—At the Grosvenor Hotel on the 12th ult., the beam which suspended the machinery of the lift gave way, and the ascending room, with persons in it, was precipitated to the bottom, causing the death of two people.

A LARGE GIRDER.—Some considerable works are being executed, and are now nearly completed, at the London and Westminster Bank, Lothbury. The alterations there being made will give the bank a room the largest in London without columns. Mr. Shaw has built a wrought iron box girder, 86ft. span, and 96ft. long, to carry all the back buildings of the bank, which, with skylights, will weigh from 400 to 500 tons distributed. The girder is 8ft. deep, and the top and bottom flanges are 2ft. 6in. wide. This girder had to be built in its place, on a stage, and the whole of the rivetting had to be done there. The total weight of the girder itself is about 70 tons.

PETROLEUM AS STEAM FUEL.—By the report of Messrs. Wood, Whipple, and Stimers, chief-engineers of the U.S. Navy, appointed to investigate by actual experiment the method and process of Messrs. Linton and Shaw, for generating steam with petroleum, it appears in the experiments under consideration, the volume of flame was so great as to pass entirely through the tubes of the boiler, and heat the smoke-pipe red hot for several feet from the base, in consequence of which the maximum amount of combustion and evaporation was not reached in the use of petroleum. The evaporation in favour of petroleum was 103·1 per cent., the same boiler being used with the best anthracite coal, and under precisely the same condition. The time of generating steam from water of equal temperature of 20lbs. pressure above the atmosphere was, for the oil an average of 28 minutes, and for the coal 68 minutes, or in favour of the oil 114·3 per cent. The time from full operation of the complete extinguishment of the fire in the use of the oils was about 16 seconds. One of our iron-clads or naval steamers, by its successful use, as suggested in the experiments so far as tried, would be enabled to keep the sea, under steam, three times as long, with less labour and greater convenience, as compared with the use of coal, equal weights of each on board being considered. It is calculated that the saving of space by the use of oil in one of the largest European steamers, occupied with freight at the present rates, would give a larger receipt by upwards of 15,000 dollars on a single crossing.

EFFECT OF COMBINED STEAM AND AIR.—A series of interesting experiments for ascertaining the effect of combined air and steam, has been made at Newburgh, New York, by a correspondent of the *Scientific American*, and as they show that there are many unknown facts about steam worthy of research and examination, he generously publishes them. He says that he made a small steam-boiler and heated it by a gas jet, so as to supply a steady and equal flow of steam through a quarter-inch pipe. He also made an air-pump similar to a gas receiver, by inverting a vessel over water, and conveyed the air into the pipe of the steam-boiler, so that the mixed air and steam should issue from the same orifice against a light wheel, and cause it to revolve. At first air only was thrown against the wheel, and the revolutions noted, next steam alone was used, and then steam and air mixed:—

Inches of air per minute	43	60	83	120	150	200
Corresponding revolutions of wheel	9	13	18	27	36	45
Volumes of steam or inches per minute	432	432	432	432	432	432
Corresponding revolutions of wheel	60	60	60	60	60	60
Inches of mixed air and steam (1 and 5)	475	492	515	552	582	632
Gave this number of revolutions	73	90	91	120	165	164
The sum of those made by air and steam separately would be (2 and 4)	69	73	78	87	96	105
Showing a gain when they are mixed	1·05	1·23	1·17	1·37	1·61	1·56

DISINTEGRATING ORE COMPANY.—This is the title of a company recently organised in New York, U.S., which has purchased from the inventor a patented process for the treatment of ores, whereby it is claimed that the most stubborn sulphurets of gold, silver, and other metals may be readily and completely desulphurised, and with far less original outlay and working cost than is possible by any other known process. It is furthermore claimed that the ores can be worked by this process up to within 95 per cent. of the assay. Large quantities can be treated in a single apparatus. Some idea of the process may be obtained from the following brief statement:—They take the sulphur, arsenic, and phosphorus, from the ore by attraction, and oxydise the baser metals; or, in other words, they attack sulphur, arsenic, and phosphorus in a heated condition, by hydrogen gas, which become by the contact, sulphuretted, arsenuretted, or phosphuretted hydrogen gas, as the case may be, and simultaneously another agent follows and oxydises the antimony and the baser metals, copper, iron, &c. By that process, the hardest minerals, combined with metals, are decomposed or disintegrated, so that, when thus treated, it is only necessary to pass the residuum between the grinding surfaces of millstones, in order to remove the oxide from the metallic particles, after which treatment it is ready for amalgamation. It is contended by the corporators of the Disintegrating Ore Company that the first outlay for apparatus, including motive power, will be about two-thirds less than the cost of the expensive, complicated, and cumbersome machinery hitherto employed in practical mining operations; while the material required for the construction of the apparatus is mostly within the reach of miners on their own ground. Those parts requiring transportation are easily obtained, and can be moved from point to point with perfect ease.

SOUTH WALES COAL IN THE LONDON MARKET.—During the year 1864, the quantity of Welsh coal consumed in the metropolis did not exceed 3 per cent. of the total consumption, although the district is considerably nearer to London than the north of England coalfields, and the quality of its coal is generally admitted to be excellent. Taking the aggregate total of coal raised in the United Kingdom, South Wales ought, in proportion to the quantity worked in the district, to send at least six times that quantity to London. Want of railway facilities is the sole cause of this state of things; but if two Bills promoted in the present Session of Parliament are successful, this will not be the case long. The Bills referred to are the Great Western and the South Wales Direct, and the Severn Junction—the chief object of the promoters of which is to develope the coal traffic from South Wales to the metropolis. At present the tonnage rates for coal from the Aberdare Valley to London average from 10*s.* 6*d.* to 11*s.* per ton; but if the new schemes are carried out, the rates will be reduced to from 6*s.* 6*d.* to 7*s.*, being a reduction of 4*s.* per ton, which will enable the Welsh colliery proprietors to compete successfully with Newcastle coal. There is no doubt entertained that once South Wales coal is sold in London at 3*s.* to 4*s.* per ton below present quotations, there will be a large increase in the demand, and the consuming public of the metropolis will be materially benefited by the competition that will thus arise between Welsh and North of England coal.

LARGE HYDRAULIC PRESS.—A large hydraulic oil press has been turned out by Messrs. Francis Berry and Sons, Calderdale Iron Works, Sowerby Bridge, Yorkshire, embodying principles patented by Mr. J. Marshall of London. The top and bottom are of cast iron planed on the faces, with holes bored out for the columns, which are of hammered scrap 9in. diameter turned, with 14in. collars. The bottom of the cylinder is of cast iron, the inner shell of hammered scrap, with two tiers of malleable iron hoops, turned and shrunk on; the total thickness being 8in. The ram is of cast iron 30in. diameter. There are two seed chambers, each 18½in. diameter, the inner shell being of steel 1in. thick and hooped with malleable iron. There are two rams and cylinders of 14in. diameter, one placed under each seed chamber to discharge the cakes after the extraction of the oil. Eight gun metal pumps worked by two malleable iron beams are, with the driving gear, fixed on a large tank, the four speed pumps being each 4in. diameter and 9in. stroke. The power pumps are as follows:—One 2½in. diameter and 6in. stroke, one 1in. diameter and 6in. stroke, one ⅝in. diameter and 4in. stroke, and one ½in. diameter and 4in stroke; each pump being fitted with a valve, that of the ½in. pump being weighted to 3 tons per square inch, giving a pressure of 8 tons per square inch in the seed chambers and a total pressure of upwards of 2,000 tons.

NAVAL ENGINEERING.

TWENTY-INCH NAVY GUN.—The *Scientific American* gives some account of the trials of this gun with heavy charges. The great gun is nearly 4ft. shorter, but has the same bore, and is intended to possess the same relative capacity. It has been in course of completion nearly ten months, and was placed in position for trial for the first time on the 25th of May last. It was suspended by the trunnions, breech, and muzzle, the sling having been constructed for the special purpose. It was charged first with sixty pounds of powder, and subsequently two successive charges of the same amount of powder, the last accompanied by a solid shot weighing 1,080lb. The gun at each discharge vibrated about one-half of its length in its slings. On this occasion, the heavier charges were tried. Eighty pounds of the usual rock powder were used, and the 1,080lb. solid shot was sent down to keep it there. Notwithstanding the great weight of the gun, the size of the charge, and the magnitude of the solid shot, the loading of the monster gun was accomplished in a briefer space than would require us to write the account. Three 80lb. charges were fired. To a sensitive tympanum the shock of this gun is pleasant in comparison with that produced by a 9in. Dahlgren. A charge of 100lb. was next introduced, the solid shot sent home, the percussion arranged, when Mr. James Knapp pulled the lanyard. The ball struck the stone bank, and tons of rock fell into the cavern, already existing from similar ponderous blows. This time the gun recoiled about two thirds of its length in the sling, and the concussion scarcely differed from that experienced with the 80lb. charges. A second charge of 100lb. was fired, and immediately after the recoil a wrought iron bolt, 3in. in thickness suddenly snapped, and the breech-hand broke letting the enormous mass to the ground, crushing as if they were made of timber, the T-rails beneath.

THE "BASILISK," 6, paddle-wheel sloop, 1,031 tons, 400 horse-power, having completed her extensive alterations and repairs in her machinery in Sheerness Dockyard, was, on the 6th ult., taken to the measured mile off Maplin Sands, for an official trial of her engines. The following were the results of the trial:—Average speed at full boiler power, 9·651 knots; ditto, at half boiler power, 8·197 knots; draught of water, forward, 16ft. 7in.; aft, 15ft. 1in.; load on safety valve, 12lb.; pressure of steam, 12lb.; vacuum, 25¼; revolutions of engines, full power, 16·75; ditto, at half power, 13·5; force of wind, 1 to 2. The time occupied in turning the circle, at full power, with helm to starboard 34·5 deg., was 5 min. 17 sec., the diameter of the circle being 420. At half boiler power the time occupied was 6 min. 33 sec., with helm to port 36 deg. The vessel had 280 tons of coal on board and six months' stores. The engines worked satisfactorily, and there were no hot bearings. The boilers produced a good supply of steam without priming. The result of the trial was highly satisfactory.

THE SCREW STEAMER CORVETTE "SCOUT," 21 guns, 1,560 tons, 400 horse-power, left Sheerness harbour on the 10th ult., for the final trial of her engines, at the measured mile off Maplin Sands, previous to her departure for the Pacific. On that station she will relieve the *Tribune*, 23, screw steam frigate. The *Scout* left the harbour under steam with top-gallant yards across and looking in good trim, being in every respect ready for sea, with four months' provisions and twelve months' stores on board. Her draught of water aft was 19ft. 9in., forward 17ft. 7in. The mean speed attained after six runs at the measured mile with full boiler power was 10·875 knots per hour, and at half boiler power 8·825 knots. The force of the wind from two to three. The ship was also tried at the circle; with helm hard to port at full power the half circle was completed in 2 min. 40 sec.; hard to starboard in 2 min. 55 sec. The complete circle at full power was completed in 4 min. 18 sec., half boiler power 5 min. 26 sec., the diameter of circles being about 345 yards. There was a pressure of steam at full power of 18lb., and at half power of 17lb.; vacuum, 25½. The trial was considered satisfactory.

TRIAL TRIP OF THE "PALLAS."—Her Majesty's armour-plated screw corvette *Pallas*, of 6 guns, has recently returned to Greenhithe, from a preliminary trial trip to the Nore, the object being to ascertain how far the ordinary relations of the pitch of screw to the section and displacement of the ship might require modification under the peculiar construction of this remarkable vessel, in which many of the time-honoured and ordinary conditions of shipbuilding have been departed from. The trial was under the inspection of Mr. E. J. Reed, Chief Constructor of the Royal Navy; the engine-builders, Messrs. Humphreys and Tennant, of Deptford; Captain Conolly, appointed to the command of the ship; and the inspectors of machinery from the steam factory. The *Vivid*, Admiralty steam vessel, Commander Biddlecombe, having on board Commodore Dunlop, a superintendent of Woolwich Dockyard, and party, also accompanied the *Pallas* during her trip. She was enabled to attain a speed of nearly 13 knots per hour with 64 rotations per minute, leaving but little doubt that when the engines are driven as they will be at from 70 to 75 revolutions per minute, a speed will be realised exceeding that of any wooden corvette or frigate in the Royal Navy. The *Pallas* proved herself remarkably strong and free from vibration under steam, and easily changed her course from one direction to the very opposite under the action of her rudder.

NEW FRENCH IRONCLAD TWIN-SCREW STEAM RAM.—The *Toulonnais* contains description of the *Taureau*, a steam ram built on a new system, and lately launched at Toulon. The *Taureau* presents a formidable appearance, due more to its form than to its size. The impression produced is that of an impregnable fortress; it is neither pretty nor light, and its beauty consists in its formidable appearance. The construction was commenced in 1863, and it was Admiral Bouet-Willaumez, at that time Maritime Prefect of Toulon, who, by permission of the Minister of Marine, prepared the plan of an iron-plated steam ram for the defence of the seaports. Its utility was incontestable, and it became more so after the attacks on Charleston and Fort Fisher. The *Taureau* draws so little water that she may be concealed close to the shore while waiting for an enemy to enter the harbour, or she may take a position in shallow water where it will be impossible to follow her. Her prow terminates in a point, and this point is armed with a kind of massive bronze cone which serves as her spur. It is with this spur that this heavy ram, driven at a speed of 12 to 14 knots an hour by machinery of 500-horse power, can strike a ship. The *Taureau* is, moreover, supplied with two screws, which enable her to turn in a very small space and with the greatest facility. She carries only one heavy gun, which weighs 20 tons. The *Taureau* has but one deck, which is plated with iron from one end to the other. The sides of the hull are likewise plated with iron the full length, from 3ft. under the water line to the deck The deck and the sides form, as it were, an iron box, safe from any shot that may be fired at it. It is in this iron box that the machinery is placed, and the entire crew during an action, except those in the tower. The deck of the *Taureau* is covered over its entire length with a cylindrical ball-proof dome. The surface of the dome is so inclined that it is impossible to walk on it; it will consequently be impossible to capture it by boarding.

GUN CARRIAGES.—Captain Astley Key, C.B., and Senior Naval Gunnery Officer, embarked on the 15th ult. on board the iron cased screw corvette *Research*, 4 guns, at Spithead. Immediately afterwards the vessel weighed her anchor and steamed out southward of the Nab lightship for experimental practice with her 100-pounder smooth-bore guns, to test the working of the carriages. The ship was under weigh about seven hours. The following is the result of the experiments:—The new Admiralty iron carriage, on Commander Scott's plan, made the first ten rounds in 10 min. 50 sec., with a charge of 20lbs.-F.; the second ten rounds in 8 min. 10 sec., with a charge of 25lbs.-D.; and fifteen rounds in 11 min. 42 sec., with a charge of 25lbs.-D. The wooden gun carriage, on the improved pattern received from the arsenal at Woolwich, made the first ten rounds in 8 min. 31 sec., with a charge of 20lbs.-F; the second ten rounds in 9 min. 10 sec., with a charge of 25lbs.-D; and fifteen rounds in 12 min. 57 sec., with a charge of 25lbs.-D. Both carriages worked well, and much better than the old pattern carriage. The iron carriage was worked with nine men as its crew, and the improved wooden carriage with twelve men, being 33⅓ per cent. in favour of the iron carriage in this respect. As regards the time, it will be found to be 4 sec. in favour of the wooden carriage in the total of thirty-five rounds fired, but there were accompanying favourable conditions which fully accounted for this.

HEIGHT OF PORT SILLS.—Instructions have been received at Chatham Dockyard from the Admiralty, conveying the announcement that their lordships have decided on adopting one uniform height of port sill in all vessels of war carrying guns above 95 cwt., and that the height has been fixed uniformly at 2ft. 2in. The same order also directs the height of the axis of guns of from 6 tons to 12 tons to be 3′ 7″ above the deck when the gun is run out, and the axis of 6-ton guns, whether rifled or smoothbore, of 3′ 4·5″ when the gun is run out.

NAVAL APPOINTMENTS.—The following appointments have taken place since our last:—J. A. Kidd, appointed Engineer in the Royal Naval Reserve; G. Tucker, promoted to he Inspector of Machinery afloat, and appointed to the *Cumberland*, as additional for service of the Reserve at Sheerness, vice Williamson; J. Bridgman, Chief Engineer, to the *Cumberland*, as additional in charge of the engines of the *Charybdis*; J. T. Williams, appointed Chief Engineer additional of the *Cumberland*, for charge of engineers of the *Lord Warden*; Robert Highet, First class Assist.-Engineer to the *Terrible*; J. London, Chief Engineer to the *Black Prince*, vice Tucker, promoted; A. Douglas, Chief Engineer, additional, to the *Indus*, for service in the *James Watt*, vice *London*; O. L. Carlisle, appointed Chief Engineer, additional, to the *Cumberland*, for charge of engineers of the *Orestes*, on that ship being paid off; W. R. Fabian, Chief Engineer to the *Arethusa*; R. C. Reynolds, Chief Engineer to the *Octavia*; J. H. Ellis, Chief Engineer to the *Constance*; J. Lowrie, Engineer to the *Arethusa*; J. Jones, Engineer to the *Octavia*; H. Duncan, Engineer to the *Constance*; R. Crosthwaite, to the *Asia*, for the *Fanny*, vice Jones; J. C. Saunders, to the *Indus*, for the *Gannet*, vice Duncan; A. Shanks and G. M'Leod, First-class Assist.-Engineers to the *Octavia*; C. D. Thomas and C. M. Johnson, First-class Assist.-Engineers to the *Arethusa*; L. Steele and J. Sharp (B), First-class Assist.-Engineers to the *Constance*; J. Copplestone, Second-class Assist.-Engineer to the *Constance*; C. F. Halford, Second-class Assist.-Engineer to the *Arethusa*; H. Scott, Acting Second-class Assist.-Engineer to the *Octavia*; A. J. B. Newman, Acting Second-class Assist.-Engineer, to the *Asia*, for the *Echo*, vice Shanks; G. F. Boothe, Chief Engineer to the *Indus*, for the *Greyhound*; G. M'Lean, First-class Assist.-Engineer to the *Constance*, in lieu of a Chief Stoker; W. Brimacombe, Acting Second-class Assist.-Engineer to the *Constance*; J. Carlisle, Chief Engineer to the *Indus*, additional, for the *Amazon*; W. Limley, Chief Engineer to the *Asia*, additional, for the *Rinaldo*; W. F. Capps, Chief Engineer to the *Cumberland*, additional, for the *Foxhound*; P. T. Gruchy, Chief Engineer to the *Cumberland*, additional, for the *Barracouta*; G. Mackney, Acting Second-class Assist.-Engineer to the *Sphinx*.

MILITARY ENGINEERING.

BELGIAN MANUFACTURE OF FIRE-ARMS.—In the description given by Mr. Barron, in his report to the Foreign-office, he states—One cause of the reputation of fire-arms of Belgian manufacture is stated to be the care with which each barrel is tested in the proof-house. The French system of proof is, in point of stringency, below that of Liège. The English proof is as strong as that of Liège; for muskets even stronger, but the penalties on fraud and forgery are lighter. France is still governed by the Imperial decree of 1810, which there, has even become relaxed in practice, while in Belgium the same decree has been materially strengthened. Thus, in France, the barrels of certain Paris makers and pocket-pistol barrels in general are dispensed from all Government proof. At Liège every barrel of a pistol and every chamber of a revolver must be proved separately. Single-barrelled ramrod guns are proved ones. Double-barrelled guns have to undergo two, and if breech-loaders three, proofs. At St. Etienne there is only one proof for gun-barrels, which evidently offers no guarantee of strength if the barrel is subsequently altered. In manufacturing at Liège a double-barrelled breech-loader is subjected to three proofs, the first on each barrel separately, the second on the barrels when welded together, the third when percussioned and jointed. If the barrel bursts on the first proof the barrel-maker must replace it, and loses, therefore, the fruit of his labour. If the barrel bursts on the second proof, the garnisher is also made responsible jointly with the barrel-maker. If the barrel bursts on the third proof, all those who have assisted in the work—viz., the barrel-maker, the garnisher, and the "systémeur" (percussioner)—must suffer, and all lose the fruit of their labour, unless the defect can be traced to the fault of any one of the three in particular. The whole price of the job is stopped from their account in the manufacturers' books. Thus every workman is made responsible for the quality of the barrel, and he is therefore in self-defence obliged to scrutinise it thoroughly before beginning to work on it. Such a severe system would be vainly attempted elsewhere. It is sometimes even unjust, but affords the highest guarantee of the soundness of a barrel. It is submitted to by all as an immemorial usage. This docility of the working class, combined with an abundant supply of labour, is one of the main causes of the astounding development of the Liège arms trade. Of the numerous manufactures flourishing in Belgium, gun-making stands seventh in the number of hands it employs. The census of 1856 sets down the number of persons engaged in it at 9,675. Other estimates bring the numbers directly or indirectly engaged in it up to 20,000, or even 30,000. This industry is confined solely to the arrondissement of Liège. It is this local concentration, together with the division of labour which prevails in this trade, and the pre-eminence which it has acquired in the markets of the world, that renders it comparable only to the watch trade of Geneva. One feature of the arms trade, proving how much it developes the intelligence, is that many of the improvements in it are due to working men. At the same time, being practised at home, it is not so demoralising as others carried on in large factories. By another rare privilege it is proof against political convulsions, thriving in war as well as in peace. Every successive innovation brings a rich harvest to Liège—such as, for instance, the percussion-lock, the breech-loader, and the rifled musket. The annual production of guns at Liège is now nearly ten times as great as that at St. Etienne (French). The Paris gunsmiths buy three-fourths of their guns at Liège, finish them carefully, and sell them as Paris workmanship. The superior qualities are about equal at Liège and St. Etienne; the produce of the former being being superior in style and appearance, that of the latter in real finish. The Belgian talent for imitation is here conspicuous. The taste of every market is carefully studied; the trade marks of other nations and makers are, we are sorry to say, counterfeited. Thus, Liège has supplanted Birmingham to a great extent in the important market of North America. A stringent law on trade marks in Belgium is a great desideratum for British industry. The best double-barrelled Lefaucheux gun costs at Liege £16 sterling. To the eye this gun will be quite identical with a £30 gun of Paris, or a £40 gun of London; but in some parts it will be found inferior to either. If selected, however, with care, and put into the hands of a gunsmith to be examined and "finished," it will do excellent service. From the immense scale of manufacture a gun seldom comes from Liege thoroughly finished and regulated. The iron work will require to be case hardened; the lock will require the closest scrutiny, and perhaps re-tempering. Here it is that England defies all competition. A pair of Wolverhampton locks will cost £3, therefore as much as an average Belgian gun, but will last for a life-time. The Belgian lock will appear quite equal, but in a year or two the main spring will become relaxed. English iron, coal, and workmen have been brought to Belgium in order to make English steel, but in vain. This is consequently attributed to the nature of the Sheffield water.

THE ARMSTRONG AND WHITWORTH COMMITTEE, of which Major Dyer, Royal Artillery, Assistant-Inspector of Ordnance in the Royal Arsenal, is secretary, completed their lengthened and fatiguing trials at the Woolwich butt. The two competitive 70-pounder guns fired the last course, terminating the appointed 3,000 rounds each, with charges of 10lbs. of powder and service shots, and are both without blemish. They were shipped for transmission again to Shoeburyness, where they will be fired at an elevation of six degrees to try if the accuracy of the guns has been affected by the severe course of trial which they have undergone.

STEAM SHIPPING.

TRIAL TRIP OF THE "DOURO."—The Royal Mail Company's new screw steamship *Douro*, of 2,414 tons and 500-horse power, left the Southampton docks on the 17th ult., and was taken to Stokes Bay for an official trial. The *Douro*, which has been built and engined by Messrs. Caird, of Greenock, is one of the most beautifully finished and complete ocean steamers yet added to the fleet of the Royal Mail Company. She is fitted and in every way adapted for the Brazil station, ventilation being specially attended to. The cooking department, arranged by Henham and Son, was much admired for the excellent accommodation it affords for the *cuisine* of a large number of passengers and crew. The engines and machinery worked steadily throughout the trial, and the performances of the ship were considered very satisfactory. Four runs were made at the measured mile, with the following results:—First run, 4 min. 8 sec., equal to 14·516 knots per hour, 58½ revolutions; second run, 4 min. 32 sec., or 13·235 knots, 59¼ revolutions; third run, 4 min. 24 sec., or 13·636 knots, 58 revolutions; fourth run, 4 min. 22 sec., or 13·740 knots, 60 revolutions. Pressure of steam 28lb. The mean speed of the four runs was 13·782 knots, or a little over 16 statute miles per hour. Steamers about to be added to the Royal Mail Company's fleet are the Rhone, Danube, and Arno, which will all be ready for sea during the present summer.

THE FRENCH COMPAGNIE GÉNÉRALE TRANSATLANTIQUE must, according to conventions concluded with the State, commence next spring a bi-monthly service from Havre to New York. The plant which the company will apply to this line consists of the *Napoleon III.*, 1,000 horse-power, launched in London in February, and the equipment of which will be completed in September or October; two large screw steamers, ordered from Messrs. Napier, of Glasgow, which are to be delivered in February, and a fourth screw steamer in course of construction at St. Nazaire, and of 850 horse-power. The *Europe*, of 850 horse-power, will be the fifth steamer devoted to the New York line, but will be regarded as a reserve steamer. The *Washington* and *Lafayette*, built on the Clyde in 1863-4, will be applied to the Antilles line.

STEAM SHIPBUILDING ON THE CLYDE.—Messrs. Hedderwick and Co., of Govan, have launched a screw of 600 tons builders' measurement, named the *Japan*. She is intended for the China and Japan trade, and is now being fitted with engines of 85-horse power by Messrs. James Howden and Co., of the Seotland-street engine works. Messrs. Scott and Co., of Greenock and St. Nazaire, have seeured contracts from the Russian Government for building four large steamers for that navy. They will also supply the engines. Messrs. Tod and Macgregor have launched an iron paddle steam yacht for His Highness the Viceroy of Egypt; she is the fifth built for his Highness by the same firm. The yacht is named the *Mukhbir Suroor* (or Bringer of Glad Tidiugs), and her dimeusions are as follows:—Length of keel and fore-rake, 220ft.; beam moulded, 20ft.; depth, 9ft.; burden, 442 tons, builders' measurement. She is flush-decked, with an after saloon 50ft. long, and a forward saloon 40ft. long, with bath-rooms, &c. She will be propelled by a pair of oscillating engines of 130-horse power nominal.

LAUNCHES.

The Launch of the Mail Steamer "Throudhjem," from the yard of Messrs. J. Wigham, Richardson, and Co., Low Walker, took place on the 21st ult. The *Throudhjem* is the second of the two fast despatch steamers built for the Norwegian Royal Mail Service. This steamer is, in all respects, a sister vessel to the *Nordland*, and like her, is fitted out from end to end for first and second-class passengers, with mail room and other postal arrangements.

TELEGRAPHIC ENGINEERING.

New Mode of Telegraphing.—M. Eugene Godard, the imperial aeronaut, has made some very interesting experiments in a method of telegraphing. By the aid of a single luminous point M. Godard sends messages to any part of the visible horizon. The experiments were tried at the Observatory and in the Rue de Puteaux. A lamp to which a reflector was placed in the third floor of a house in that street, while a similar lamp was burning on the terrace of the observatory. Within three minutes M. Godard sent a message of twenty words to the Observatory. The system is extremely simple. By means of screens, which by concealing or allowing the light to escape, partial or total eclipses are produeed. The screens are either of white or red glass. The colours emitted and the duration of that emission suffice to form an alphabet analogous to that of words used by the usual eclectric telegraphs. The extreme simplicity of this method would be specially useful for signalling at sea in times of war. Two corps d'armee could thus most easily communicate with each other.

The Seismometer.—Lieut.-Col. Ramstedt, of Helsingfors, has constructed a new form of seismometer, for which he proposes the descriptive name—Telegraph of the accidental movements of the earth. Considering that these movements are much more frequent and continuous than is commonly supposed, and that the greatest number escape notice through want of proper observation, he suggests that his instrument should be placed in the principal magnetic observatories of Europe, and other parts of the world, where, being self-recording, it would note the occurrence of every shock or movement, however slight. If, as Lieut.-Col. Ramstedt remarks, there are tremhlings of the earth nearly every day, it seems desirable that some notice of them should be taken; and, perhaps, established observatories, with their staff of assistants, would be the best places for the investigation. As all the records would have to be sent to one central office, the localities in which shocks and tremhlings are most frequent would be discovered; and, in course of time, some conclusions might be drawn as to whether the movements were periodical, or form part of some intermittent system of vibrations by which the earth is affected. The seismometer is so constructed as to indicate, by lines traced with a peneil, the time at which a shock takes place, and its force and direction.

The Atlantic Telegraph.—The *Great Eastern* now the coiling in of the cable has been completed has in her as nearly as possible 7,000 tons of cable, or, including the iron tanks which contain it and the water in which it is sunk, about 9,000 tons in all. In addition to this she has already 7,000 tons of coal on board, and 1,500 tons more still to take in. Her total weight, including engines, will then be rather over 21,000 tons, her measurement tonnage being 24,000. Her way out from the Nore will be by Bullocks Channel, which the Admiralty are having carefully buoyed to avoid all risk in these rather shallow waters. Before the following spring tides set in, the *Great Eastern* will start for Valentia, were she will be met by the two ships of war appointed to convoy her —the *Terrible* and the *Sphinx*. Both these vessels are being fitted with the best apparatus for deep sea soundings; with buoys and means for buoying the end of the cable, if ever it should become necessary; and with Bollen's night light naval signals, with which the *Great Eastern* is likewise to be supplied. To avoid all chance of accident, the *Great Eastern* will not approach the Irish coast nearer than 20 or 25 miles, and her stay off Valentia will be limited to the time occupied in making a splice with the massive shore end, which for a length of 25 miles from the eoast will be laid previous to her arrival. This monstrous shore end, which is the heaviest and strongest piece of cable ever made, will be laid from the end of a sheltered inlet near Cahirciveen out to the distance stated, where the end will be buoyed and watched by the ships of war till the *Great Eastern* herself comes up. Some idea of the strength and solidity of this great end may be guessed by the fact that its weight per mile is very little short of half the weight of an ordinary railway metal. For the shore end at Newfoundland only three miles are required, and this short length will be sent in the *Great Eastern*. When once the spliee is made from the great cable ship to the English shore end—an operation which, it is expected, will eonsume about five hours—the work of laying the cable will commence. By that time every mile of the cable in the tanks will have been joined up, and at a stated hour, morning and evening, a series of signals will be sent through the cable to the land at Valentia, and thenee to London, giving the latitude and longitude of the great ship, the state of the weather, and the number of miles paid out. The cable will be first taken out from the forward tank, next from that amidships, and lastly from that astern; and if all goes well the vessel should arrive with nearly 500 miles of cable in her still unused, an excess which is most wisely allowed in case of accident. As regards the commercial prospects of the undertaking, it may be stated that the Atlantic Company have begun their work under the reuewed agreement with the Government for a subsidy of £20,000 a year, and, in addition, a guarantee of 8 per cent. upon a capital of £600,000. Thus, in return for their guarantee, which is only to continue in force while the line is in working order, the Government demand that the maximum eharge for messages shall not exceed 2s. 6d. per word.

Telegraphic.—A new submarine cable has just been laid between Sicily and Algeria. Italy will thus be directly connected with Africa by two telegraphic lines, establishing immediate communication with Tunis and Algeria. These lines pass over the island of Favognana.

RAILWAYS.

Metropolitan Railway.—The number of passengers eonveyed on the Metropolitan Railway on Whit Monday, was 83,410. This is the largest number conveyed in one day since the opening of the line.

Pneumatic Railway under the Thames.—The recent experiment at the Crystal Palace has led to the idea of carrying out a short line to connect the Waterloo Station of the London and South-Western Railway with Whitehall, passing in a troughed iron bridge, or surface tunnel, under the Thames. Three piers will be built below the bed of the river, by means of iron caissons. When these piers have been brought up to within a few feet of the bed of the river, the upper portions of the caissons will be taken off, and the bed of the river between the line of piers dredged down to the level of the upper course of the masonry of the piers, and in the trough thus formed the iron tube will be made. The tube will be lowered in four separate seetions. When down, these will be kept seeurely in their place by cramps, and will be eovered with a thick bed of concrete. The internal diameter of the tube will be 12ft. The portion of the line between Whitehall and up to the river front of the Thames Embankment will be built in brickwork; and on the Surrey side the line will also be continued in brickwork under College-street and Vine-street, close to the Waterloo Station of the South-Western Railway, with which it will communicate by a flight of steps from the York-road side of the station. The steepest gradient throughout will not be more than 1 in 30, which is nearly one-half more favourable than the aseent of Holborn-hill, or that of the experimental line at the Crystal Palace.

RAILWAY ACCIDENTS.

Accident on the Edinburgh and Glasgow Railway.—An aecident occurred on the 22nd ult. to the passenger train leaving Glasgow at 11.45, and due at Edinburgh two hours later. While passing Haymarket depôt, about a mile and a half from Waverley station, the train came in collision with a goods engine which had just come out of a siding. The driver of the goods engine had left the train on the down line to go to the water tank, across the up line, but in returning failed to regard the danger signal plaeed on the up line, to protect the passenger train. The driver of the passenger train, observing the error, signalled to the goods train to keep up steam and go on first through the tunnel, but the driver having in the alarm of the moment, stopped the goods train, the latter eould not again put it in motion in time. The result of the collision was that many of the passengers were seriously injured.

Accident on the South Eastern Railway.—The fast tidal train, timed to leave Folkestone at 2.30 p.m. on the arrival of passengers from Boulogne, who quitted Paris on the moruiug of the 9th ult. at seven o'clock, started, as usual, with about 110 passengers, and proceeded nearly thirty miles on her journey, until Staplehurst, was reached, where it appears that the railway crosses a stream which in winter is of formidable dimensions and of considerable depth, but in summer shrinks to the proportions of a rivulet. On the bridge itself a plate had been loosened by the platelayers, and the engine running over this was thrown off the rails. Though displaced from the proper track the locomotive adhered to the permanent way, but the train broke into two parts, and seven of the carriages plunged into or through the stream, a fall of 15ft., the breadth of the ditch itself being 50ft. These vehicles were so crushed and shattered to pieces that together they did not occupy the space of two whole carriages; cushions and luggage were thrown out, into, and upon the mud in all directions; and, as regards the occupants, it was found that ten were killed on the spot, and many others most seriously injured.

Accident on the Shrewsbury and Chester Railway.—An accident took plaee on the 7th ult., at Rednal, a station ou the Shrewsbury and Chester Railway. A large exeursion train, consisting of 35 carriages, and drawn by two powerful engines, was proeeeding from Liverpool to Birmingham, the rails had been newly relaid, and on approaching that portion of the line the carriages began to oscillate. The train was proceeding at great speed, and the drivers, seeing the danger, attempted to draw up, but were unable to do so, and both engines dashed off the line, proceeding in opposite directions. From 800 to 900 persons were in the train. The engines and a great portion of the carriages were smashed to atoms. One of the stokers was killed, and one of the drivers was seriously injured. When the bodies of the passengers were got out, it was found that seven men and women and two childen were killed, and about 50 persons, including men, women, and children, were more or less injured, the greater portion of them very severely.

Accident on the Great Western Railway.—On the 6th ult., at midnight, an accident occurred on the Great Western Railway between Salford and Keynsham, some five or six miles from Bristol. It appears that the down passenger train leaving London at 8.10 p.m., had been stopped on a steep embankment, half a mile east of Keynsham, owing to the driver thinking that he had either run over something or that the erank-axle was broken. Having examined his engine and found everything to be right, he had just started his train, when the special mail train leaving London at 8 46, and going about the same speed as the fast (8 10) train, was heard approaching. There was a dense fog prevailing at the time, and it was evident that a collision was about to occur. The passenger train ecmprised an engine, tender, van, a first and a second class carriage, and horse-box, with the doors all locked. The driver, however, hoping to get sufficient speed on to enable him to place a safe distance between his train and the one approaching, proceeded on his way. In the last compartment of the first-class carriage (next the horse-box) a gentleman, happening to have a key in his possession, opened the door, and, with three or four companions, jumped out on to the embankment just as the mail train came up and dashed into the horse-box, knocking out one side of it. The last compartment of the latter was completely smashed to pieces; the other parts escaped, but the second-class carriage, which was in the middle of the train, sustained the most damage, being made a complete wreck. In this were most of the passengers, and numbers of them sustained serious injuries. A third train of empty carriages returning from Bath afterwards ran into the mail and did further injury.

BOILER EXPLOSIONS.

Boiler Explosion at a Brewery.—On the moruing of the 1st ult., at about a quarter to eight o'clock, an accident occurred at Messrs. Bass and Co.'s old brewery, in High-street, Burton-on-Trent. A large boiler burst, killing two men and injuring several others. For many yards the brickwork was scattered in all directions, and the boiler was moved from its bed some six or eight feet. Fortunately the large chimney stack connected with the boiler was not thrown down, or the consequences would have been very serious.

DOCKS, HARBOURS, BRIDGES.

A Prospectus of the Downs Docks Company has been issued, with a capital of £240,000, in shares of £10, to construct sea docks at Sandwich, for which an Act was obtained last Session. The facilities it will offer to the passenger and goods traffic to Brussels and the North of Europe, *viâ* Dunkirk, and its fitness as a Channel harbour for vessels in the Downs, are the advantages by which the project is recommended. The land to be taken consists chiefly of sand hills, little raised above high-water mark, on a substratum of chalk, and in the prospectus reliance is placed ou the smallness of the cost at which the undertaking can consequently be completed.

The Iron Bridge over the Po at Piacenza, was opened to the public on the 3rd ult. The length of the bridge is full 577 yards. The seven pillars which support the bridge are entirely of iron. There is a single roadway over the bridge, and side flagging for foot passengers. The construction of the pillars required 3,000,000 bricks, 1,400 cubic yards of granite, and 500 tons of iron. There were 2,400 tons of iron used in the construction of the bridge itself. This enormous mass of metal is of English origin, but was wrought in the ironworks of Lille. Half of the expense is said to have been defrayed by the Lombard Railway Company, and the remainder by the Italian Government.

New Iron Bridge.—There has recently been completed, in the yard of the Regent's Canal Ironworks Company, an iron bridge, which is constructed on a system invented by Mr. A. Sedley. The structure in question has been made to the order of the Indian Government, and is designed to be erected in India. The leading feature of the new principle is that, without the necessity of any subaqueous works, or the erection of any intermediate towers or piers, the bridge can be built to cross in a single span any river or chasm up to an extreme width of 500 yards, or 1,500ft. The bridge just finished is of

75ft. span and 14ft. wide; its total weight is 22 tons, including the roadway, and it will support a nominal strain of four tons per sectional inch, but really a greater weight. Two great cantilevers, or wedge-shaped girders, are built up piece by piece till they are projected from opposite sides of the chasm or river which is to be bridged over, and extended till they approach within a distance something less than a third of the whole span. Across this space a central girder is thrown, which, while it completes the continuity of the bridge, acts, when fixed in position and riveted down, as the key-stone, so to speak. The wedge-shaped girders which project from either side of the stream are at their wide ends embedded and built into massive piers of masonry on the shores. The base of the wedge is fixed by iron tugs, in an upright position; the central arm of the girder supports the actual roadway of the bridge; the lower arm, stretching to the point of the girder, becomes a bracket support; and the upper arm passing over the summit of the upright end, which makes the thick end of the wedge, is extended backwards as a tension-bar, and anchored firmly in the earth, thus giving suspensory support to the central arm, which attains a perfect rigidity.

THE LAYING OF THE FOUNDATION-STONE OF THE HARTLEPOOL RESERVOIR has taken place. The reservoirs are situated near the village of Hart, at an elevation of 170ft. above the level of the sea. They are capable of containing 25,000,000 gallons of water, and are supplied by a spring which is estimated to fill the reservoir in twelve hours. The supposed cost of the works is £12,000.

DOCKS IN NEW SOUTH WALES.—The Fitzroy Dock, belonging to the Government, situate at the penal establishment of Cockatoo Island, is capable of taking in vessels of the largest tonnage. The Waterview Dock is very largely used in docking the vessels engaged in the mail services and those belonging to several local companies and proprietors, and is capable of taking in the largest class of ships. Adjoining are shipwright and engineering works, large shears for masting purposes, and every requisite for the repair of vessels in the several branches to which they apply. The floating dock in Darling Harbour is chiefly used in docking sailing vessels and small steamers. There is a very large establishment formed for making large power boilers and heavy machinery, provided with steam hammers for heavy forgings, large lathes, and all requisite tools for the construction or restoration of engines of large dimensions. The slip dock is capable of taking up separately two vessels of about 1,000 tons each. At these works four iron vessels have lately been built, adapted to the peculiar requirements of short river navigation, one of which was a gun boat built for the New Zealand Government, fitted with shot-proof towers, which has done good service and taken a very prominent part in the history of the present New Zealand war. The vessels are of large dimensions, to ensure a light draught of water.

A BRIDGE OVER THE MERSEY.—The Mersey Dock Board have had before them the preliminary plan of the proposed bridge across the Mersey, to extend from Canning-street (about the central point of the docks on the Liverpool side) to Birkenhead. The idea is, that the bridge shall be supported on three columns, each column to be 150ft. above high-water mark, while another column will be placed on the river margin. The chairman of the board thought that it would be scarcely possible to construct such a bridge without interfering with the navigation of the river; but the scheme was referred to the Works Committee for consideration.

THE HIGH-LEVEL RAILWAY BRIDGE ACROSS THE SEVERN.—The report of the referees upon this undertaking has been issued. The engineers, Messrs. Fowler and Fulton, propose that the railway shall be increased to 120ft. above mean-tide level, instead of 115ft., and that the span of the main opening of the bridge shall be 600ft., which is as wide as the Thames at Southwark.

NEW BATTERSEA BRIDGE.—The Albert Bridge Company having obtained power to construct a bridge over the Thames to connect Chelsea with Battersea, the several points being Cheyne-walk on one side and Prince Albert-road on the other, are inviting applications for 9,000 shares of £10 each, representing a capital of £90,000 for that purpose. They have power also to borrow £30,000. The bridge is to be partly on the suspension principle, and a responsible contractor has undertaken to complete it ready for traffic in eighteen months for £82,000, taking part payment in paid-up shares. Arrangements have also been made for the purchase of Battersea Bridge for a rent-charge of £3,000 per annum, the tolls on which, in 1862, were £6,153. A clear income of 9 per cent. is anticipated.

MINES, METALLURGY, &c.

AN IMPROVEMENT IN IRON.—An improvement in iron (says a New York paper), increasing greatly its tensile strength, is claimed by Mr. J. D. Williams, of Pittsburg, U.S. Tested at Fort Pitt, a specimen of wrought iron made by him was subjected to a strain of 166,900lb. per square inch, without breaking, which is nearly twice the endurance of any iron ever tested, and is much greater than that of cast steel. The process of imparting this unexampled tenacity of strength to iron, adds only two dollars per ton to its cost. If after facts justify this test, it will add nearly 150 per cent. to the strength of steam boilers, the thickness of plate being the same. Chains of equal tractile strength can be made of less than half the iron now used. For suspension bridges it will be invaluable. The improvement is chemical in its nature, and is applied in the boiling furnace. The iron of which the piece which was tested was made, was principally anthracite pig, with a small quantity of charcoal iron.

THE SALT MINES OF CRACOW were discovered in 1251. The length of these mines from east to west is about 6,000ft.; the breadth from north to south above 2,000, and they are 800ft. in depth. When a tranger wishes to visit these mines he is habited in a suit of miners' clothes, and let down a perpendicular descent of 600lt. The place is very dark, and the miner, who descends has a guide, who strikes a light and conducts the stranger forward through several gloomy winding passages, at the end of which they descend by ladders 200ft. lower into a larger cavern; through this cavern they enter upon an open plain, peopled by the miners and their families, together with their horses, dogs, and other domestic animals. Nothing can exceed the brilliancy of this place: illuminated by thousands of lamps, reflecting their light upon the beautiful and transparent surface of the salt in every varied colour.

IMPROVEMENTS IN TIN DRESSING.—At Dolcoath Mine meeting, Capt. Charles Thomas stated that by introducing a buddle he had seen at work at North Robert, which was taken from a mine in Dartmoor, he had effected a saving already in the dressing cost of Dolcoath amounting to £160 per month, and a further saving of £40 more could be made when the erections were completed, making £200 a month, or £2,400 a year to the adventarers. In addition to this saving, he expected to save £2,000 a year from the tin that bad been allowed to flow down the river by the old process of dressing, making an entire saving of over £4,000 a year.

ACCIDENTS TO MINES, MACHINERY, &c.

COLLIERY ACCIDENT AT TREDEGAR, MONMOUTHSHIRE.—A colliery explosion occurred at the New Bedwellty pit, the property of the Tredegar Company, on the morning of the 16th ult., causing the death of twenty-six persons. The men went down as usual that morning, and everything appeared to go on right and well until about half-past ten o'clock, when a sudden rumbling noise was heard by the men on the top of the pit, and it was immediately discovered that the gas had fired. Fortunately the effects of the explosion did not reach the bottom of the shaft; and through this rather fortuitous circumstance, no time was lost in examining the colliery in order to see what were the results of the explosion. Mr. Bevan, the manager, the overman, and other officials, were immediately on the spot, several of them being in the pit at the time of the explosion. Gangs were immediately formed for the purpose of exploration, and it was at once discovered that the gas had fired in what was termed the "back workings." Forty-six men and boys were at work in this section of the colliery, and by dint of extraordinary exertion on the part of the exploring parties, under the guidance of Mr. Bevan, a good many were got out who would inevitably have fallen a prey to the fatal choke or after damp, had they not been taken out. The first body was brought up in about three-quarters of an hour, so it will be at once seen that no time was lost in examining the workings.

GAS SUPPLY.

THE HARWICH AND THE WOODBRIDGE GAS AND COKE COMPANIES have each declared a dividend of 8 per cent. per annum.

THE MARKET HARBOROUGH GAS COMPANY have agreed to reduce the price of their gas from 5*s.* 6*d.* to 5*s.*

THE MELROSE GAS COMPANY have announced a dividend of 7½ per cent. per annum, and a reduction of 1*s.* 3*d.* in price.

MR. JAQUES, from the London Equitable Gas Company, has been appointed engineer to the Borough Gasworks, at a salary of £300, in the room of Mr. Leslie, C.E., who is now with the Crystal Palace Gas Company.

GAS IN THE CITY.—The several petitions against the present quality and price of gas having been referred to a special committee, the committee, in reply, recommend that an effort should be made to obtain some alteration of the Gas Act of 1860; but, as this solution of the matter seems unsatisfactory, a motion has been put before the Court of Common Council to return the report to the committee, with instructions to obtain power for the Corporation either to contract for the supply of gas or to manufacture the gas, as is done by the Corporations of Manchester and other towns.

WATER SUPPLY.

WATER SUPPLY.—At Bolton there is already a scarcity of water. The *Bolton Chronicle* draws attention to the urgent necessity of economising the use of it as far as possible, alike for domestic and manufacturing purposes. At the council meeting it was stated that at present there are 58,000,000 gallons less in storage than at this time last year. The quantity of water in the lodges is 139,000,000 gallons, or only two months' supply; and, with dry weather such as the present, the supply must further diminish.—The engineers of the Sheffield Water Company are resuming work at the Agden embankment, which was partially completed before the Bradfield inundation. Immediately after the bursting of the Dale Dyke, the directors of the company stopped the works at Agden. The directors obtained the advice and services of Mr. Hawksley, engineer, instead of Mr. J. T. Leather. Mr. Hawksley immediately requested that Mr. J. Gunsen would continue to act as the resident engineer. It is expected that the Agden bank will be completed in about two years. The Strines dam will shortly be commenced. It is said that the embankment at Bradfield will be repaired so as to admit of the storage of a comparatively small quantity of water for the supply of the mills in the valley below; and that a large reservoir will be constructed at a point higher up the stream.

APPLIED CHEMISTRY.

DESULPHURATION OF GOLD ORES.—According to the process of Mr. E. N. Kent, late of the New York Assay Office, the ore is ground in the ordinary manner, then mixed with a solution of salt in water to a consistency of dough, then pressed in the form of bricks or slabs by any suitable moulds; then being hard enough to retain their form, they are piled up in a manner similar to bricks, in an ordinary brick kiln, and a fire built beneath them. The heat from this source, aided by the presence of the salt derived from the salt water, will decompose the sulphurets, making sulphate of soda and chloride of the base metals, and leaving the gold entirely free from its combination, so that there is nothing left to interfere with the ordinary process of mechanical separation. With this process no ovens with separate fires are necessary for the desulphurising of a large amount. The quantity of ore capable of being piled up in an open yard, in the form of bricks, is, of course, unlimited. That the desulphurisation must be perfect seems to be secured by the intimate mixture of the particles of salt (chloride of sodium) with the pulverised ores. Any other method than dissolving the salt in water would hardly effect this desirable result.

RESEARCHES ON BLACK PHOSPHORUS, BY M. LE DR. BLONDLOT.—The colour of crystallisable phosphorus presents three varieties—it may be white, yellow, or black. The last variety discovered by Thenard can only be reproduced accidentally, and indeed its existence has been doubted by most chemists. Endeavouring to find out the secret of this preparation, I found that agreeably to Thenard's opinion, the colour of phosphorus owes its degree to the way in which it is cooled after having been melted. Phosphorus is, as we know, purified by distillation. I perform this operation in a current of hydrogen by means of a small tubular retort, heated in a sand bath, and adapted to a flask half full of water, resting at the bottom of a large vessel filled with water at 70°. On dismounting the apparatus there is usually found a certain quantity of red phosphorus at the bottom of the retort. Now, from what I have observed, it is in the production, and in the successive elimination of the latter that the conversion of ordinary yellow into white and reputed pure phosphorus consists. I also found that to insure success in bleaching phosphorus by repeated distillations, it is necessary between each operation to submit it to insolation in glass tubes, so as to convert the yellow part which is volatile into red phosphorus, which is fixed. When bleached in this way phosphorus has a strong tendency to turn suddenly black. Rapid cooling may produce this effect, as Thenard has shown; he obtained this result by melting his phosphorous in fine tubes, which he then plunged into cold water. Melted again, the black phosphorous thus produced lost its colour, and did not regain it till it had been rapidly cooled. Hence it has been inferred that black phospherous is the result of a kind of tempering. This is an error, for I have obtained it more easily in quite a contrary way—that is to say, by very gradual cooling. In this way I habitually procure black phosphorous. For this purpose It distil phosphorous, previously insolated, until the product collected in the balloon very slowly cooled in the water-bath suddenly turns black. This curious change generally takes place in the following manner:—When the temperature has fallen to about 44°, the phosphorus solidifies in the usual way into a white mass; then, when after several hours the water is only at 5° or 6°, the phosphorus suddenly—in the space of a second—turns to a beautiful black. Black phosphorus, when once obtained, may be re-melted and re-distilled without fear. When liquid it is colourless, but returns to black by very slow cooling. It presents, moreover, all the characteristic properties of ordinary phosphorus, except that it is softer. It follows, from the above researches, that as yellow phosphorus is recognised as impure, and as the white is but a transitory state before arriving at the black, the latter, much more stable, should be considered not as an anomaly, but, on the contrary, as the true type. A support for this opinion is to be found in the fact that phosphorus which has been long exposed to diffused light, and has become covered with a layer of red, is found to be black inside, as though, in becoming spontaneously purified, it had undergone a molecular change somewhat analogous to crystallisation.

LIST OF APPLICATIONS FOR LETTERS PATENT.

We have adopted a new arrangement of the Provisional Protections applied for by Inventors at the Great Seal Patent Office. If any difficulty should arise with reference to the names, addresses, or titles given in the list, the requisite information will be furnished, free of expense, from the office, by addressing a letter, prepaid, to the Editor of "The Artizan."

Dated May 27th, 1865.

1444 C. Cotton and F. Anderson—Puffing and pressing machine
1445 W. Clark—Knitting machines
1446 W. E. Gedge—Stay or corset busk
1447 J. A. Heinrich—Rotary machines to be used as steam engines
1448 R. Canham—Furnaces
1449 G. Elliot and R. P. Clark—Loading and discharging cargo from ships
1450 C. B. Smeth—Extinguishing fires
1451 M. Cohen—Construction of furnaces or fireplaces

Dated May 27th, 1865.

1452 C. Frazer—Sawing machines
1453 S. Sequelin—Purifying animal or vegetable oils
1454 L. Brierley—Ornamenting japanned surfaces
1455 J. M. Rowan—Railway tyres
1456 R. A. Brooman—Manufacturing oil from fatty matters
1457 R. A. Brooman—Reproducing or producing copies of writings
1458 R. A. Brooman—Measuring gas and other fluids
1459 T. Bourne—Turning and finishing bodies of a spherical form
1460 L. Moser—Steel, and in furnaces used in the manufacture
1461 T. Bissell—Breech-loading fire-arms, and in sights for rifles
1462 L. Diele—Locking or fastening tiers or sets of drawers
1463 G. G. Bussey—Loading or turning over the shells of cartridges

Dated May 29th, 1865.

1464 J. A. Heinrich—Washing raw materials worked out or unworked to be employed in the manufacture of fabrics
1465 H. Tipper—Shirts
1466 W. Settle—Bottle stopper
1467 P. A. Le Comte de Fontainemoreau—Manufacture of lime
1468 H. Mosely—Machine to be driven by the pressure of a fluid
1469 P. Young—Furnaces
1470 H. Son—Keyless watches
1471 E. Myers and J. Stodart—Preventing downward draught in chimneys
1472 W. Johnson—Vices
1473 F. A. Paget—Locking screws and the nuts of bolts
1474 C. H. Murray—Cutting off wooden piles below water
1475 W. T. Hamilton—Circular saws, commonly called drunken saws

Dated May 30th, 1865.

1476 S. Davis—Dog leash or slip
1477 W. Smith—Self-delivering road-scraper
1478 W. H. Stanley—Wickets
1479 J. Hare—Cleaning the interior of tubes or hollow cylinders
1480 J. Hibell—Annealing pots and saucers
1481 J. Jopling—Steering vessels
1482 W. Martin—Brooms
1483 M. Meisel—Spinning machinery
1484 B. Lawrence—Inkstands
1485 S. Grafton—Keys of locks having through holes
1486 R. H. Collyer—Materials for the manufacture of paper
1487 J. Calvert—Locks
1488 L. Martin—Wheel moulding machine, and method of moulding wheels

Dated May 31st, 1865.

1489 T. Spencer—Paints applicable to iron and other ships' bottoms
1490 T. A. Browne and J. Knight—Hair brushing by machinery
1491 P. Pilkington—Steam hammers, partly applicable to steam engines
1492 R. Howorth—Apparatus for increasing the safety of railway passengers
1493 I. Rogers—Signalling on railway trains
1494 H. Monier—Gas burners
1495 F. Hazeldine—Carts employed for transporting furniture
1496 W. A. Brown—Mechanical arrangements for steering ships
1497 F. N. Gisbourne—Indicating the pressure of steam or liquids in gauges
1498 T. Summerson—Foundry cupolas
1499 W. E. Newton—Carpets
1500 J. Petrie—Washing wool and other fibrous substances

Dated June 1st, 1865.

1501 F. Richmond, H. Chandler, and J. G. Richmond—Cutting hay
1502 H. Martin—Signalling on railway trains
1503 W. J. Burgess—Reaping machines
1504 D. Hancock and F. Barnes—Obtaining motive power
1505 H. Allman—Hollow cylinders used in hydraulic apparatus
1506 H. Allman—Iron and steel
1507 W. Clark—Treating aeriform fluids for lighting and heating purposes
1508 T. Brunsmead—Exercising chair for infants
1509 F. Knight—Economic boiler for hot water apparatus
1510 T. E. Wright—Steam pressure gauge
1511 T. Hunt—Construction of the permanent way of railways
1512 H. Mallet—Manufacture of lace in twist lace machines
1513 W. E. Newton—Pocket lantern
1514 W. E. Newton—Raising the pile of woven or other fabrics

Dated June 2nd, 1865.

1515 H. Allman—Preventing the ignition of combustible matter
1516 J. Nuttall—Valves
1517 T. Pritchard—Furnaces used in the manufacture of welded iron tubes
1518 R. A. Brooman—Electro-magnetic clocks and other timekeepers
1519 W. Gadd and J. Moore—Manufacture of pile fabrics
1520 G. Kent and W. H. West—Apparatus used when boiling milk
1521 H. E. Newton—Steam boilers
1522 F. J. Bolton and H. Matheson—Producing printing surfaces
1523 J. Shepherd—Steam boilers

Dated June 3rd, 1865.

1524 T. Forster and J. Eckersley—Looms
1525 A. Lancaster—Breech-loading fire-arms
1526 W. Holden—Putting twist in all fibrous substances
1527 C. Taylor—Tube cutters and screw stocks
1528 E. Eastman—Measuring the human figure for garments

Dated June 5th, 1865.

1529 J. Stephenson—Umbrellas
1530 W. Townend—Twisting yarns whereby much waste is prevented
1531 C. de Bergue—Bending and straightening iron bars
1532 C. de Bergue—Iron erections
1533 C. de Bergue—Rivets
1534 T. Gentle and J. Allmark—Turbines
1535 P. Coombes—Whey extractor, to be employed in the manufacture of cheese
1536 A. J. Aspinall—Hand stamp for printing letters
1537 J. A. Woodbury—Paper or cloth lined paper collars
1538 J. Robertson—Actuating the slide valves of marine steam engines
1539 J. H. Johnson—Corks or bungs for stopping bottles
1540 R. A. Brooman—Soap
1541 W. E. Newton—Photo-electrotyping process
1542 F. Tolhausen—Break applicable to various descriptions of steam engines
1543 A. I. L. Gordon—Telegraphic communication on railways
1544 J. Kennedy—Submerging telegraphic cables
1545 C. H. Wansbrough—Condensing pans used in the condensation of milk

Dated June 6th, 1865.

1546 G. Haseltine—Breech-loading fire-arms and in cartridges for the same
1547 D. Barker—Artificial fuel
1548 H. H. Kromschroder and J. F. Kromschrorder—Dry gas meters
1549 R. A. Brooman—Reservoirs for storing petroleum and other oils
1550 R. A. Brooman—Combing wool
1551 A. Pemberton and A. W. Pemberton—Twisting fibrous materials
1552 G. Haseltine—Fuses and projectiles for rifled ordnance
1553 J. Howarth—Distilling coal shale and other carbonaceous substances

Dated June 7th, 1865.

1554 A. C. Henderson—Tanning hides, and in apparatus connected therewith
1555 V. Duterne—Metallic stuffing
1556 F. Foster—Oil feed ra
1557 W. Touge—Machinery for combing fibrous materials
1558 T. Smith—Tools having a hole for receiving a handle
1559 W. Sim and A. Barff—Generating heat, and in the apparatus for effecting the same
1560 J. Ferguson and R. Miller—Steel
1561 W. B. Newton—Governors

Dated June 8th, 1865.

1562 J. R. Cooper—Central fire breech-loading fire-arms
1563 S. B. Tucker—Heated air engines
1564 H. Hunt and R. Hunter—Frames for looking-glasses
1565 S. Stell, T. Broughton, and F. Hall—Preparing and spinning fibrous substances
1566 J. Draper—Sewing machines
1567 B. S. Cohen—Sheathing or coating the bottoms of ships
1568 G. Haseltine—Sifting flour and other substances

Dated June 9th, 1865.

1569 J. Holmes and F. R. Holmes—Horse hoes and drills
1570 H. B. Fox—Construction of the necks of hot tles
1571 W. W. Hulse—Tools for cutting metals or other materials
1572 G. Haseltine—Sewing machines
1573 W. E. Gedge—Penetrating or impregnating woods
1574 J. de Hemptinne—Spinning of cotton and other fibrous substances
1575 C. Vernon and W. Hodgkins—Safety valves for steam engines
1576 J. Baker—Obtaining power when fluid pressure is employed
1577 W. H. Harfield—Apparatus for steering ships and vessels
1578 G. E. Meek and W. H. Howes—Fastenings for doors

Dated June 10th, 1865.

1579 J. M. Deutith—Manufacture of chromate of potash
1580 J. Henderson—Printing wool, worsted, or other
1581 A. H. Gilmore—Supporting doors or windows in any required position
1582 R. A. Brooman—Furnaces
1583 D. Spink—Propelling vessels
1584 J. Glazebrook, M. N. Mills, and B. R. Mills—Sewing machines

Dated June 12th, 1865.

1585 E. T. Hughes—Violet of rosaniline which is soluble in water
1586 J. E. Poynter—Improvements in purifying paraffine
1587 G. Haseltine—Cutting and excavating rock for railway tunnels
1588 G. Bonelli—Applying photography to the effects of microscopical animated images
1589 G. Speight—Machine for curling or carving collars and cuffs
1590 R. A. Brooman—Furnaces
1591 J. Thomas—Purification of heating and lighting gases
1592 J. Hayes—Improved construction of sewing machines
1593 W. J. Hixon—Permanent way of railways and in locomotives

Dated June 13th, 1865.

1594 A. Robinson—Apparatus for firing and curing tea
1595 G. Haseltine—Improvements in fuses for shells for ordnance
1596 J. A. Millington and A. Allnutt—Machinery employed in and for the manufacture of paper
1597 C. A. Hemingway—Improved cased splint for fractures
1598 J. J. Bodmer—Partitions, walls, floors, and roofs of buildings
1599 W. J. Hopkins—Force dispeller or spring buffing apparatus
1600 C. J. Collins—A new or improved artificial fuel
1601 J. H. Johnson—Wheels for locomotives and other purposes
1602 T. Routledge and W. H. Richardson—Paper and paper stock
1603 S. Horridge—Communicating signals in railway trains
1604 J. Griffiths—Self-acting break for four-wheeled carriages
1605 F. A. Laurent and J. Casthelaz—Manufacture of phthalic acid

Dated June 14th, 1865.

1606 H. G. Fairburn—Compressing and solidifying coal
1607 B. Massey and S. Massey—Hammers and other machines actuated by steam
1608 C. de Vendeuvre—Spring stoppers to chain cables
1609 A. E. Brae—Conducting electric currents through railway trains
1610 W. Edson—Indicating the hygrometric condition of the atmosphere
1611 G. E. Keats and J. Keats—Improvements in sewing machines
1612 W. R. Mulley—Improvements in sheathing iron ships
1613 S. Courtauld and C. W. Atkinson—Opening and shutting carriage windows
1614 H. Ormson—Improvements in multitubular hot-water boilers

Dated June 15th, 1865.

1615 S. Helcman—Fastening shirt collars and other articles
1616 S. Helcman—Stud for fastening shirts and other articles
1617 J. F. Dubois—Bit for stopping runaway or restive horses
1618 V. Poitevin—Steam plough
1619 T. Ruthwell—Rubbing or rolling woollen or cotton cardings
1620 R. A. Brooman—Furnaces
1621 W. Clark—Preventing collisions and other accidents on railways
1622 M. P. W. Boulton—Improvements in generating steam
1623 G. E. Way—Improvements in the manufacture of pianofortes
1624 P. Lawrence and G. Jeffreys—Improvements in copying presses
1625 J. Hartley—Corn screens
1626 H. A. Bouneville—Facilitating the traction of vehicles

Dated June 29th, 1865.

1627 W. R. Gedge—Apparatus for manufacturing pottery
1628 M. Henry—Effecting and recording telegraphic communications
1629 R. A. Brooman—Shaping of iron intended for horse shoes
1630 R. A. Brooman—Watches and other timekeepers
1631 J. H. Johnson—Lamp burners and parts connected therewith
1632 C. A. Lamont—Desiccating eggs, and apparatus for effecting the same
1633 W. T. Wanklyn—Silk winding machines, part of the said improvements being also applicable to cleaning and doubling machines

Dated June 17th, 1865.

1634 W. Deltour—Preparation of vegetable fibre for the manufacture of paper
1635 H. E. Clifton—Lap and surface shaving the splitting and bevelling of leather and other like substances in sheets and strips
1636 A. Klein—Gunpowder for mining and war purposes
1637 W. Howes and W. Burley—Lamps for railway and other carriages
1638 G. Payne—Improvements in purifying cotton seed oil
1639 T. R. Crampton—Roadways, floorings, and other surfaces
1640 E. Byerley—Communication between passengers and guard
1641 G. Haseltine—Sewing machinery and stitch formed by the same
1642 V. Baker—Applying and utilising water power and in compressing air, and in the means to be employed therein

Dated June 19th, 1865.

1643 H. Defries—Enabling the guards of railway trains to pass from one part of a railway train to another
1644 E. Whalley—Twisting, doubling, and laying all kinds of yarns
1645 C. Hook and A. Peace—Propellers for ships and other vessels
1646 G. Smith—Locomotive engines and railway carriages
1647 J. H. Johnson—Treatment and preservation of the hair
1648 W. Clay—Ventilating railway carriages and in the apparatus employed

Dated June 20th, 1865.

1649 P. Mingaud—Obtaining jellies and other products from the Arbutus Unedo, known as the Arbutus
1650 G. Clark—Protecting bottles, jars, and other fragile articles
1651 A. Colley—Improvements applicable to breech-loading fire-arms
1652 W. E. Gedge—Improved elastic mattress or spring bed
1653 P. Carlevaris—Producing n light applicable to photographic and other purposes
1654 I. Baggs—Improvements in electric telegraph instruments
1655 E. G. Brewer—Improvements in the construction of taps or valves
1656 W. Clark—Apparatus and means for generating motive power
1657 J. Parrish, C. Thatcher, and T. Glasscock—Preventing the forcing or wedging open of iron safes
1658 J. Scholl—Invention of improvements in gas burners
1659 W. Henson—Communication between passengers and guard
1660 M. Audinwood—Improvements in reaping machines
1661 D. McGlasham—Sewing machines, and in the apparatus connected therewith
1662 E. Vignier—Distilling and rectifying, and in the apparatus employed
1663 E. Dupont—Improved system of wheels for railway carriages

Dated June 21st, 1865.

1664 J. Busfield and S. B. Walmsley—Combing wool and other fibrous materials
1665 W. Clark—Typographic and lithographic printing
1666 W. E. Gedge—Fire escape, applicable to other purposes
1667 M. Henry—Improvements in apparatus for measuring fluids
1668 C. H. Gardner—Polishing, smoothing, and facing stone
1669 C. P. Porter—Surface condensers for steam engines
1670 W. C. Rickman—Rigging of sailing boats and vessels
1671 W. Roberts—Improvements in machinery for cutting dovetails

Dated June 22nd, 1865.

1672 S. Godfrey—Improvements applicable to furnace bars
1673 N. de Becker—Improvements in umbrellas and parasols
1674 E. K. Dutton—Measuring and indicating the flow of liquids
1675 J. M. Abrams—Apparatus for the reception of coin
1676 M. Siegriat—Apparatus for signalling on railways
1677 W. E. Newton—Improvements in surface condensers
1678 G. Haseltine—Sewing machines
1679 J. Gale—Improvements in preparing and treating gunpowder

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THE EDUCATION OF ENGINEERS.

A perfect engineer, if such an one could be found, would be a man of gigantic intellect and vast researcb, a thorough master of all the sciences, and an unerring observer of all natural phenomena, and, withal, gifted with a wondrous power of classification, whereby to order to the best advantage the cornucopia of precedents stored in his memory. Being unable to bring our engineers to this Utopian condition, it devolves upon us to endeavonr to ascertain the best mode of approaching it, each generation adding to the general development of the professional body. In the beginning, kuowledge must be generated in the mind, and tutorial teaching only becomes necessary, or useful, when a great number of facts and generalisations thereupon have accumulated, hence the pioneers of any new science or art are of necessity self taught, and, accordingly, liable to many errors, notwithstanding which, they are usually idolised by succeeding generations, and very often, in character, entirely misunderstood. From snch causes, some of tbe most grotesque conceptions arise, one of which may be recognised in the conventional "practical man" of the last generation, which individual was rather identified by his grimy aspect than by his mental qualifications. Telford, who may reasonably be termed the father of modern civil engineering, has been said to have despised mathematicians in the profession; but an examination of his works and reports proves most incontestibly that he was himself a very sound practical mathematician.

There has, however, been good ground for objecting to the complication which some matbematical authors seem to delight in introducing into their practical (!) treatises ou the various branches of constructive science, preferring the elegant method of the infinitesimal calculus to the simpler one of plebeian arithmetic. To mention an instance, continuous girders were treated theoretically thus until 1861, though, in some instances, the authors were fearfully at fault, probably from omitting those constants which they were incapable of determining, or otherwise liking to be rather original, and, therefore, slightly altering theorems borrowed from the works of their contemporaries.

It is, however, useless to criticise the instructors of the past, except so far as it may tend to create a more healthy tone in those of the future, by warning them that a writer who wishes his reputation to be enduring, should have for his object rather by his simplicity to instruct his readers than to astonish them by his erudition; therefore, we will pass on to consider the state of the profession, and the prospects of its members in futnro times.

Any one who has the necessary funds to pay a premium can enter the engineering profession, and experience shows that many do it, or have themselves so placed by their friends, because they must do something and like to be *professional men* nominally without the trouble and anxiety of undergoing a period of probation, occupied with unceasing attention to study and the practical departments of an active business life. The result is that they often come through their pupilage scarcely more informed than they were at entering it, their futuro depending upon their own private means and influence, which, not being available to all, those who lack them must degenerate into the lowest class of mechanical draughtsmen. This arises from the fact that in most engineers' offices pupils learn just what they choose to pick up, there being no instruction, as it were, forced upon them, nor even a present reward offered to such as become most competent, and at the age at which youths usually enter the profession, there are but few who energetically pursue it from a clear couception of their own interests, and two or three years then lost cannot be afterwards redeemed; for the necessity of subsequently attending to commercial, as well as scientific matters, gives rise to a mental anxiety which unfits the brain for continuous or elementary study, although it does not prevent the application of knowledge already gained to fresh objects nor impede its development into new ramifications.

The result of this system is tbat those who ultimately attain scientific eminence, though not necessarily commercial prosperity, are a class who, as youths, are diligent and persevering from a deep and innate interest they take in the processes which are brought under their uotice, but the conclusions at which they arrive are usually to a very great degree influenced by particular prejudices, and in many cases they cannot obtain information, even where they are desirous of profitiug by the experience of others. This arises from one of two causes—either the priucipal is too much occupied to give any time to those whom he has undertaken to render proficient, or he is his himself but ill informed in his profession. In this latter case it is hardly possible to condemn too strongly the conduct of the pretended instructor; but it is unhappily a fact that there are many calling themselves Civil Engineers who exist by taking pupils, when tbe latter are frequently better informed than themselves; and this is an evil which will probably last as long as engineers are allowed to practise without diplomas of some kind.

In the offices of such men as we refer to, the discouragement is immense, even sufficient to deter any but the most obstinately persevering from taking any interest in the course of life marked out for tbem; for although they may at first be attentive and diligent, yet tbe force of that evil example which encompasses them is but too apt to sap the very foundations of those good inclinations which, encouraged or even let alone, could scarcely fail, in the course of time, to bring honour to him in whom they are developed.

When it is through press of business that the pupils cannot obtain such information from the principals as they might wish, there is usually the compensation that there are works on hand from which they may themselves derive much information of the most valuable description; but in the other case alluded to, they are shut out from this, and often confined to such work as the tracing of plates for illustration of books, in which beauty of execution is usually set before accuracy of detail; hence, although this occupation may serve to give a faint general idea of some engineering works to those engaged in it (at least, such as take the trouble to understand what they are about), yet, practically, they fall short in attempting to design similar works, because the very parts which they have been accustomed to overlook, are frequently of the greatest importance when they have to be actually executed.

Let us now enquire into the nature of such a method of training, as appears most likely to produce satisfactory results—the point of impressing the importance of diligence, affording facilities for obtaining information and encouraging talent, need no comment, as the necessity of urging them is sufficiently self-evident; but the mode in which theoretical and practical instruction is combined, requires very careful consideration, in order that the information gained in one department may be balanced with and adjusted to that acquired in the other. It does not appear satisfactory, ultimately, to impart a thorough elementary education to the intended engineer, *first*, that is before he has any opportunity of dealing practically with work, as certain notions thereby become fixed in the mind, which are prejudicial, and difficult, subsequently, to set at their true value. These refer to the application of abstract considerations to the actual execution of constructive works. The value of a correct understanding of the application of mathematical science in such cases, can scarcely be overrated; but if the limits within which its operation should be confined be not ascertained, the results may be serious in the extreme. If an engineer designs, say a sea wall, according to careful calculations, based on strict theory, and that sea wall fails to attain the end for which it was erected, it does not necessarily follow that the theory itself is erroneous or inapplicable, but merely that it has been acted upon by some individual who did not comprehend the limits of its application.

In using any calculation of the class to which we allude, a very wide margin has to be allowed for possibilities, as the data given to work upon are frequently very meagre, and the fancy cases given in academical courses of tuition are not to be met with in reality, nor can important matters be decided on the first data, it more frequently happening that alterations are necessary, or desirable to be made, during the progress of the work; and he will be esteemed the best engineer who most rapidly and clearly sees where such deviations from the original plan are needed, and to what extent they must be carried, so as to hold the middle course between danger and expense—the Scylla and Charybdis—by which all who take the responsibility of carrying out great undertakings in the engineering profession are constantly threatened.

If a practical course of work is passed through by the student, in the first instance, he is in danger of imbibing from those with whom he is necessarily brought into contact an ignorant contempt for theory of all kinds, though fortunately this feeling does not appear to exist to nearly the extent to which it had spread during the last generation, a result probably due to the increased facilities for education afforded to the working classes; nevertheless, the remaining elements are quite serious enough to be carefully guarded against.

The obvious conclusion is that the practical and theoretical instruction must proceed simultaneously, but not after the fashion of some establishments where engineering is professed to be taught at the present time.

Making a model steam engine will not acquaint the learner with the nature of materials, as be will in after life have to deal with them, and in all probability, unless his model is comparatively large, he will be forced to make it disproportionate in many details, especially steam passages and valves, and, in fact, as far the real utility of such occupation to him is concerned it is very little better than imaginary.

How, then, it will be asked, are we to proceed? We think by the following course:—Let the tyro be placed in such a position that he may have access to works, mechanical or civil, of magnitude and importance, use all endeavours to develope in his mind an interest in the general principles by which they are affected, and the difficulties which arise during their progress; then let him study theory for each case as it arises, merely to enable him to understand those principles and their application. Thus if he is diligent and intellectual, be will have most strongly impressed upon upon his mind the necessity of ascertaining and overcoming obstacles which can only be understood by inspection, and will value abstract science rightly as his guide in completing such projects as he may undertake. If on the other hand, he is not diligent and intellectual there is but one remark to make, let him not attempt to enter the profession.

In order to carry out the view promulgated above a really honest intention to do his duty must exist in the engineer to whom the pupil may be articled, combined with a thorough knowledge in himself or his assistants of his business, and it is certainly the duty of guardians to ascertain whether such be the case with one with whom they propose to place a youth; for so long as they are careless, and charlatans, broken down attorneys, and others of that numerous body of vultures that live upon the labour of the honest part of society, can style themselves Civil Engineers and obtain pupils—while the really competent members of the profession are too busy to attend to their pupils, we cannot hope for any amelioration of the grievance which now burdens it with so many incapables, who are useless to themselves and injurious to others.

THE ECONOMY OF PUMPING ENGINES PRACTICALLY AND COMMERCIALLY CONSIDERED.

One of the earliest applications of the dynamic power of steam was in raising water, as is shown in the writings of the oft-quoted Marquis of Worcester, whose method was subsequently improved by Captain Savery; but it was not until the invention of Newcomen's engine that anything like practical success was achieved—and even that, ingenious as it was, considering the age in which it was produced, presented an ungainly aspect, and yielded but little work for the fuel consumed. Different, indeed, is the present Cornish pumping engine, improved, as it has been, by the powerful intellects brought to bear upon the first crude form by Stephenson, Watt, Wicksteed, and others, both of the past and present time.

Our object, however, at present is not to occupy space with matter merely historical, but to establish some criteria as to the most suitable forms in which pumping engines may be applied in the different localities and under the diverse circumstances which present themselves to the hydraulic engineer.

If the question resolved itself merely into the relation of fuel consumed and duty done, it would at once be settled by reference to certain well established experiments, or, more correctly, results of working. Thus two double-acting engines at Vauxhall in 1843-4, which were constructed by Messrs. Fenton, Murray, and Wood, consumed 11·5 lbs. of coals per horse-power, whereas two Cornish engines at the East London Water Works, averaging seven years to 1850, yielded more economical results, consuming only 2·99 lbs. of coal per horse-power per hour. In these cases the circumstances were so similar that decision in favour of engines of the Cornish class was arrived at, and on that principle the machinery at the Vauxhall Water Works was subsequently designed. On the other hand it must be remembered that Cornish engines are costly, and large in proportion to their power, their movements being comparatively slow and action single; hence in cases where the power required is small and space an object, it may sometimes be found that the advantages of the Cornish engine are outweighed by its disadvantages.

Direct-acting or bull engines are usually stated not to be nearly so economical in their working as the Cornish engines, but the cause of this may not at first sight appear clear. It is, however, by some supposed that it is due to the equalising influence of the heavy beam upon the motion of the engine; if so, this can of course be obtained by attaching a vibrating wheel to the machine, but we are not inclined to attribute what inferiority may exist to this cause, but rather to a less perfect arrangement of the working gear.

The economy of the Cornish engine is, doubtless, due to two peculiarities; first, the high degree of expansion employed; and second, the mode of applying the dynamic force of the steam to propel the water. The advantages of applying steam expansively, so well known now to engineers generally, appear to have been early appreciated by the Cornishmen, whether accidentally or by scientific research, as far as we are concerned, it matters not; but these are available to a greater extent at the opening of a mine than afterwards, as an engine of greater power than at first requisite, will usually be erected, and, of course, the steam can then be cut off very early in the stroke; but as the works extend, and more water flows to the pump well, more steam is needed, and, consequently, so high a degree of expansion as was commenced with, is not maintained.

The experiments tried on the Cornish engine at the East London Water Works, showed the following effects:—When there was no expansion, the duty done being taken as 100; it was when the steam expanded through 0·397 of the stroke, 162·6, and when through 0·687 of the stroke, 224. While speaking of trials, it is desirable to refer to a source of error existing in some of the reports of duty in Cornwall—that is, the inefficiency of pump valves. In the case of the Holmbush engine, the water actually raised was 14·7 per cent. less than the calculated quantity adopted in reporting, and this loss appears to represent the quantity of water which ran back through the valves of the pump while they were closing; thus the duty represented by the steam power was 231, 486, 192 foot pounds per 112lbs. of coals, and the useful effect with Welsh coals, only 122, 376, 128 foot pounds. This duty is high, but it must be mentioned, that when the trial was made, the engine had not long been erected, and was doing but light work—the diameter of the cylinder being 50in., and stroke 9ft. 1in., while the horse power was but 26·5 horses; thus the area of piston being 1963·5 square inches, the allowance per horse power would be 74 square inches, and the steam expanded through 0·83 of the entire stroke, or nearly five times its initial bulk, its pressure varying from 24·98lbs. per square inch, down to 4lbs. per square inch.

In comparison with the duty above mentioned of the Holmbush engine, we may take some of those reported in Cornwall for September, 1864. The following list comprises those out of thirty-four which exceeded the average duty of 49,800,000ft. lbs. per 112lbs. of coal:—

Boscawen, 70in.	52·2 millions.
Chiverton, Cookney's 60in.	57·0 „
Cargoll Mines, Michell's 72in.	58·6 „
Carn Brea, 76in.	50·0 „
Cook's Kitchen, 50in.	53·9 „
Crane, 70in.	64·5 „
Great Wheel Busy, Harvy's 85in.	63·2 „
Great Work, Leed's 60in.	60·3 „
North Wheal Crofty, Trevensons 80in.	52·0 „
South Wheal Frances, Marriot's 75in.	55·9 „
West Caradon, Elliot's 50in.	70.8 „
West Wheal Seton, Harvy's 85in.	56·1 „
Wheal Ludcott, Willcock's 50in.	53.0 „
Wheal Margery, Wesley's 45in.	55·6 „
Wheal Seton, Tilly's 70in.	59·6 „
Wheal Tremayne, Michell's 60in.	53·7 „

To this list we will append the duties attained at various times by some other pumping engines:—

East London W. W., 80in. Cornish	97·1 millions.
„ „ 60in. Boulton	47·7 „
„ „ 80in. C., highest duty	103·0 „
„ „ 90in. Wicksteed	81·8 „
„ „ 90in. with Welsh coal	109·0 „

It should here be noted that the highest duties of the Cornish and Wicksteed engines are calculated for Welsh coal, from its relative evaporative value to that used at the East London Waterworks:—

West's engine, 11 years' average	83·5 millions.
Taylor's engine, 8 years' average	93·1 „

In tendering for the erection of certain pumping engines at the Grand Junction Waterworks, in 1844, the contractor was bound to guarantee each engine (having a 40in. cylinder) during the first twelve months to do a duty of 73·8 millions.

This shows the extent of economy attained at the East London Water Works, at that date to be very considerable, as it is highly improbable that any contractor would render himself liable to conditions involving a doubtful issue.

It is usually supposed that small engines are not so economical as large, but there are now some near London doing a duty of about 80,000,000 of foot pounds per 112lbs. of coal.

We will now proceed to consider the second advantage of the Cornish engine, namely, the mode of applying the dynamic force derived from the steam in the cylinder.

The steam acts in raising a weight and drawing water from the well into the pump barrel, this latter item being small in proportion to the former; then the pressure being equalised on both sides of the piston, the weight which had been lifted falls, forcing the water through the outlet valve from the pump barrel, and drawing up the steam piston ready for, another stroke. From Mr. Wicksteed's experiments* on the 80in. Cornish engine we quote the following particulars, to show the distribution of the steam power, averaging during the stroke those quantities which vary:—Preponderating weight, 55,401lbs. or 11·037lbs. per square inch of piston; water raised by engine, 4,125lbs., or 0·821lbs. per square inch; cold water pump, 186lbs., or 0·037lbs. per square inch; hot water pump 6lbs.; air pump 591lbs., or 0·117lbs. per square inch; friction 1,009lbs. or 0,200lbs. per square inch; imperfect vacuum 3,664lbs. or 0·730lbs. per square inch; total 64,982lbs., or 12·94lbs. per square inch steam pressure on the piston.

Now, the effect of the steam in raising the preponderating weight is evidently produced most conveniently, for if, at the commencement of the stroke termed the indoor or steam stroke, the engine runs a little fast no shock occurs, but the extra momentum is quietly absorbed by a slight increase of speed, upward, of the weight being raised. Then when the outdoor stroke begins, the preponderating weight, by its own gravity, quietly forces the water out of the pump to wherever it may be required, coming gradually to rest at the termination of the stroke. The superiority of this mode is at once evident when we consider what may be called the riotous movement of the water in a pump worked by an engine with a fly wheel, the direction of the water's motion being in this case reversed without allowing the current time to come to rest, and producing, as it were, a series of blows, destructive alike to the machinery and its economy and to any observer the effect of hydraulic shocks may be made evident by placing the hand upon a main, leading from a pumping engine, as thereon the beat of the pump valves may be felt even a mile from the engine. This transmission of blows is, of course, to be traced to the comparative inelastic quality of water. Then, again, the gradually failing pressure of expanding steam is not favourable, if it be directly applied to the propulsion of water, which being liquid cannot so well carry the varying effect without loss of power.

With regard to rotary pumps, all we shall observe is this:—A *perfect* rotary pump, worked by an uniform moment of pressure, would probably be an improvement on the Cornish pumping engine, if its motive power could be produced as cheaply, otherwise, except for purposes of trifling importance, we do not feel disposed to place much reliance upon them. One of the most important details of the pumping machinery, rests in the valves, upon the construction of which the smooth working of the engine mainly depends. When the old clack valves were used, the vibration due to their closing was something enormous, in some cases shaking the buildings to such an extent, that the engine could only be worked a few hours at a time; but when Harvey and West's double beat valves were introduced, this difficulty, and that arising from loss of water, while the valves were closing, were at once obviated; subsequently, valves closed by numerous balls, or small india rubber flaps, were introduced, and also valves consisting of cylinders perforated on their peripheries, and surrounded by india rubber straps, were applied; as also a variety of other contrivances, most of them ingenious, and some useful. The double beat valves may occasionally be fouled, as once happened at the Ajax engine at the East London Water Works, when an eel came up the wind bore of the pump, but such cases are exceedingly rare. Recently, surface condensers have been applied to Cornish engines, both at the Scarborough and Kent Water Works, and certainly this description of steam machinery appears to afford them great facilities for working satisfactorily, as all the water passing to the main pump may, if it be desired, be allowed to flow through the condenser, thus ensuring a good vacuum.

In entering upon the next branch of our subject, the question of finance, great caution is needed, as the means of obtaining correct information are very scarce, and, when found, give data rather perplexing to generalise, especially for comparison with those relating to double-acting engines. The figures, which will be quoted, are taken from actual practice, not mere estimates. In the first place, it will be necessary to come to some conclusion as to criteria of horse-power of Cornish engines, as usually worked. For this purpose various particulars have been gathered, which tend to show that, taking a wide range of practice, there is, on the average, an allowance of about thirty square inches of piston surface per horse-power, and this does not appear unreasonable, as it corresponds to fifteen square inches per horse-power, in a double acting engine—the mean velocity of the piston on both strokes, and including stoppages at the end of each stroke, may be taken for an engine working regularly, as being about one hundred feet per minute, but in different engines the speed varies very considerably. Taking the allowance of thirty square inches per horse-

* See Wicksteed's "Experimental Enquiry."

power as granted, the mean cost of bright Cornish engines will be found to amount to about fifty four pounds per horse-power, exclusive of boilers. This appears very heavy, but it applies to engines of average dimensions, and includes the pump work and duplicates of the valves; and of this amount the main pump work costs about twenty-five per cent., or about £14 10*s.* per horse-power, leaving, for the price of the engine proper, about £39 10*s.*, or nearly four times as much as an ordinary horizontal engine would cost.

It would be scarcely worth the while here to enter upon the question of current expenses, as these are exceedingly various. Thus it would require no more labour to work a one hundred horse engine than a fifty horse. Hence in the former case, as compared with the last, the cost of labour would appear unusually small. Two examples will suffice—Cost of labour per horse-power per annum was, for two double engines at the Hull Water Works in 1845, £5·991, and for two Cornish engines at the East London Water Works, averaging seven years to 1850, £1·852 only. Cost of stores are more uniform, varying from £2·341 down to £0·784, showing an average of £1·483 per horse-power per annum.

Some idea may, however, be formed as to the cost of raising water, from the following statistics, which give the cost per 1,000 barrels of 36 gallons each raised 100ft., including the entire works, engines, buildings, &c., capital being taken at the interest of five per cent. per annum:—

Total cost, average, of nine years .... 18·114*d*,
Total cost, average, of five years .... 21·336*d*.

The two engines worked day and night during the first period, during the second one worked in the day only. After these engines were improved by the introduction of Harvey and West's valves, and by coating the boilers and steam pipes more effectually.

Total cost, average, of nine years .... 20·452*d*.
Total cost, average, of five years .... 16·437*d*.

The second period being, of course, that during which the improvements were in use, the saving thus obtained was nearly twenty per cent. per annum.

HISTORICAL AND DESCRIPTIVE SKETCH OF THE MERSEY DOCKS AND HARBOUR.

By J. J. Birckel.

(*Illustrated by Plate* 283.)

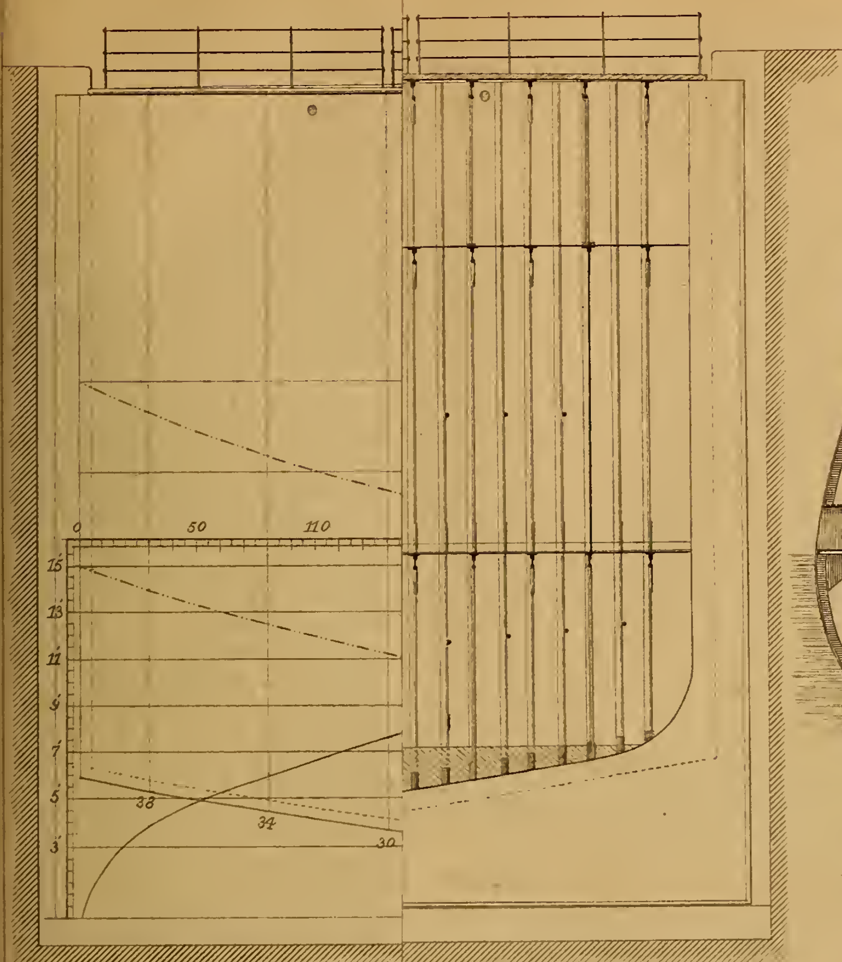
In order to complete the subject of the structural details of the docks proper, we now proceed to describe the general features of the gates with which their entrances throughout are provided, and have, in Plate 285 (which will be given in our next), illustrated one-half of a pair of the 100ft. gates.

Numerous schemes of dock gates have been proposed from time to time, both with a view to obtaining structural durability, and with that, also, of effecting economy of labour in the operation of opening and closing them: thus, since iron has been introduced so largely into all our structures as a substitute for wood, iron dock gates have been made, chiefly, we presume, with a view to durability; and at the Newcastle meeting of the British Association in 1863, Mr. R. A. Peacock, of Jersey, read a paper on the subject of "Dock Gates," in which he proposes to construct them in such manner that they may carry themselves, and thus dispense with rollers and tramways, which, he contends, are only impediments to their free and easy motion; because they are liable to become clogged with mud and silt. This is to be effected by balancing the gate with a weight which is to move in a chamber especially prepared in the masonry, the weight being suspended from a stiff girder fixed to a prolongation of the upper gudgeon of the gate; the pivot proper which carries the whole weight of the structure is to be 6 *feet above water,* so that it may be properly oiled and looked after, a very ingenious proposition, indeed, which, if it can be carried out, we should think well worth patenting.

Mr. Peacock, who prefers wood to iron, chiefly because it is cheaper, calculates that the two wings of the gates of a 70ft. entrance, with a depth of water of 27ft., would weigh 45 tons, and might be opened by four men each, without gearing, in 41 seconds, by exerting a pull of 146lbs., and in this calculation he proceeds upon the assumption, that there is no other resistance to be overcome, but that due to the friction of the pivot, although some allowance, by estimation, is made for loss of time incurred in overcoming resistances due to deposits of mud or silt. It is obvious, however, that these resistances cannot be overcome without increasing the direct pull which the men are exerting, and as the amount of this increase is not known, the question at once presents itself, whether at all they will be able to overcome it, since it is impossible for any man to exert a much greater horizontal pull than that due to his own weight when he is walking. Assuming, however, that the men have to exert the pull of 146lbs. only, a closer inquiry will show that they are quite unable to open the gates in 41 seconds, for to do this they would have to travel at the rate of about 69ft. per minute, and accomplish a mechanical work of 146lbs. × 69ft. = 10,074 foot-pounds per minute, or very nearly *one-third* the power of a mechanical horse, whereas under ordinary circumstances, a man is capable of exerting *one-eighth* only of a horse-power; so that finally it is found that if the men did perform this work they would be putting forth a power *four times* as great as that which it is known they are able to exert under ordinary circumstances, which we think very unlikely. It is, satisfactory, therefore, to find further on that Mr. Peacock proposes, as a matter of prudence, to go to the expense of a pair of winches; but we have thus scrutinised this calculation in order to show how inventors may be led into errors by overfondness of their own ideas. In doing so we have, moreover, shown that even the balanced gate, with its pivot 6ft. above water, will not ensure any very great saving of time in the operation of opening or closing, for as soon as the winch is introduced, so soon is there an end to the quick performance of that operation. In first cost, we presume, it is not contended that such a gate could offer any advantage over the one hung in the old fashioned way and supported by rollers upon tramways, for in order to dispense with these a heavy balance weight has to be introduced, and the extra expense of the chamber in which that weight is to travel, which has to be specially prepared in the masonry, must not be overlooked.

Passing now to the consideration of the nature of the material used in the construction of gates, we think, with Mr. Peacock, that there can be no considerable difference in the respective durability of the two substances, wood and iron, under conditions such as those we have at present in view; for while the one decays, the other corrodes, and, indeed, the experience which we have of the behaviour of iron in sea water, as in the case of iron ships, for instance, and in those parts of the machinery of the marine engines which are constantly exposed to the action of sea-water, leaves no room for doubt that the latter decays much more rapidly than the former, unless very great care is taken of it. In the choice of materials for dock gates, however, the position or situation of the harbour itself must not be lost sight of. In any port not subject to be visited by heavy storms, as, for instance, that of London, the gates have really no strain to resist, but that of the static pressure of the water behind them; and as the intensity of that pressure is known the gates may be readily constructed of just sufficient strength for that purpose—that is to say, they may be made as light as possible; but in the case of a port lying close upon the sea, like that of Liverpool, whose waters therefore are, subject to those violent disturbances which invariably accompany heavy storms, the dock gates have to resist the shocks of waves whose intensity it is absolutely impossible to estimate beforehand. Here, therefore, they must be made as massive as may consistently be done without increasing to an unpractical extent, the labour of opening or closing them, and under such circumstances it is desirable to employ a material that offers the greatest possible amount of strength combined with the least possible weight or specific gravity. Now it is a well known fact that those kinds of wood which are generally used for building purposes, *when similarly*

SEY DOCKS.



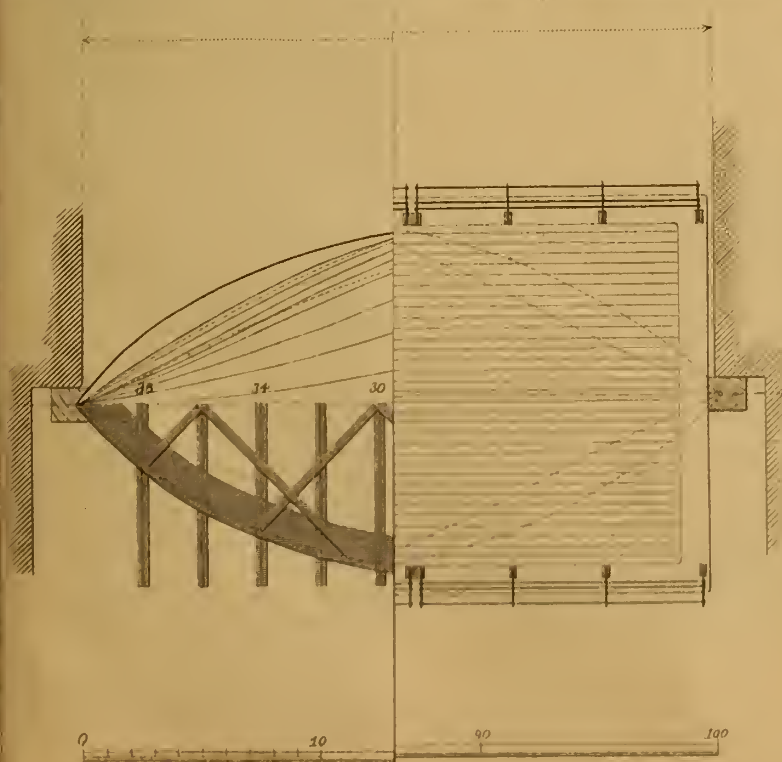


FIG. 3.

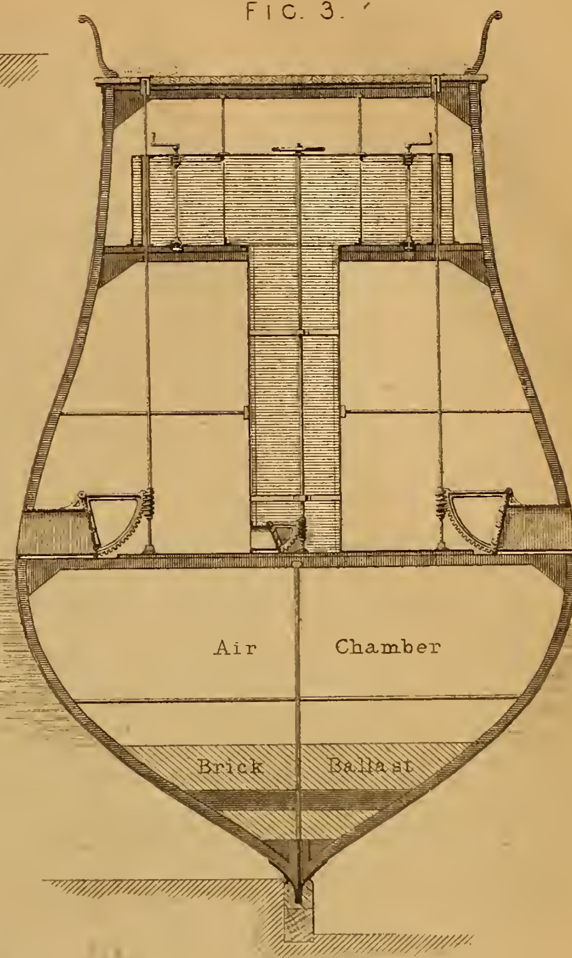


FIG. 4.

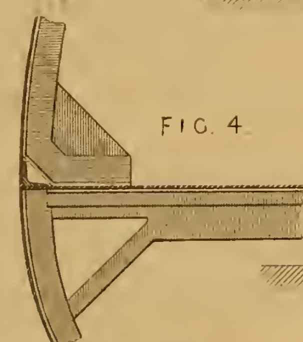


FIG. 5.

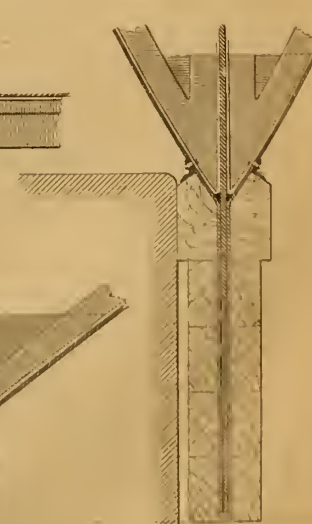


FIG. 6.

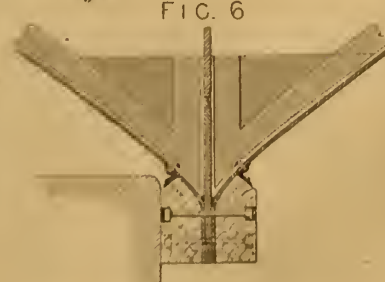


FIG 7

W. Smith C.E. direx.

IRON CAISSON FOR CLOSING 100 FT. ENTRANCES MERSEY DOCKS.

FIG. 1.

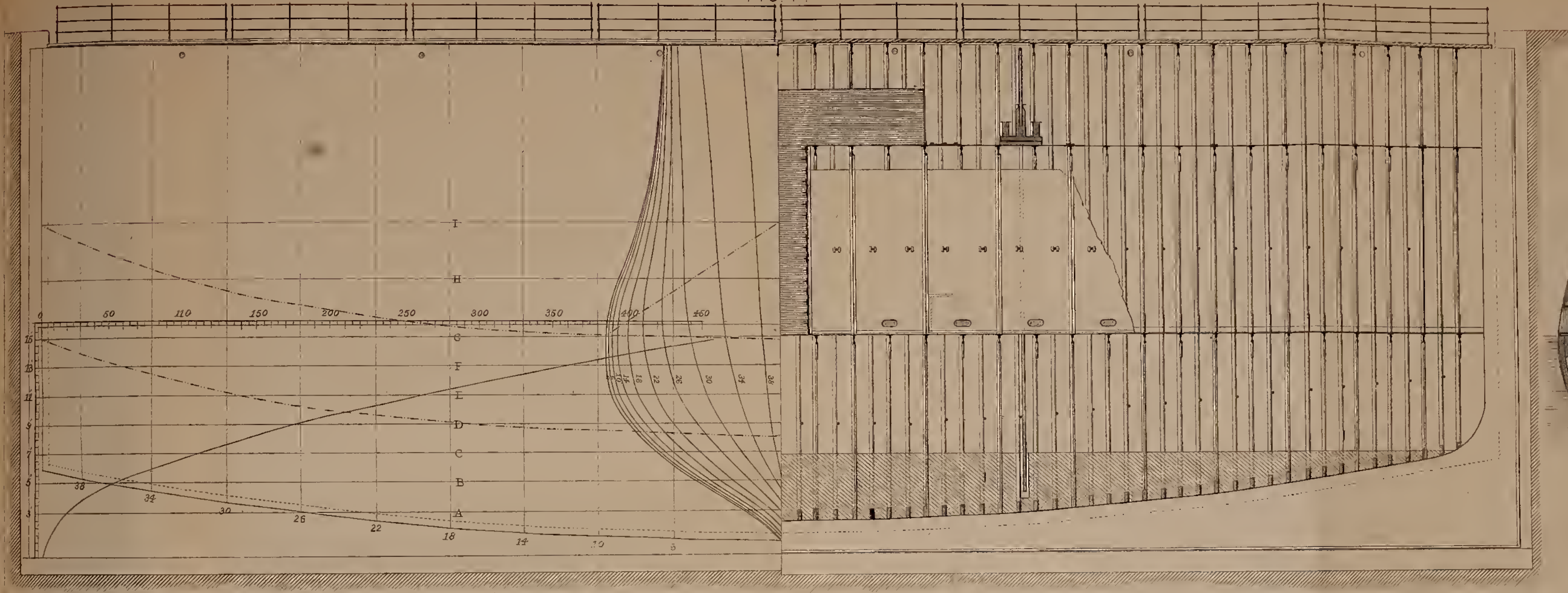
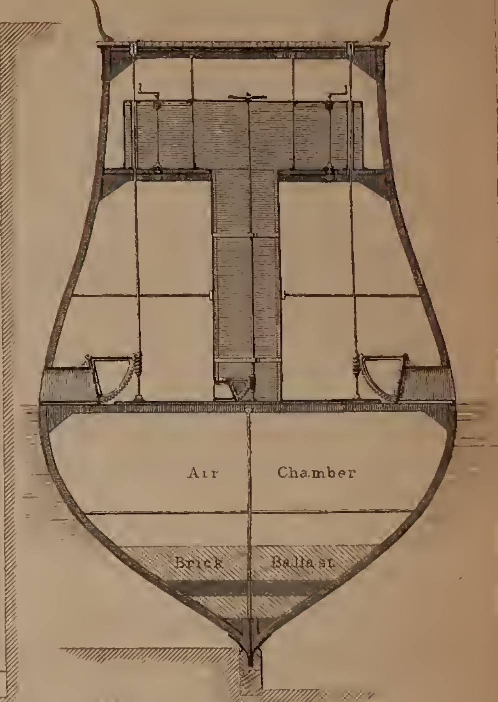
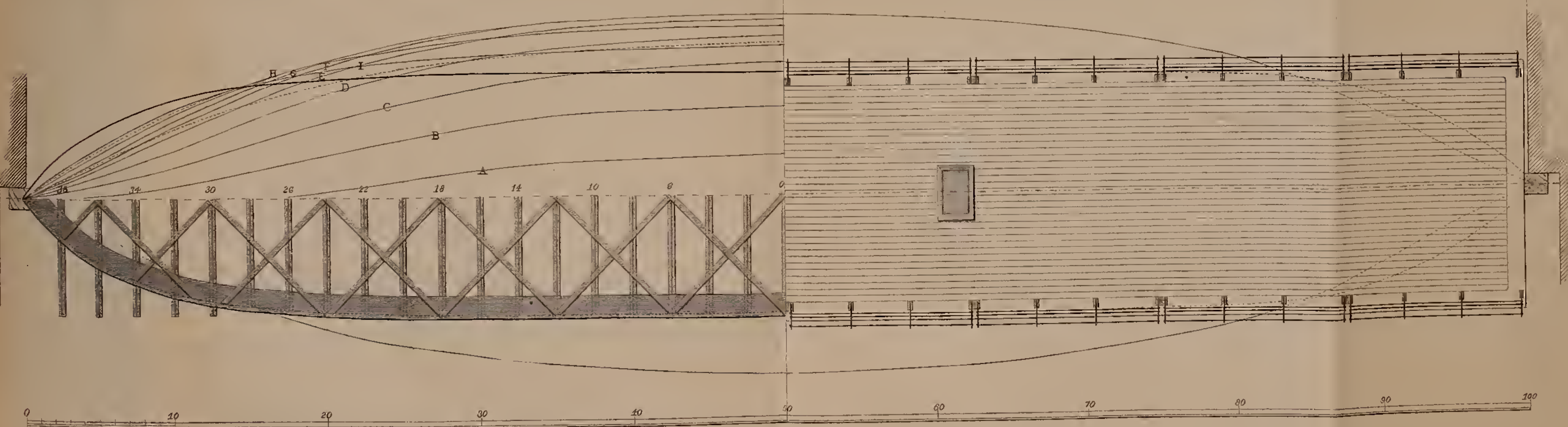


FIG. 3.



100 FEET

FIG. 2.



SCALE OF FEET.

FIG. 4

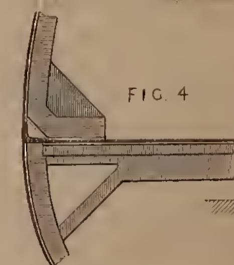


FIG. 5

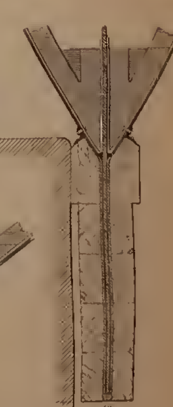


FIG. 6.

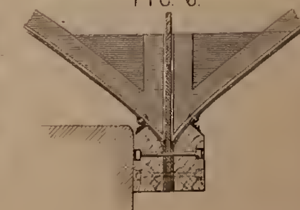


FIG. 7

W. Smith C.E. direx

circumstanced and of similar sections, offer at least from $2\frac{1}{2}$ to 4 times the amount of resistance to rupture by flexion, as iron, for equal weights (and on that account also do we believe that wood will for ever remain the king of all elastic building materials). If, therefore, a kind of wood can be found which offers the same conditions of durability as iron in sea water, while it offers the advantage of being three times as strong under equal weight, subject, of course, to the conditions above stated, nothing could justify the use of the latter in preference to the former, since there can be little doubt but that the wooden gate would be cheaper than the iron one. Upon these works the kind of wood invariably used for this purpose is Greenheart, which it is found is not destroyed readily by any of the various forms of decomposition which usually render wood useless, as an agent of resistance, and which is not readily attacked by those treacherous enemies, the teredo and other insects which devour the body of the material without attacking the surface to any visible extent, and thus leave nothing but a rotten staff in the stead of that which was, and still has, the appearance of a tower of strength.

Thus, we think, we have conclusively shown that it is not without good reasons that the dock engineers here have adhered to the practice of supplying their dock entrances with wooden gates.

Their construction is so simple, that, with the detailed illustration which we have given, it is scarcely necessary to enter into a description of them here. The frames proper are built up of panels, the ribs of which are made of timbers of from 12in. to 15in. in section, bolted together, and bound by means of iron bands extending over the entire length of each wing of the gates, and by means of strong beams, the number of which depends upon the height of the gate. The spaces between the main ribs are filled up with soft wood planking, which, as it may be easily renewed, does not require to be made of the more costly material. The gates are fitted with one or two sluices in each wing, through which part of the water behind them may be released, and a direct scour of the platform in front be effected at low tide. The sluice valves are made of cast iron, and are worked by hand with lever and screw. The pivots upon which the gates swing, and which, probably, carry the greater portion of the weight, are far from being 6ft. above water; but in order to reduce, as much as possible, its liability to become fast by being clogged with silt, it is made in the shape of a ball socket. At the level of the coping the gate posts are fixed to cast iron hollow quoins of great weight by means of strong wrought iron straps, and these castings themselves are tied to the masonry of the coping by means of long wrought iron straps let and leaded into the stone; the gates are, moreover, supported at one or two points by rollers resting upon segmental tramways, upon which they travel when they are being opened or closed. The brackets which carry the rollers are so fixed that the position of these may be adjusted to a certain extent to suit the level of the tramway by means of a cotter. All the wrought iron work connected with these gates is galvanised.

Many of the entrances, and, in particular, those which assume the form of a lock, are provided with two pairs of gates, namely, one pair to keep out the sea, and another pair to keep the water within the docks when the tide has receded.

In our illustration, which represents a wing of one of the 100ft. gates, fig. 1 is a front elevation, showing all the mountings; fig. 2, a side or end elevation, the gate brought close up to the sill; fig. 3, a partial elevation, showing the roller and its bracket endways; fig. 4, a plan at the level of the coping, showing the width of the footway, with which all the gates are provided; and fig. 5, a section through the sluices, showing also the rollers and part of the tramways.

In some of the more recent dock constructions additional provision has been made for closing the entrances independently of the gates by means of a caisson, which affords this great advantage—that the locks and docks may be run dry, and the gates repaired without necessitating the construction of a temporary dam—an advantage of no mean importance when it is remembered how easily gates may be damaged in stormy weather, either by ships that are driven from their moorings, or by the direct action of the sea itself. The caisson being a permanent structure, is readily to hand whenever it may be needed, since it may be floated to any place where it is required, and the adaptation of any dock entrance for its reception entails little additional expense—at any rate in the new ones—since it is necessary only to provide a recess in the walls, and a straight or square sill to the platform of the entrance.

A caisson for closing dock entrances 100ft. in width, as designed and constructed by Messrs. Vernon and Sons, of Liverpool, to whose courtesy we are indebted for drawings of this structure, is illustrated upon the accompanying Plate, No. 283; from the nature of its design it might almost be termed "self-acting," since all the necessity for pumping is avoided in the operation of floating it when it has been submerged, as will appear from the following description of its general construction and of the manner of working it.

The caisson is divided into three compartments by two water-tight iron decks. On the floor of the upper compartment are tanks, capable of containing about 38 tons of water, which communicate by a large square trunk with the compartment below, called the tidal ballast chamber, but which communication may be shut off by means of a sluice valve, which is worked by a worm from the upper deck; the tidal ballast chamber itself is opened or closed to the tidal waters by sluice valves, fixed on either side to the skin of the caisson. The lower compartment has been termed the air chamber, and its bottom is filled with brick ballast to such extent as to float the caisson at a line 3in. below the floor of the tidal ballast chamber when both the latter and the water tanks are empty. When the caisson is required to be placed in position it is moored over its sill, the sluices of the tidal ballast chamber being open and that of the water tanks closed; water is then run into these tanks until sufficient weight has been added to submerge the floor of the tidal ballast chamber, and then with the addition of such slight quantities of water as are required to overcome the displacement of the material of that portion of the caisson which still remains to be submerged, it will continue to sink until the sill is reached, or else the sinking motion may be arrested at any point by simply closing the tidal sluices.

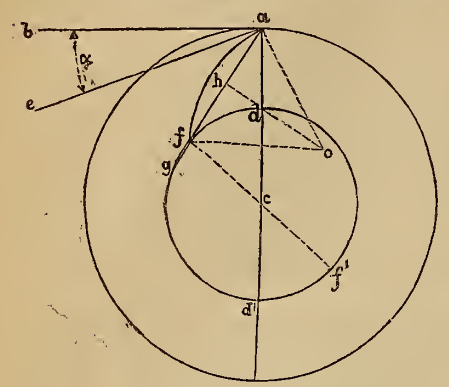
When the caisson is to be raised again, all the sluices are opened, and the water is allowed to run out as the tide recedes, when, as soon as the tanks are entirely empty, it will have risen to its original line of floatation 3 inches below the floor of the tidal ballast chamber. Viewed in its details, its construction is generally similar to that of the hull of an iron vessel. The skin, which is made of plates of from $\frac{1}{2}$in. to $\frac{5}{8}$in. thick, is riveted to a series of stiff angle iron frames which are placed at very close distances, to enable the caisson to resist the great pressure of water, behind when the tide has receded in front. In order to prevent them opening out when the structure rests with nearly its entire weight upon its keel, the frames are bound together athwart ships by two rows of tie rods, and in the bilges (if that term may be used here) by a row of tension plates; the keel, moreover, is stiffened by a row of vertical stays which bind it firmly with the lower deck at every alternated deck beam, and thus it will be seen that the portion of the hold which has been termed the air chamber, really constitutes a well braced hollow girder, in which the resisting powers of all the parts are taken advantage of to enable it to carry the entire load without straining any portion of the structure.

Upon the upper deck is placed a small pump for discharging from the hold.

The caisson which, as has already been stated, is made for closing dock entrances of 100ft. in width, is 103ft. long, 21ft. wide, and $35\frac{1}{2}$ft. deep. It has a roadway at the top of 16ft. in width, which is provided with a handrailing made in panels of short lengths, which may each be separately turned down upon the floor of the roadway. In our illustration, Fig. 1 is a half longitudinal section and a half shear plan, including also a scale of displacement. Fig. 2 is a deck and deck beam plan and a half breadth plan. Fig. 3 a midship section showing the several sluices and valves. Fig. 4 an enlarged section at the floor of the tidal ballast chamber. Figs.

5 and 6 enlarged sections of the keel at lines 0 and 34 respectively of the shear plan, and Fig. 7 an enlarged horizontal section of the keel.

Note.—We now give a corrected diagram of the way to construct the blades of rotary pumps, which was produced in an incomplete state in our paper on that subject, owing to inadvertence on the part of our wood engraver. We should state, also, that those pumps were constructed by Messrs. Hick and Sons, of Bolton, to whose courtesy our readers are indebted for the interesting plate which we were able to give in our last issue.



(*To be continued.*)

ON MACHINERY ADAPTED TO COAL MINING.

(*Illustrated by Plate* 284.)

The following paper by Mr. George Lauder, C.E., was recently read before the Liverpool Polytechnic Society :—In this paper it is proposed to treat of some of the methods that have been suggested and put into operation for mining coal by machinery; the object being to explain, as clearly as possible, the main features of the machines, rather than go into any lengthened description of detail, and further, to describe more particularly an American invention for this purpose, and which is illustrated in the accompanying Plate.

In working beds of coal, two distinct plans have been adopted by mining engineers, according to the nature of the roof and thickness of seam, viz., "long wall," and "post and stall," or "stoop and room" methods. In the first plan, a clear opening is made along the whole face of the coal to be got, the coal being removed entirely as the work proceeds, the roof is supported by props of timber, a sufficient distance from the working face to allow the miner room to work; as the coal is extracted, these props are withdrawn and advanced, allowing the floor and roof to come together, which it does, in many cases, as if the bed of coal had never existed. In the latter method, a system of galleries are driven from the foot of the shaft, at right angles, or nearly so, to each other; as the work proceeds, these galleries increase in number, so that in a pit that has been sometime in operation, the plan of the workings presents a similar appearance to a draught-board. When the limit of distance from the foot of the shaft is reached, the stoops, or posts of coal that have been left in working forward, are removed as far as practicable—the mining now proceeding from the remote part towards the shaft; this operation is attended usually with very great danger, from the great difficulty experienced in supporting the roof effectively.

The long wall method is that best adapted for the application of mining machines.

In both methods the coal is extracted by "holing" or "undercutting;" this consists in cutting a continuous channel in the lowest part of the coal, or in the stratum immediately below it; when this is done, the coal, in some cases, falls by its own weight, in others, it has to be wedged down froom the roof, while in others, blasting with gunpowder, has to be resorted to. The holing is at present performed by hand labour, and is what we hope in future to see done by a machine, which, while doing the work cheaper, will relieve the men from the hard and physically debilitating labour. To accomplish the holing, the miner has to lay himself on his side, his shoulders only sufficiently raised from the floor to admit of his working the pick; in this position he continues, frequently in a very bad atmosphere, during the whole day's work; a good man holes at the rate of a yard an hour, three feet deep.

The earliest attempts of engineers to apply machinery to mining is of comparatively late date. The first I will notice is a plan patented by Mr. Waring, in 1852. He placed a number of cutters round a wheel, projecting beyond the rim; this wheel, worked by steam, air, or water, was forced into the face of the coal, and, further, had a transverse motion, so that, when set in motion, a continuous channel was cut. A number of plans similar to this have been proposed since, but none of them, as far as I am aware, have been practically successful. Designs for cutting with saws, cutters on endless chains, &c., have all in their turn been tried, but none of these have been so successful as to merit my taking up your time describing them more particularly.

The first class of machine that has met with anything like practical success, is that in which the holing is accomplished by picking. Ridley and Rothery obtained a patent for a pick machine, in 1861; this is the first, as far as I am aware. Since then, many improvements have been made; these I will mention as we proceed.

The essential features in all pick machines are these:—A pick is mounted on a vertical shaft, free to move in a horizontal plane; the shaft is supported by bearings in a strong frame, or carriage, mounted on wheels, so that it may be run along the face of coal. The carriage carries a cylinder, with piston, piston rod and stuffing box, and a suitable arrangement of valves, to admit the motive power—compressed air. The piston rod is connected to the vertical shaft carrying the pick, a vibratory motion is by this means effected. The pick being placed in proper position, the holing is thus performed:—A hand wheel is provided, geared with the wheels of the carriage, by which the attendant moves it forward as the holing proceeds. The attendant is seated on the back part of the carriage, the hand wheel and valve gear being placed in position conveniently reached by him.

Frith and Dormisthrope's machine, one of the class described, is said to be at work successfully at West Ardsley Colliery, holing 100 yards length of face, 3 ft. deep, per day of eight working hours; when tried at Redding Colliery, Scotland, the results were not so satisfactory, the rate being only five yards per hour.

Jones' machine has a toothed wheel, fitted on the rocking shaft gearing, with an endless screw, by which means he is enabled to turn the pick in any required direction.

Nisbet's machine differs from the others in having the piston rod attached to a separate shaft, and similar to the crank shaft of an ordinary steam engine; an adjustable connecting rod communicates motion from this to the shaft carrying the pick. The relative position of the pick and piston can thus be easily altered, and the pick made to deliver its stroke when the piston is at its maximum velocity. A self-acting traversing motion is added, likewise a self-acting motion to work the valves for the return stroke.

In all these machines, the motive power employed is compressed air, the compression being effected at the surface, or at the foot of the shaft, and the air led by pipes to the machine at the working face. A considerable loss is entailed by this method; all the heat generated in the compression is lost during the transmission, which is just so much loss of mechanical energy, and amounts to a considerable per centage of the whole power employed. A good deal has been said of the advantages of having a stream of cool fresh air issuing at the working face; but the opinion of most of the practical colliery managers I have heard on the subject is against having their ventilating arrangements interfered with. A supply of air, necessarily intermittent, cannot be taken into consideration in ventilating arrangements, and may interfere prejudicially with the regular currents.

The next machine I have to notice is Carrat's; it differs in its principle of action from the pick machines, and also in the motive power employed. The holing is performed by a set of three cutters, mounted on a strong iron rod, worked to and fro by a hydraulic engine, mounted on a

FIG. 3.

FIG. 1.

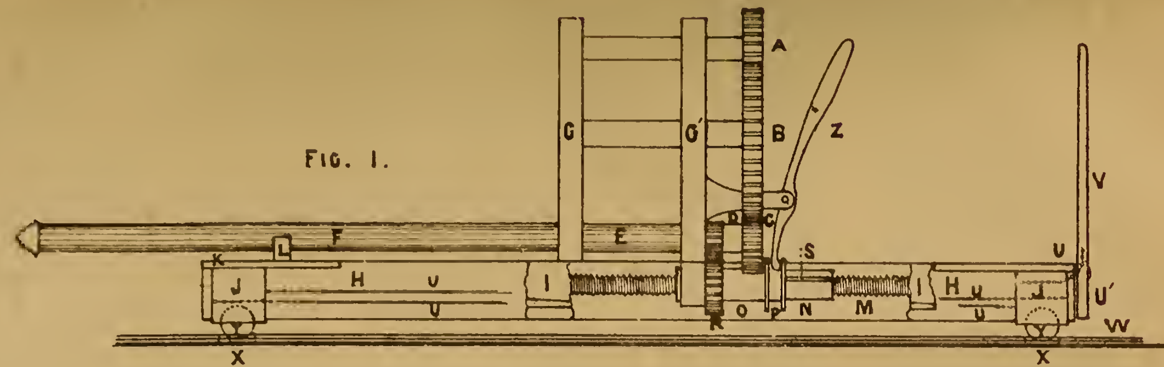
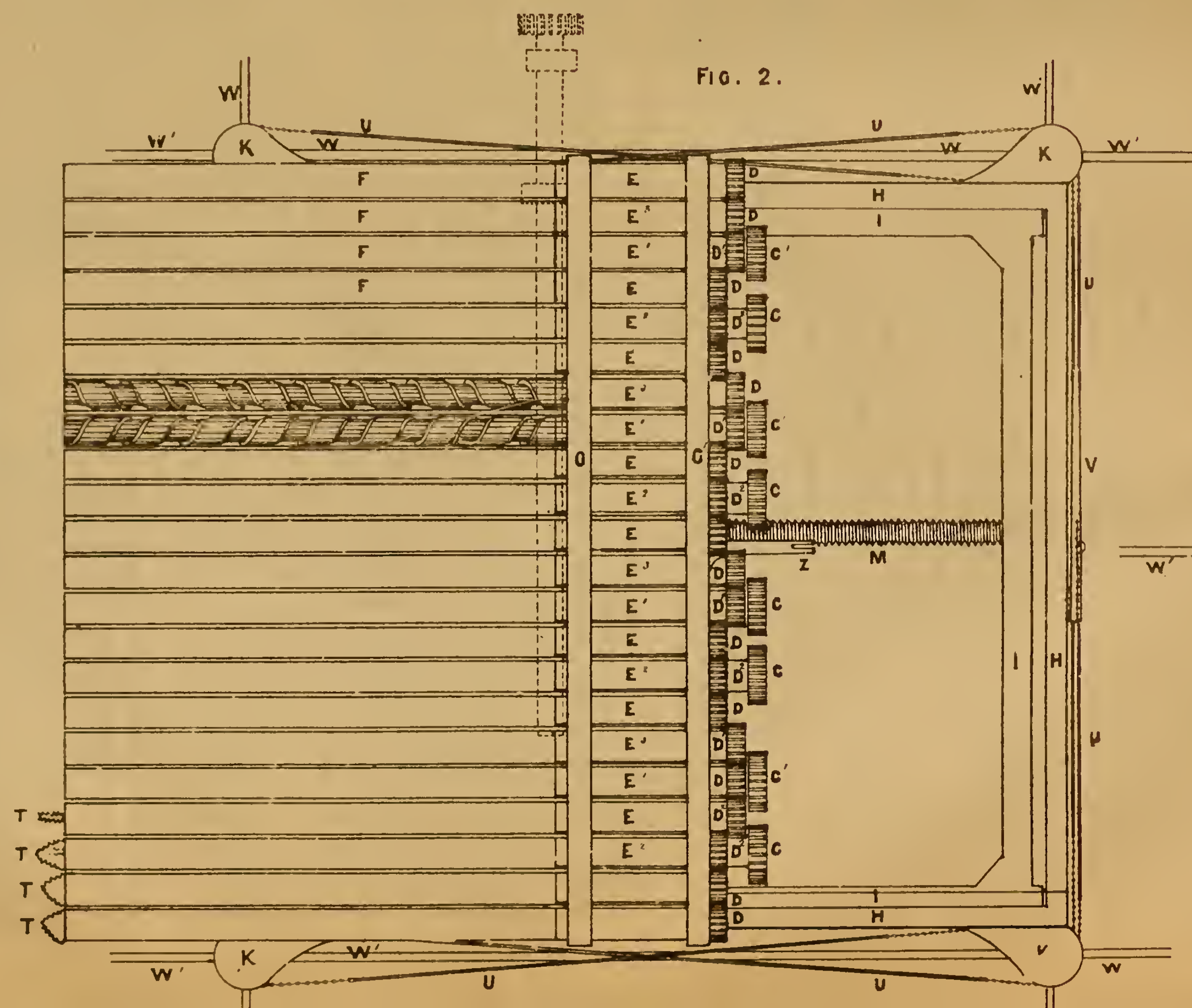


FIG. 2.



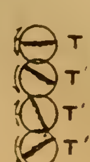
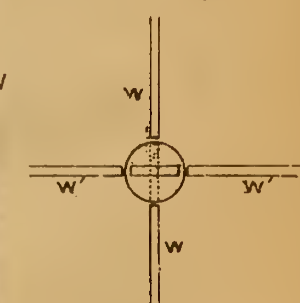


FIG 4



COAL MINING MACHINERY.

carriage; the cutter bar is rigidly attached to the piston rod. The cutters are arranged on the bar at distances of 16in. apart, the first one, at the point of the bar, is placed the distance of a cut behind the second one, and the third is placed the same distance in advance of it. The machine, therefore, does its work by cutting a series of steps in the coal. The stroke is 16in., a clear cut of 4ft. is therefore made at every stroke, the second cutter taking up the cut where the third left off in the preceding stroke. To prevent the machine being pushed off the rails while cutting, a very ingenious device is adopted to fasten it for the time being. A second upright hydraulic cylinder is placed on the carriage, fitted with a plunger, working through a stuffing box; by a suitable arrangement of valves water is admitted to this cylinder, before the working cylinder, the plunger is thus forced against the roof, and the whole machine held between the roof and rails, before and while the cutting of the coal takes place.

The next machine I have to notice, is that which is illustrated in the accompanying Plate. The principle on which it is proposed to mine by this machine, is by boring with a series of drills placed in a line, and so constructed that each drill works partly into the field of the adjoining drills, so as to cut out a continuous channel; the drills are kept to their work by means of a screw attached to the supporting frame, pressing them forward, as they cut their way into the face of the coal.

Fig. 1 is an elevation, and Fig. 2 a plan of the machine reduced from the inventor's drawings.

E E represents a number of short shafts, having a recess in the one end to receive the drills, in which they are fixed by cotters; on the other end a toothed wheel or wheels are fixed as shown. The drills are made augur shaped; they may be either screw form or shell, as in the drawings, for the purpose of clearing the debris from the holes as the boring proceeds. The point of the drill is spread out, as shown in Fig. 3, so as to cut the required depth into the field of the adjoining drills. The points are made separate from the augur-shaped spindle, so as to be easily renewed when worn out, or taken out for sharpening, without disabling the machine. The size of the drill is $2\frac{3}{4}$in. diameter.

The shafts E E are supported in a frame G G, which in turn is supported by the rectangular frame H H, on which it is free to slide backwards and forwards; it is also provided that it can be lowered or raised, to suit inequalities of the floor of the mine in which it may be at work. A screw M is fixed in the frame H H, and has a nut N working on it; the nut, being attached to the frame G G, on being turned, carries the frame and drills backwards or forwards, according to the direction of rotation of the nut. O is a thimble, free to slide on the nut N, but prevented from turning on it by the feather S, which slides in a groove in the thimble, and is secured to the nut. The tooth wheel R is rigidly attached to the thimble O, and gears with the wheel D on one of the drill shafts E, from which motion is communicated. A groove P, in the thimble O, receives the forked end of the lever Z, which serves to draw back the thimble, throwing the wheels R and P out of gear, and bringing the wheels R and C in gear; D and C revolve in opposite directions, so that according as R is in gear with the one or the other, the drills are advanced or drawn back. The wheels D, C, and R, are so adjusted that the forward is much slower than the backward motion. L is a rest fixed on H H to support the points of the drills.

The frame H H is carried on four wheels, marked Y Y; the axles run in journals in the pieces J J, which are free to turn on a vertical axis; the arrangement is similar to an ordinary castor. Chains are passed round the pieces J J, and fixed to them, the ends being attached to the lever V, which is free to move in such a way, that on being moved, the pieces J J are turned, and with them the wheels Y Y, one of which is shown in plan fig. 4, W W and W′ W′, showing the rails, upon either of which it may be caused to run at will. The attendant has it in his power, therefore, to run the machine in any direction without the necessity of turning it.

The mode of working will be readily seen from the description above given. The machine being run forward to the face of coal to be mined, motion being given to A, the drills are set rotating, the frame is moved forward by the nut N working on the screw M; when the required depth is reached, the lever Z is moved, the wheel R brought into gear with C, and the drills withdrawn; the machine is then moved along the face a distance equal to the length of the channel cut, and the operation repeated.

The principle of boring out a continuous channel seems to be quite new in mining, and it seems to me to present very promising results. That it is practicable to bore coal so has been proved by practices in America: there the users of the machine bore 3ft. deep, in the course of a few minutes, in the anthracite, which is much harder than our coal. The facility with which power can be applied is another recommendation; a turbine placed on the shaft A appears to be the cheapest and most economical method. To dispense with valves in an engine to be worked at the working face of a coal pit, amongst the dust arising from the working, must be an important consideration. Further, the motion is continuous from the time of starting till the one operation is complete, no working of valves on the part of the attendant being required, nor is his attention taken up pushing forward the machine while in motion. In roomy workings the greater part of the driving gear might be dispensed with, and a band substituted so as to simplify as much as possible the parts liable to derangement.

One important point in all the machines described is their economy in working. The miner, in holing by hand, is obliged to make a considerable opening in the fore part of the cut so as to get room to work back to the required depth—in holing 3ft. deep, the width of hole must be 10in. to 12in. at the front, tapering towards the back. The most of the coal thus hewn out is necessarily much broken up, the most of it only being fit to be sold as slack at a considerable reduction of price and consequent loss. The machines in working only require to make a cut of from 2in. to 3in. wide; in working thin seams this saving amounts to a considerable per centage of the coal got from the mine. As to the comparative cost of machine and hand labour, Mr. Carrat, in a paper read before the Institution of Engineers in Scotland, states that in a mine at Rippax the holing by hand costs 8*d.* per ton, by machine 4·8*d.*, showing a saving of 3·2*d.* per ton; the saving from the reduced quantity of slack amounts to 10·8*d.* per ton—total saving, $13\frac{3}{4}$*d.* The saving effected in national resources by this simple invention, whenever it comes into general use, will be immense. The total output of coal in Great Britain was somewhere like one hundred million tons last year. A shilling on a ton on this amount gives us £5,000,000 saving; this is large, but nothing more than may be reasonably expected.

ON THE LAW OF DENSITY OF SATURATED STEAM EXPRESSED BY A NEW FORMULA.

THOMAS ROWE EDMONDS, B.A., CANTAB.

(From the "Philosophical Magazine," July.)

The expansive force of a unit weight of saturated steam, according to temperature, is usually measured by the product of the pressure P in pounds to the square foot, multiplied by the volume V in cubic feet occupied by one pound weight of such steam. The product P V represents the work done or resistance overcome in foot-pounds, and is equal to the effect produced by a constant force P pounds driving a piston, whose area is one square foot, through the linear space represented by the number which expresses V in cubic feet. When the laws of pressure and volume are both known, the law of expansive force represented by the product P V will be known also. But such a compound will not be entitled to the appellation of a third law, if the two formulæ for P and V, when united, do not yield for result a third formula equal in simplicity to either of the two constituent formulæ.

The pressure P of saturated steam appropriate to every temperature, from − 30° to + 230° Centigrade, has been satisfactorily and accurately determined through the observations of M. Regnault, published in the year 1847. The law of pressure deduced from these observations, has been investigated in the "Philosophical Magazine" for March, 1865, and the formula indicating the law has been found to be

$$\text{hyp. log. } P = \frac{a\alpha}{n}\left\{1 - \left(1 + \frac{t}{a}\right)^{-n}\right\}.$$

This formula was directly obtained from the Table of pressures adopted by M. Regnault, through observing that the differential co-efficient of log P, at any temperature t, was always represented by

$$\frac{d \,.\, \log. P}{d\, t} = \alpha \left(1 + \frac{t}{a}\right)^{-\frac{1}{k}}$$

the exponent $\frac{1}{k}$ $(= n + 1)$ being equal to the number 2·302585, which is the hyperbolic logarithm of 10.

The first and only satisfactory observations made for determining by experiment the density of saturated steam at various temperatures, are those of Messrs. William Fairbairn and Thomas Tate. They are published in the "Philosophical Transactions" of the year 1860. The difficulties are great in the way of making correct observations on the density of saturated steam in free communication with water. Such steam has not yet been obtained in a pure state, there being always an admixture of water with such steam. Part of the water is suspended in the form of cloud or mist, and part is pressed as a film of fluid against the sides of the containing vessel. Messrs. Fairbairn and Tate appear to have overcome the chief impediments to correct observation by the use of their "saturation-gauge." On examining the results obtained, it will be found that the law of progression according to temperature for the density as given by these observations, is not much less regular than the law of progression for pressure as given by the observations of M. Regnault. It will be found that the function of the variable t involved in the law of density is identical with the function of the variable t involved in the law of pressure. The differential co-efficient of log P has already been found to be

$$+ \,\alpha \left(1 + \frac{t}{a}\right)^{-2\cdot302585}.$$

It will now be found that the differential co-efficient of log V is

$$- \,\alpha_1 \left(1 + \frac{t}{a}\right)^{-2\cdot302585}.$$

The constant α for pressure at temperature 100° C. was found to be + ·03580. The new constant α_1 for volume at the same temperature, will be found to be − ·03265.

In the investigation of the law of pressure above referred to, it has been shown ("Philosophical Magazine," Vol. xxix., p. 179) that for any given interval of temperature, the logarithm of the pressure P of saturated steam is a simple function of the logarithm of the expansive force p of a unit weight of a perfectly elastic vapour maintained at a constant volume. The quantity p being

$$= 1 + \frac{t}{a} = e^{t_1},$$

it was there shown that

$$\frac{d \,.\, \log. P}{d \,.\, \log. p} = \alpha\, a\, p^{-n} = \alpha\, a\, e^{-n\, t_1} = \alpha\, a\, e^{-\log. p}.$$

By integration was obtained for value of hyp. log. P,

$$\log. P = \frac{\alpha\, a}{a}\left\{1 - e^{-n \log. p}\right\}$$

If we put

$$\phi \log. p = \frac{a}{n}\left\{1 - e^{-n \log. p}\right\},$$

we get

$$\log. P = \alpha\, \phi \log. p, \text{ and } P = e^{\,\alpha\, \phi \log. p}.$$

The formula for the pressure of saturated steam being $P = e^{\alpha\, \phi \log. p}$. the formula for volume is $V = e^{-\alpha_1 \phi \log. p}$; and the formula for the expansive force of a unit weight of such steam is

$$P V = e^{(\alpha - \alpha_{,})\, \phi \log. p} = e^{\alpha_{,,}\, \phi \log. p}.$$

The value of α in the formula for pressure has been shown to be ·03580, which represents the rate of increase per degree (Centigrade) of the pressure at the absolute temperature 376°, or at 100° on the Centigrade scale. In order to represent the law of volume, we have to put (for the same temperature) $\alpha_{,} = -$ ·03365; and to represent the law of expansive force we have to put $\alpha_{,,} = +$ ·00215. We thus obtain the following expressions for pressure, volume, and expansive force, reckoned from 100° Centigrade:—

$$P = e^{\alpha\, \phi \log. p}, \text{ and } \log. P = + \cdot03580\, \phi \log. p.$$

$$V = e^{-\alpha_{,}\, \phi \log. p}, \text{ and } \log. V = - \cdot03365\, \phi \log. p.$$

$$P V = e^{\alpha_{,,}\, \phi \log. p}, \text{ and } \log. P V = + \cdot00215\, \phi \log. p.$$

By the aid of the three foregoing equations any one of the three quantities P, V, or P V may be expressed in terms of either of the other two quantities. In order to express V in terms of P, we obtain, by dividing log. V by log. P,

$$\frac{\log. V}{\log. T} = -\frac{\alpha_1 \phi \log. p}{\alpha\, \phi \log. p} = -\frac{\alpha_1}{\alpha} = -\frac{\cdot03365}{\cdot03580}$$

$$= -\frac{1}{1\cdot06389} = - \cdot939944;$$

consequently

$$V = -^{\cdot939944},$$

and

$$P V = P +^{\cdot060056}.$$

Similarly may be obtained

$$P = V -^{1\cdot06389},$$

and

$$P V = V -^{\cdot06389}.$$

According to the notation herein used, the quantities P, V, and P V represent ratios of pressure, volume, and expansive force at absolute temperature $(a + t)$ to similar quantities at absolute temperature (a) degrees. That is to say P, V, and P V are used to represent quantities usually represented by $\frac{P}{P_0}$, $\frac{V}{V_0}$, and $\frac{P\,V}{P_0\,V_0}$, the quantities P_0, V_0, and $P_0\,V_0$ being constants determined of, or assumed to be determined, by observation for the absolute temperature (a) degrees. The theoretical numbers contained in the four annexed Tables have been obtained by adopting the absolute temperature 376° (corresponding to 100° C.) as the fixed point from which the variable (t) is measured. At this point $P_0 = 2116\cdot4$ lbs. to the square foot, as determined by observation. At the same temperature, $V_0 = 26\cdot36$ cubic feet occupied by 1 lb. weight of water when converted into steam. And at the same temperature, $P_0\,V_0 = 2116\cdot4 \times 26\cdot36 = 55788$ ft. lbs. expansive force exerted by 1 lb. weight of saturated steam. These three constants, P_0, V_0, and $(P\,V)_0$, may, however, be more conveniently denoted by the letters H, $H_{,}$, and $H_{,,}$.

In Table I. are exhibited the results of twenty out of the twenty-three

TABLE I.—*Volumes of a unit weight of saturated Steam at different Temperatures, as deduced from the experiments of Messrs. Fairbairn and Tate, compared with the volumes given by the new formula and by Dr. Rankine's theory respectively.*

Temperature.		Pressure of saturated steam according to Regnault.	Specific volume relative to water according to Fairbairn and Tate.	Volume of one pound weight according to			
Fahrenheit.	Centigrade.			Fairbairn and Tate.	Differences.	New formula.	Rankine.
°	°	atmospheres		cub. ft.	cub. ft.	cub. ft.	cub. ft.
136·8	58·2	·180	8275·3	132·56	− ·49	123·07	132·20
155·3	68·5	·288	5333·5	85·44	− ·39	85·05	85·10
159·4	70·8	·317	4920·2	78·82	− 1·19	77·53	77·64
170·9	77·2	·415	3722·3	59·63	+ ·56	60·19	60·16
171·5	77·5	·421	3715·1	59·51	− ·08	59·43	59·43
174·9	79·4	·455	3438·1	55·08	+ ·12	55·20	55·20
182·3	83·5	·537	3051·0	48·87	− 1·57	47·30	47·28
188·3	86·8	·611	2623·4	42·02	− ·17	41·85	41·81
198·8	92·7	·764	2149·5	34·43	− ·50	33·93	33·94
242·9	117·2	1·793	943·1	15·11	+ ·12	15·23	15·25*
244·8	118·2	1·855	908·0	14·55	+ ·20	14·75	14·77
245·2	118·5	1·869	892·5	14·30	+ ·34	14·64	14·67
255·5	124·2	2·238	759·4	12·17	+ ·19	12·36	12·39
263·1	128·4	2·548	649·2	10·40	+ ·54	10·94	10·96
267·2	130·7	2·728	635·3	10·18	+ ·08	10·26	10·29
269·2	131·8	2·819	605·7	9·70	+ ·25	9·95	9·98
274·8	134·9	3·017	584·4	9·36	− ·22	9·14	9·16
282·6	139·2	3·590	497·2	7·96	+ ·16	8·12	8·14
237·2	141·8	3·767	458·3	7·34	+ ·24	7·58	7·60
292·5	144·7	4·086	433·1	6·94	+ ·08	7·02	7·04

* Instead of 15·61, stated in error by Dr. Rankine.

experiments on the density of saturated steam made by Messrs. Fairbairn and Tate. Three of the experiments made at high pressure and nnmbered 9′, 10′, and 14′ respectively, have been excluded, because the particulars given of these experiments show them to have been defective. Nine of the selected observations were made for temperatnres below 100° C. In the last column of this Table are given, for purposes of comparison, the densities of saturated steam at corresponding temperatures according to Professor Rankine's theoretical Tables, as stated by himself in a paper communicated to the Royal Society of Edinburgh in the year 1860. In that paper Professor Rankine expresses his opinion that the resnlts of the experiments of Messrs, Fairbairn and Tate are in near accordance with his own theoretical Tables at all temperatures. He adds, however, that at temperatnres above 100° C., the aggregate of experiments indicates an excess of density above the theoretical density. This excess he states to amount on an average to ·27 parts of a cubic foot, being the difference between the experimental and theoretical volnmes occupied by 1 lb. weight of satnrated steam. It will be found on reference to the column of differences in the Table annexed, that the above discrepancy has been redneed to one-fifth part of a cubic foot. This has been effected by excluding the three defective experiments mentioned, and by correcting an erroneons number given by Professor Rankine.

In the year 1850, M. Clausius pnblished a formula, by means of which the density of saturated steam may now be calculated. This formula is given in the "Philosophical Magazine" for August, 1851, at page 107. It contains two qnantities which are superflnous, as they are not fonnd in the new formula above given. Nevertheless the resnlts yielded by M. Clausius's formula for volume are nearly identical with the results of the new formula for volume. M. Clausins deduced his formula from a theory of the moving force of heat originating with M. Carnot in 1824, and improved by M. Clapeyron in 1834.

The formula of M. Clausius is an expression for the latent heat of satnrated steam relative to water (L), in terms of Joule's mechanical equivalent for a unit of heat (J), absolnte temperature $(a + t)$, excess of volume of a unit weight of saturated steam above volume of same weight of water $(V - v)$, and the differential co-efficient $\frac{dP}{dt}$. If v be omitted as insignificant and within the errors of observation, the formula of M. Clausius may be written thus,

$$L = \frac{1}{J}(a + t)\,V\,\frac{dP}{dt}.$$

The value of $\frac{dP}{dt}$ obtained from the new formula for pressure has been shown to be

$$P\,\alpha\left(1 + \frac{t}{a}\right)^{-(n+1)}.$$

If this valne be substituted in the formula of Clausius, we shall have

$$L = \frac{1}{J}(a + t)\,V \times P\,\alpha\left(1 + \frac{t}{a}\right)^{-(n+1)} = \frac{1}{J}\,\alpha\,a\,P\,V\left(1 + \frac{t}{a}\right)^{-n};$$

$$L = \frac{1}{J}\,\alpha\,a\,P\,V\,p^{-n}$$

In the preceding eqnation the variables L and P V represent ratios to constants L_0 and $P_0\,V_0$. The actual latent heat is represented by $L \times L_0$, and the actual expansive force by $P\,V \times P_0\,V_0$. On substitution of these values in this equation we get

$$L \times L_0 = \frac{1}{J}\,.\,\alpha\,a\,P\,V \times P_0\,V_0\,p^{-n};$$

or separating variables from constants, we have

$$L = \frac{1}{J}\,.\,\frac{\alpha\,a\,P_0\,V_0}{L_0}\,P\,V\,p^{-n}.$$

If $t = 0$, we have

$$P\,V = 1,\ p^{-n} = 1,\ \text{and}\ L = 1;$$

consequently,

$$1 = \frac{1}{J}\,.\,\frac{\alpha\,a\,P_0\,V_0}{L_0}\ \text{or}\ J = \frac{\alpha\,a\,P_0\,V_0}{L};$$

that is,

$$J = \frac{\cdot0358 \times 376 \times 2116\cdot4 \times 26\cdot36}{536\cdot5} = 1399\cdot7.$$

The quantity J, whose value has thus been determined to be 1399·7, is the mechanical equivalent in foot-pounds of a centigrade unit of heat, tho corresponding eqnivalent for a Fahrenheit unit of heat being 777 foot-pounds. The value of such mechanical equivalent, as determined by Dr. Joule, is 1389·6 for a centigrade unit, or 772 for a Fahrenheit unit of heat. If the constant V_0 be assumed to represent 26·17 cubic feet instead of 26·36 cnbic feet, the resulting value of J will be identical with the value adopted by Dr. Jonle himself.

It having been found that

$$L = \frac{1}{J}\,\frac{\alpha\,a\,P_0\,V_0}{L_0}\,P\,V\,p^{-n}\ \text{and}\ J = \frac{\alpha\,a\,P_0\,V_0}{L_0},$$

it follows that

$$L = P\,V\,p^{-n}$$

an eqnation which represents the corresponding values of L and P V when the latent heat, as well as the expansive force at the absolute temperature a, whence t is measured, are taken equal to unity.

By means of the last equation and the formula for P V in terms of log. p, the latent heat may be expressed in terms of the differential co-efficient of the expansive force P V. The formula mentioned gives on differentiation,

$$\frac{d\,.\,\log.\,P\,V}{d\,.\,\log.\,p} = \alpha_{11}\,a\,p^{-n},\ \text{or}\ P\,V\,\frac{d\,.\,\log.\,P\,V}{d\,.\,\log.\,p} = \alpha_{11}\,a\,P\,V\,p^{-n};$$

consequently, since

$$\frac{d\,.\,P\,V}{P\,V} = d\,.\,\log.\,P\,V\ \text{and}\ L = P\,V\,p^{-n},$$

$$\frac{d\,.\,P\,V}{d\,.\,\log.\,p} = \alpha_{11}\,a\,P\,V\,p^{-n} = \alpha_{11}\,a\,L = 80140\,L.$$

That is, the latent heat of saturated steam (relative to water at the same temperature) is equal to the differential co-efficient of the expansive force P V, divided by $\alpha_{11}\,a$ (= ·80840).

By means of the differential co-efficient of log. P V above given, we may find the temperature at which d . log. P V becomes equal to d . log. p; that is, the temperature at which the rate of increment of the expansive force of a unit weight of saturated steam is equal to the rate of increment

TABLE II,—*Volumes occnpied by a unit weight of saturated Steam at different Temperatures, according to the new formula, the formula of M. Clausius, and the formula of Dr. Rankine respectively.*

Temperature.			V.	V × H₁.		
			Relative volume according to new formula.	Volume of one pound weight of saturated steam according to		
Fahrenheit.	Centigrade.	Absolute.		New formula.	Clausius.	Rankine.
°	°	°		cub. ft.	cub. ft.	cub. ft.
32	0	276	12360	3258	3350	3390
50	10	286	6400	1687	1722	1732
68	20	296	3486	919·0	932·7	934·6
86	30	306	1988	524·0	529·5	529·2
104	40	316	1180	311·2	313·4	312·8
122	50	326	727·2	191·8	192·5	192·0
140	60	336	463·0	122·1	122·4	122·0
158	70	346	303·8	80·08	80·18	80·02
176	80	356	204·8	53·98	54·01	53·92
194	90	366	141·5	37·80	37·30	37·26
212	100	376	100·0	26·36	26·36	26·36
230	110	386	72·15	19·02	19·02	19·03
248	120	396	53·04	13·98	13·98	14·00
266	130	406	39·68	10·46	10·46	10·48
284	140	416	30·17	7·95	7·96	7·97
302	150	426	23·27	6·14	6·14	6·15
320	160	436	18·20	4·80	4·80	4·82
338	170	446	14·42	3·80	3·80	3·81
356	180	456	11·55	3·05	3·05	3·06
374	190	466	9·360	2·47	2·47	2·48
392	200	476	7·661	2·02	2·02	2·02
410	210	486	6·330	1·67	1·67	1·67
428	220	496	5·276	1·39	1·38	1·39
446	230	506	4·431	1·17	1·16	(not stated)

TABLE III.—*The Expansive Force of a unit weight of saturated Steam at different Temperatures, according to three different formulæ, compared with the Expansive Force of a unit weight of a perfectly elastic gas maintained at a perfect volume.*

Temperature.		$p = 1 + \frac{t}{a}$.	P V.		$P H \times H_{,,}$.	
		Relative expansive force of a unit weight of a perfectly elastic vapour occupying a constant volume.	Relative expansive force of a unit weight of saturated steam.		Absolute expansive force of one pound wieght of saturated steam.	
Centigrade.	Absolute.		New formula	Clausius.	New formula.	Rankine.
°	°				Ft.-pounds.	Ft.-pounds.
0	276	·7340	·7351	·7557	41008	41589
10	286	·7606	·7966	·7824	42769	43170
20	296	·7872	·7970	·8088	44461	44730
30	306	·8138	·8261	·8348	46085	46250
40	316	·8404	·8541	·8601	47646	47720
50	326	·8670	·8809	·8847	49145	49160
60	336	·8936	·9067	·9091	50583	50560
70	346	·9202	·9315	·9326	51964	51940
80	356	·9468	·9552	·9558	53291	53250
90	366	·9734	·9781	·9781	54564	54520
100	376	1·0000	1·0000	1·0000	55788	55788
110	386	1·0266	1·0211	1·0211	56964	56960
120	396	1·0532	1·0414	1·0415	58095	58130
130	406	1·0798	1·0608	1·0611	59182	59240
140	416	1·1064	1·0796	1·0801	60228	60300
150	426	1·1330	1·0976	1·0981	61235	61320
160	436	1·1596	1·1150	1·1157	62204	62330
170	446	1·1862	1·1317	1·1319	63138	63260
180	456	1·2127	1·1479	1·1479	64037	64180
190	466	1·2323	1·1634	1·1625	64904	65040
200	476	1·2660	1·1784	1·1766	65740	65860
210	486	1·2926	1·1928	1·1894	66546	66670
220	496	1·3191	1·2068	1·2016	67236	67470
230	506	1·3457	1·2203	1·2126	68077	(not stated)

of expansive force of a unit weight of a perfectly elastic gas maintained at a constant volume. Since

$$\frac{d.\ \log.\ P\ V}{d.\ \log.\ p} = \alpha_{11}\ ap^{-n} = \cdot 80840 \left(1 + \frac{t}{376}\right)^{-1\cdot 302585},$$

we shall have $d.$ log. P V = $d.$ log.p, when

$$\left(1 + \frac{t}{376}\right)^{1.302585} = \cdot 80840.$$

The value of t which satisfies the above equation is negative, and equals − 56°. Consequently the absolute temperature at which $d.$ log. P V = $d.$ log. p is (376−57), or 320°, which corresponds to (320−276), or 44° of the Centigrade thermometer. The ratio $\frac{d.\ \log.\ P\ V}{d.\ \log.\ p}$ is less than unity for all temperatures above 44° C., and greater than unity for all temperatures below that point.

In Tables II. and III., the values at different temperatures of V and P V given by the new formulæ are compared with similar values obtained from the published tables of Professor Rankine, and with similar values obtained from the formula for volume by M. Clausius, in combination with the new formula for pressure of saturated steam. On comparing together the three series of results, it will be perceived that for all temperatures above 60° C. the three series of results may be said to be identical with one another. At temperatures below 60° C., the two series of M. Clausius and Professor Rankine continue to agree with one another, but they disagree slightly with the results of the new formula. This disagreement arises from the circumstance that the first two series of results are regulated by the law of latent heat adopted by M. Regnault, which law is in complete accordance with the formula L = P Vp^{-n} for all temperatures above 60° C., whilst it deviates slighly from such formulæ for all lower temperatures.

In Table IV. will be seen, for various intervals of temperatures from 0° C. to 220° C., the relation between the numbers for latent heat given by M. Regnault, and the true numbers for latent heat which flow from the adoption of M. Clausius's formula for volume in combination with the new formula for pressure of saturated steam. It will be seen that for all temperatures above 60° C. there is no appreciable difference between experimental and theoretical numbers. At temperatues below 60° C. there is a slight discrepancy between the alleged experimental numbers and the theoretical numbers. On a reference, however, to the account given by M. Regnault of the various unsatisfactory experiments which he has made for temperatures below 60° C., there will be found no ground for believing that the new law for latent heat (expressed by the equation L = P Vp^{-n}), which is indisputably true for all temperatures above 60° C., is not also true for all lower temperatures. (See *Mémoires de l' Académie,* vol. xxi. pp. 712 and 722.)

TABLE IV.—*The latent heat of saturated Steam according to M. Regnault, compared with the latent heat deduced from the formula of M. Clausius, which is* $L = \frac{1}{J}(a + t)V\frac{dP}{dt} = P\,Vp^{-n} \times$ *by a constant.*

Temperature.		$p^{-n} = \left(1 + \frac{t}{a}\right)^{-n}$.	P V.	L.	L × L_0.	Latent heat (Regnault).	Differences.
Centigrade.	Absolute.			P Vp^{-n}.	P Vp^{-n} × 636·5.		
°	°				Units of heat.	Units of heat.	Units of heat.
0	276	1·4959	·7351	1·0996	589·9	606·5	− 16·6
20	296	1·3656	·7970	1·0883	583·9	592·6	8·7
40	316	1·2541	·8541	1·0711	574·7	578·7	4·0
60	336	1·1478	·9067	1·0498	563·2	564·7	1·5
80	356	1·0738	·9552	1·0257	550·6	550·6	·3
100	376	1·0000	1·0000	1·0000	536·5	536·5	·0
120	396	·9347	1·0414	·9734	522·2	522·3	·1
140	416	·8766	1·0796	·9464	507·7	508·0	·3
160	436	·4246	1·1150	·9195	493·3	493·6	·3
180	456	·7778	1·1479	·8928	479·0	479·0	·0
200	476	·7355	1·1784	·8667	465·0	465·0	+ ·7
220	496	·6971	1·2068	·8413	451·4	449·4	2·0

The latent heat of saturated steam adopted by M. Regnault is deduced from a well known empirical law propounded by him, as affording a near representation of the total heat absorbed by a unit weight of saturated steam during its conversion from water, and its elevation in temperature from 0° C. to t° Centigrade. The total heat is called λ, and the formula is

$$\lambda = 606{\cdot}5 + {\cdot}305t,$$

this quantity representing units of heat for temperature measured by the Centigrade thermometer, and a unit of heat representing the quantity of heat absorbed by a unit weight of water on elevation of its temperature from 0° C. to 1° Centigrade. The latent heat is obtained by substracting from the "total heat" (λ) the number of units of heat absorbed by a unit weight of water whilst its temperature is being raised from 0° C. to t° Centigrade. For example, if t = 200° C., then we have

$$\lambda = 606{\cdot}5 + {\cdot}305 \times 200 = 667{\cdot}5.$$

From this number is to be deducted the heat absorbed by a unit weight of water whilst its temperature is being elevated from 0° to 200° C. This is 200 units of heat, together with 3·2 units addition made for increased specific heat or capacity of water at 200° C. We have consequently the resulting latent heat of saturated steam at 200° C. = 667·5 − 203·2 = 464·3 units of heat, which is the number adopted by M. Regnault, as stated in the last page of vol xxi. of the *Mémoires de l'Académie,* &c.

The lowest average temperature at which observations on latent heat were made by M. Regnault was + 10° C. At this point the latent heat observed is stated to have been 599·5, whilst the new formula would give 587·4 Centigrade units of heat. The difference 12·1, which is the maximum difference between theory and a selected series of experiments. M. Regnault remarks that the difficulties are great in obtaining results to be relied upon from observations on latent heat of saturated steam made at temperatures below 60° C., or at pressure less than one-fifth of an atmosphere. He says that he has tried various methods of observation at these low temperatures; he assigns no reason for the preference given to the method of observation finally adopted; and be expresses no confidence in the results which he adopts. In speaking of the "total heat" adopted for the lowest temperature observed + 10° C., M. Regnault says that he "believes that it will be found not very far from the truth.

M. Regnault's table of latent heat is mainly dependent on his empirical law for "total heat" expressed by the formula A + B*t*. This law is of extreme simplicity, and for that reason the chances are very much against its being true for the entire range of temperature from 220° C. to 0° C., to which M. Regault tries to make it apply. That it should be found to be true from 220° C. to 60° C. is something extraordinary, and ought to satisfy all reasonable expectation. There is, however, a good reason for anticipating failure in this empirical law when extended to low temperatures. The point of temperature where the suspected failure occurs is not very distant from a remarkable point of temperature (44° C.) indicated (as already stated) by new formula by P V, where *d.* log. P V = *d.* log. *p.* It is highly improbably that an empirical law so simple as A + B*t* should indicate correctly the "total heat" for ranges of temperature *below* this remarkable point (44° C.) as well as for ranges of temperature *above* this point.

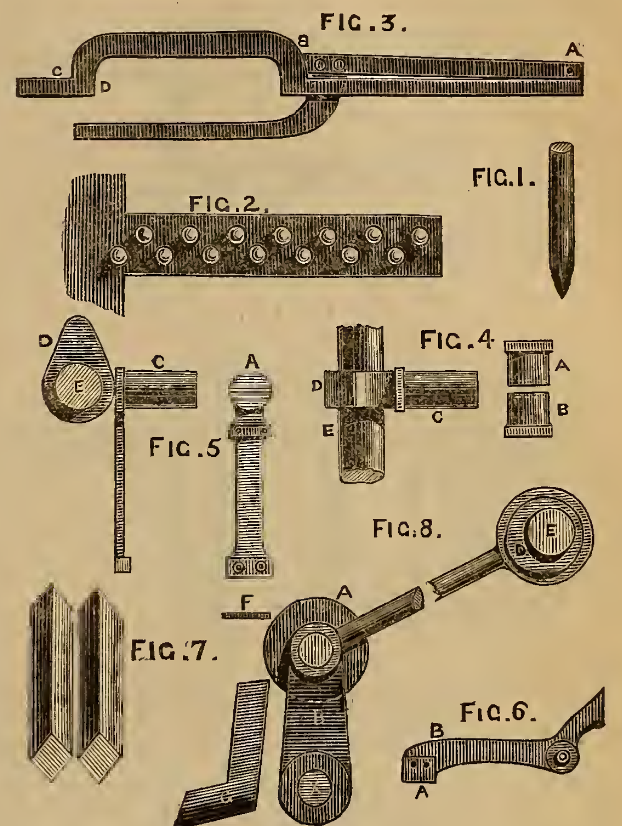
PIN MAKING MACHINERY.

It appears somewhat curious that a class of machinery ingenious in its design, and very effective in practice, should for some years have remained comparatively unknown to those without the immediate circle in which it was first applied, but such has been the case with the machines made by Mr. Thomas Ruler for the production of solid headed pins from wire. The exact period of the invention is not very easily to be decided, as the apparatus does not appear to have been patented, but it must have been prior to 1819, about which time the death of Mr. Ruler occurred. Our present object is to give an account of the general principles and construction of the pin making machinery as improved in 1859, at which period its action was as perfect as could be desired.

The work done in these machines involved a considerable number of processes, but the sum of it amounted to this, that a coil of brass wire was placed upon a reel at the feed end of the machine, and pins complete with solid heads and round points were poured out at the rate of about three hundred per minute from a spout at the delivery end, the sizes varying with the machines from the smallest or "minikin" pins up to the largest in ordinary use. First it was requisite to supply the means of straightening the wire, after which the head had to be hammered up by a process of "upsetting," effected in two blows; then it remained to cut the pin to the proper length, and form the point, which, it is to be remembered, must be convex, as shown in figure 1, not concave, as it would be if merely ground upon a revolving cutter, or stone with a fixed centre of revolution. We mention this point, as it formed one of the especial difficulties to be overcome, in order to render the action of the apparatus perfect, and its products, therefore, commercially valuable.

We shall now describe the various processes effected in this machinery separately, as the details thus presented will probably be more comprehensible than if illustrated in their combined form.

In the first place the wire to be used must be carefully drawn, and coiled on a reel so that there shall be no vertical bends or kinks, the only deviation from a straight line being that produced by coiling. Thus, the first step or operation to be effected will be to straighten the wire in the horizontal plane, which is done by drawing it through a series of studs shown in plan in figure 2. The apparatus by which the wire is fed into the machine, consists of a species of nippers shown in figure 3. The wire enters by the hinge A, passing through, and out ultimately at B; the frame A B C is continued throughout the length of the machine, its extremities sliding in guides, it is moved forwards by a cam acting against the inner surface D, and brought back by a blade spring, which keeps the surface D against the cam by which it is actuated. When these nippers are moving forward their two limbs are closed also by a cam acting on the upper one opposed by a spring, they have to be twice advanced for the production of one pin. The wire being drawn forward sufficiently to receive the first blow towards the formation of the head, is released by the nippers and gripped by two jaws A and B, figure 4, which are closed upon it by the simultaneous action of the cams or swash plates, the jaws themselves being attached to springs which tend to open them, and having grooves of semicircular section to receive the wire to be operated upon. C is the die which produces the head, in the centre of its face is sunk a cup shaped depression, corresponding to the form of head to be produced. D is the cam by which it is driven against the wire end, which is carried by a stout shaft E. Figure 4 is a plan, and figure 5 a side elevation of this arrangement; in the latter the jaw B is removed, to show the form of groove in the jaw A. The head having been partly formed by the first blow of the die C, the jaws A B release the wire so that it may be advanced sufficiently for completion, when a second blow from C finishes the head. The pin is next cut off to its proper length by a shear, figure 6. This shear is fixed upon an axis C, surrounded by a helical spring which holds up the arm B C, to the end B of which the keen cutting edge A is attached. When the pin has been headed, a cam



striking the end D of the shear depresses the cutting edge A, and so causes it to cut off the pin close to the jaws (A B, figure 4). The work so far finished falls down into an inclined pair of rails shown partly in section in figure 7; between these the pins are supported by the heads, and they gradually slide down to the pointing mill. As the pins arrive at the bottom of the rails they are received in a similar channel, running across the end of the machine parallel to the pointing mill, figure 8. A represents the grinding roller, which is coated with file-like surfaces of hard steel bent to fit on to its periphery, and there secured by suitable belts, against which the points of the pins are pressed by a sliding piece F, actuated by a lever connected with a cam or swash plate on one of the cam shafts, the movement of the sliding piece rolls the pins round so that the points are uniformly ground, but it is so arranged that at every alternate back stroke it rides clear of the work, so that the pins are gradually advanced towards the spout or shoot G, from which they fall out of the machine. The mill A has its revolving motion communicated through a band, its bearing being supported at each end on an arm B, capable of vibrating on an axis C, and vibratory motion is given to this arm by the eccentric D on the shaft E. The object of this peculiar movement is to insure that the pins shall not be ground hollow, but of the form shown in figure 1, as before alluded to. The pins after leaving the machine only need to be tinned, and stuck into papers to fit them for the market.

It yet remains for us to give some idea of the form in which the various details above described are brought together into the complete machine.

The framework of the machine is of rectangular form, and the various series of elements follow upon each other in close succession. The reel carrying the wire is supported upon a bracket at the back or feed end, at the lower part of which the driving shaft is placed, from which by straps the cam shafts and pointing mill are driven. Figures 9 and 10 show the general arrangements of the framing and shafting, Figure 9 being an elevation, and Figure 10 a plan. A is the pin to carry a reel of wire, B the straightening table, C the cam shaft, D the driving shaft, E the pointing mill, F the rocking arms carrying the hearing to the pointing mill, G rails for pins to descend on to the mill, H the discharge spout, I the slot in which the pins are suspended during the operation of pointing.

Fig. 9.

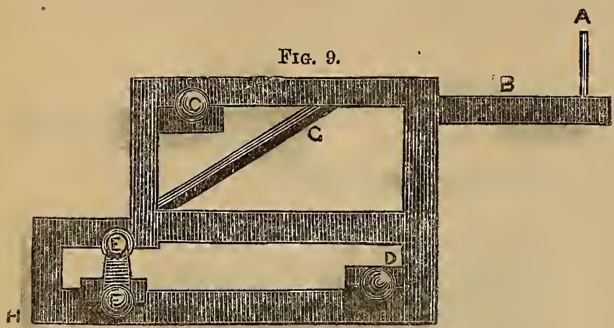
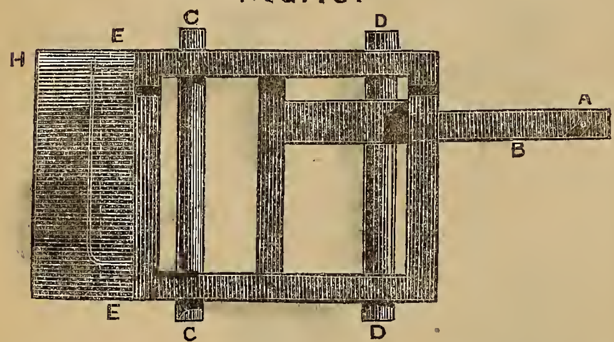


Fig. 10.



In order to start the machinery, the reel having been supplied with wire, it is necessary to draw the end of such wire into the nippers, after which the apparatus acts automatically, a short length of wire heing probably spoiled in the first few revolutions.

In the manufactnre of this description of pin making machinery some slight variations have been made from time to time, but in the foregoing description we have endeavoured to give a general account of the processes effected, aud the special details required for them without occupying space, with particulnrs of those parts the arrangement of which must be obvious.

CELLULAR SHIPS OF WAR.

A paper upon a "Proposed Cellular Ship of War" was recently read before the Scottish Shipbuilders' Association by Mr. H. J. Boolds, wherein the author points out at the commencement the various disadvantages of the present system of construction adopted for vessels of war, summing np as "the defects of our war ships to the present date" "all the defects of iron ships and of wooden ships separately." The author subsequently proceeded to describe a sample ship constructed according to the plan which he advocates.

The vessel is taken as 320ft. long, 45ft. broad, and 25ft. deep in hold to upper deck; register tonnage, 2,160; displacement, 18ft., about 4,000 tons; engines, I.H.P. 3,000. A speed of 15 knots is calculated on, using two screws. The frames are iron, 18in. apart at the centre and 2ft. at each end, formed of plate 18in. wide, with double angle irons on each edge. Inside the frame is an iron skin, rivetcd and caulked water-tight. On the top of this skin the vessel is divided into water-tight or, if necessary, air-tight compartments, by transverse and longitudinal bulkheads, each cell being 12ft. by 10ft. by 18ft. deep. The outside hull of the ship would be of wood plauk, bolted to the iron frames with galvanised iron. Along the engine room on each side of the ship the frames are set back 6in., and filled with teak against the inner skin from the lower deck to the bilge. On this bed 6in. armour plates are fitted, forming a target which could easily be made complete of the strongest kind. Outside of this the plank is continued without interruption from stem to stern.

By this construction the author hopes to gain a combination of sufficient strength, with speed enough to enable his ships to get rapidly out of danger—a property which he cousiders the ironclads do not possess.

INDUSTRIAL EXHIBITIONS.

On the 12th ult. was opened, at the St. Mary Street School-room, Whitechapel the East Londou Industrial Exhibition by the Rt. Hou. the Earl Shaftesbury K.G., and its success has surprised even its most sanguine promoters.

The beneficial effect of the institution of industrial exhibitions upon the working classes can scarcely be overrated, and the thorough appreciation of their objects by those for whose encouragement they are designed is fully shown by the specimens exhibited at Whitechapel.

There is, perhaps, no metropolitan locality so capable of developing in the highest degree the intellectual euergies of the working classes as the East End, swarming, as it is, with that busy throng of hard workers who, having to fight their way in life by sheer industry aud tact, are quite prepared to take advantage of any openiug which may tend to elevate their position, both commercially and intellectually.

Our readers doubtless know that this class of exhibition is designed to receive such specimens as the working man may produce after his hours of labour, and nsually of such character as to be distinct from his own occupation. As such, the results were very satisfactory, as will be shown subsequeutly.

The opening of the Exhibition was attended by considerable *éclat*, the speeches made on the occasion by Lord Shaftesbury and the other gentlemen present being most appropriate, and obtaining great applause, as did also the choir. Nor must we forget the goodly muster of the guard of honour, supplied by the 1st Tower Hamlets Volunteer Engiueers, as contributing much to the success of the *debût*.

Passing to the Exhibition itself, our attention was first drawn to an apparatus for signalling between the passengers and guards in railway trains, exhibited by Mr. Myers. Its construction is extremely simple, but at the same time thoroughly effective. In case of danger or accident, the occupant of any compartment in the train has but to break a glass cover and move a stud, which releases a red disc at the end of the carriage, allowing it to rise obedient to the impulse of weights provided for its elevatiou, and thus it becomes visible to the guard of the train. In the same invention other safeguads are comprised equally effective and simple, supplying means of communication between the guard and engine, driver, and also for actuating a danger signal, carried npon the engine, by mechanism worked from any station towards which the train might be approaching.

An electric engine, seut by Mr. T. F. Downs, evinced signs of cousiderable skill. Its acting parts consist of two electro-magnets acting upon two losing levers, wherefrom, by connecting rods, the cranks are worked. The machine, though of course workiug with far less economy than the ordinary steam engine, reflects great credit upon its inventor, being extremely simple in its construction and smooth in its working.

To enter upon an account of even a small comparative portion of the models would be tedious; as, although they are extremely creditable to their makers, yet the bulk of them show no new principles, those of steam engines abounded, mostly constructed by exhibitors whose busiuesses are removed from that of the engineer, and this alone tends to show the universal interest in the mighty servant of moderu civilisation, not less than the advanced conditiou at which our working men have arrived in scientific as well as commercial education.

Turning from the mechanical to the fine arts portion of the Exhibition, we observed, with great pleasure, the objects everywhere striking the view and their abundance proved the existence of much refinement in a circle where, according to the conventional *pseudo-doxia epidemicæ*, we have not been taught to look for it.

In glancing round the cases, many objects reminded us of Lord Shaftesbury's remark, that not only the working man, but his wife and children also helped in preparing the objects before us, and in one instance were we particularly inclined to detect the delicate manipulation of the gentler sex, where appeared a group of excellently desiccated skeleton leaves, very tastefully arranged, and showiug their anatomical structure without any break or blemish.

Some beautiful cork models attracted great attention, their execution being praiseworthy iu the extreme, and their accuracy indubitable, as the plans of those structures to which they referred were placed by them. One showing the form of the fountain in Victoria Park is perhaps the best of the set.

We observed some fac-similes of engravings executed by Mr. Wm. Stevenson in such a style that it was really difficult to be convinced that they were not original engravings, the distiuct and clear outline being retained, together with the soft graduation of shade peculiar to steel engravings: they appear to have been executed in indian ink. The subjects we observed were portraits of the late Lord Macaulay and the late Lord Advocate, Lord Rutherford. There were also exhibited by Mr. T. B. Stevenson portraits of Robert Hanbury Esq., M.P., and the late Henry Erskine, Esq., in indian ink, and "The Bird's Nest," in sepia; these latter being also *fac-similes* of engravings.

In conclusion, we may observe that this Exhibition is well worthy the attention, not only of all well wishers of the working classes towards whose elevation they so materially teud, but also of those who, either professionally or as amateurs, have any interest in the mechanical, or constructive, or fiue arts. It is to be hoped that the system so far advanced in many districts will be further pursued as, by affording the intelligent members of the vast body of working men who dwell in and about the metropolis opportunities and encouragement in developing their ingenuity with a fair prospect of receiviug due credit, and, in mauy instances, obtaining introductions to public notice which may ensure their permanent prosperity, they are thereby supplied with a recreation for their leisure hours, not only pleasing but profitable.

Finally, we wish to express our approbation of Lord Shaftesbury's suggestion that in future it would be more beneficial, instead of repeating the district exhibitions as exclusively as heretofore, to adopt a system of centralisation in certain localities, so as to widen the scope of these most useful competitions.

INSTITUTION OF CIVIL ENGINEERS.

The Council have awarded the following premiums:—

1. A Telford medal, and a Telford premium, in books, to Joseph William Bazalgette, M. Inst. C.E., for his paper "On the Metropolitan System of Drainage, and the Interception of the Sewage from the River Thames."

2. A Telford Medal, and a Telford premium, in books, to Callcott Reilly, Assoc. Inst. C.E., for his paper "On Uniform Stress in Girder Work, illustrated by reference to two bridges recently built."

3. A Telford Medal, and a Telford premium, in books, to Edward Hele Clark, for his "Description of the Great Grimsby (Royal) Docks, with a Detailed Account of the Enclosed Land, Entrance Locks, Dock Walls, &c."

4. A Telford medal, and a Telford premium, in books, to Capt. Henry Whatley Tyler, R.E., Assoc. Inst. C.E., for his paper "On the Festiniog Railway for Passengers; as a 2ft. Gauge, with Sharp Curves, and worked by Locomotive Engines."

5. A Telford premium, in books, to John England, M. Inst. C.E., for his paper on "Giffard's Injector."

6. A Telford premium, in books, to Thomas Hawthorn, for his "Account of the Docks and Warehouses at Marseilles."

7. A Telford premium, in books, to Edward Fletcher, for his paper "On the Maintenance of Railway Rolling Stock."

8. A Telford premium, in books, to Edward Johnston, M. Inst. C.E., for his paper on "The Chey-Air Bridge, Madras Railway."

9. A Telford premium, in books, to Godfrey Oates Mann, M. Inst. C.E., for his paper "On the Decay of Materials in Tropical Climates, and the methods employed for arresting and preventing it."

10. A Telford premium, in books, to William Jerry Walker Heath, Assoc. Inst. C.E., for his paper "On the Decay of Materials in Tropical Climates, and the methods employed for arresting and preventing it."

11. A Telford premium, in books, to Joseph Taylor, Assoc. Inst. C.E., for his paper on "The River Tees, and the Works upon it connected with the Navigation."

12. The Manby premium, in books, to Henry Burdett Hederstedt, Assoc. Inst. C.E., for his "Account of the Drainage of Paris."

INSTITUTION OF ENGINEERS IN SCOTLAND.

ON LOW'S PATENT BORING MACHINES, &c.

By Mr. JOHN DOWNIE.

The title of the paper read by Mr. Downie was, "On Low's Machinery, as applied to Working in Rock or Minerals, in Tunnelling, Driving Adits, Perpendicular and Inclined Shafts for Mines; Working against Face and Surface of Quarries; Open Rock Cuttings for Railways or other purposes; to Coal Cutting, and to Mining operations generally, in lieu of the very slow, laborious, and unhealthy method of executing the above kind of work by hand; with a few remarks on some of the other most recent appliances for Mining purposes."

Having given a brief notice of different boring and coal-cutting machines, the author returned to the main subject of the paper, and described Mr. Low's machinery; first, stating what he thought to be the essential conditions of a good boring machine, derived from actual experience, and which are fulfilled in Mr. Low's new boring cylinder.

These conditions are:—

1st. That the boring part, or the boring cylinder with tool, should be as short as possible, so as to allow it to transit in any direction in the tunnel, and so enable it to be set to bore at any angle, no matter how acute, and in the most favourable position and direction, so that the blast of such hole may displace the largest amount of debris.

2nd. That the carriage-frame carrying such cylinder should allow the same to be set easily in any position, so as to work in any direction, or at any angle.

3rd. That the reciprocating parts should be as few as possible, and no screws, levers, &c., should be used, as they work loose in time, and in the direct line of percussion there should not be more than the piston and rod, in one piece of steel, and the tool, which should be secured in the piston so as to allow no play.

4th. That the advancement of the tool should be exactly in the same ratio as the tool is cutting, however variable may be the nature of the rock. For instance, in one part of the hole the tool may be cutting at the rate of three inches per minute, and in another one inch per minute; so that the tool should be fed forward self-acting, and so keep up for any of those varying rates of cutting that it may not over-feed or under-feed itself.

5th. In order to prevent crystallisation of the part exposed to the direct concussion, a cushion of air should be provided, if possible, at the back of cylinder, which will also relieve the carriage-frame from the shocks of the blows.

6th. The outer end of tool should be guided in a bearing to compel it to go straight as it bores, as a vein of quartz., &c., will invariably cause the tool to go to one side, and jam it if not secured.

7th. That the tool should reciprocate with the piston, as the hole can be easier kept free from debris than if the tool is stationary and receives blows from the piston, as experienced in the case of Westmacott's machine at Allenheads and elsewhere.

8th. The carriage-frame should be so constructed that it can be brought to work again immediately after a set of holes have been blasted—(a jet of air being left open near the face at the time of explosion soon dilutes and clears off the gases resulting from the explosion of the powder)—and before the debris is removed, which can be done whilst the machine is at work, being carried or thrown through the machine. This will save the time, which is so much lost at Mont Cenis, removing the debris before the machine can be set to work.

9th. The working parts should be as much covered as possible, to prevent wear and tear resulting from the quartz and rock dust.

10th. The motion for working the valve should be effected as gently as possible, to prevent shocks so destructive, and, if possible, a steam-moved valve should be adopted.

11th. The best system for rapid driving of tunnels, &c., is by boring holes and blasting, as so much time is occupied in cutting either a rectangular or circular trench, there being so much cutting ground to go through; whereas if a hole is bored in a right direction, a single blasting will displace a large amount of debris, and the smoke will be cleared in a few minutes if compressed air is used. It may be, however, found, that in very soft stone, such as sandstone, grit, &c., that Gay's machine will drive a tunnel as rapidly, if not quicker.

12th. A strong water jet should be always used to clear the hole of debris, to prevent the tool from jamming.

13th. The advancing of the tool should be done without any propelling gear, such as screws, worm, and worm-wheels, ratchets, levers, &c. The want of such appliances greatly increases the durability of the machine, and for this cause it is preferred to dispense with the turning gear and turn the tool by hand.

I will now describe the first boring cylinder which Mr. Low constructed, before the present kind, and which, with its tool, is but 4 feet 9 inches long.

The chief peculiarities are, that the cylinder is stationary (unlike all others, in which the cylinder moves), the tool being telescopic, and is propelled from the piston (by a screw which goes up inside the piston-rod) in the progress of boring, and is actuated by a diagonal slot attached to the cylinder by a roller ratchet wheel. The screw, therefore, receives the blows centrally, thus obviating the danger of the tool leaning to either side. Although provision is made that the tool travels at four different rates, proportionate to the hardness of the rock, this being regulated by the position of the diagonal propelling slot, which can be placed with a greater or less slope, so as to actuate either one, two, three, or four teeth, and thus to move the screw with tool more or less quickly, it required too much attention; and this, coupled with the crystallisation and gradual loosening of the screw and other parts, induced Mr. Low to construct one to do away with screws and gearing altogether, and to propel self-acting, according to the rate that the tool is then cutting, and which, I am happy to say, Mr. Low has accomplished, and according to recent trials, granite was bored by it at the rate of 14½ inches in seven minutes, and 3 inches in 55 seconds; and the average rate at which it bores the rock at the Dublin Corporation Water-works Tunnel, Roundwood (which is excessively hard, so much so that the miners have sometimes used from 24 to 36 tools to complete one hole 24 inches deep), composed of green hornblende interspersed with white quartz veins is one inch per minute. The advancement of the tool as it bores, requires no attention, and Mr. Low has considered it best also to do away with the turning motion, and effect the same by hand, as the very great rapidity of the blows is rather severe upon the turning motion. I may here mention that they can bore quicker, and keep the edge on tool better, by striking less hard, and to make up for not cutting so deep, the blows have been increased from 250 to 500 or 600 blows per minute; consequently the result is, that they have been enabled to bore one hole with two tools without sharpening, instead of using five or six as formerly, and with one tool a hole 26 inches deep has been bored in the Roundwood granite without sharpening.

TABLE I.—*Giving the rate of working of the New Improved Boring Cylinder in the specimen of Granite exhibited.*

No. of Hole.	Distance bored.	Time.	Trials.	Tool changed.
	inches.			
FIRST HOLE	3	55 seconds	First	New tool.
	14½	7 minutes	Second	
	7	3¼ „	Third	New tool.
	24½	11 min. 10 sec.		
SECOND HOLE	8½	7 minutes	Fourth	New tool.
	11	7¼ „	Fifth	New tool.
	19½	14 minutes		

Table II.—*Trials by the Cams slipping over Notches, each Notch being 1½in. apart, and corresponding to every 1½in. bored.*

No. of Hole.	Number of Notches.	Dist'nce of each Notch.	Time in boring each 1½ inch. min.	sec.	Tool changed.
		Inches.	min.	sec.	
First Hole	First	1½	1	30	First tool.
	Second	1½	1	30	
	Third	1½	0	55	
	Fourth	1½	0	30	New tool.
	Fifth	1½	0	45	
	Sixth	1½	0	45	
		9 inches	5 m.	55 sec.	
	Seventh	1½	0	20	New tool.
	Eighth	1½	0	50	
	Ninth	1½	1	0	
		4½ inch.	2 m.	10	
Second Hole	First	1½	1	30	New tool, but was very blunt
	Second	1½	1	15	
	Third	1½	1	40	
	Fourth	1½	1	15	
	Fifth	1½	0	55	
	Sixth	1½	1	0	
		9 inches	7 m.	35 sec.	
	Seventh	1½	1	25	Longer tool.
	Eighth	1½	1	15	
	Ninth	1½	0	45	
	Tenth	1½	0	50	
	Eleventh	1½	0	35	
	Twelfth	1½	0	35	
		9 inches	5 m.	25 sec.	

The average rate at which the machine bores the excessive hard rock at Round-ood is 1in. per minute.

I might also mention that a hollow tool has been tried, into which was in-rted a water jet, and also having the exhaust from the cylinder turned into it, hich forced the water at a considerable pressure out at the point of tool in the le. This was found a most excellent plan for keeping the hole clean; but in nsequence of its complication it was abandoned for a separate water jet.

New Boring Cylinder. Figs. 1 to 8.

This machine is also only 4ft. 9in. long, and the working cylinder, constructed of brass, A, is placed inside another cylinder of wrought iron, B, in which it is free to move from one end to another, and also to rotate. The back end of the cylinder A is packed with india-rubber metallic, or other suitable rings C, so as to be air or steam tight. The front end fits into a wrought iron crosshead D (in which it is free to revolve). This crosshead is slotted on each side to fit into two slide bars E E (carried from cylinder to end bearing of machine), along which it slides as the cylinder A is moved along inside the cylinder B in the process of boring. The sides of the above-named crosshead D, where it fits into the slide bars E E, is projected in front on each side of the slide bars E E, between which is placed two cam bars F F, partly forked on each edge of slide bars. The other end of the said cam bars F F, rests in notches G G, cut at intervals of 1½in. from each other on the inner side of the slide bars E E, and are constantly kept pressed against the bottom of the said notches by two spiral springs of steel wire H H. The other end of the cam bars F F, which works on centres I I, are so curved towards each other at L that the end of piston rod may strike them at the proper time. The operation may thus be explained:—The air, steam, or other motive fluid is admitted by the pipe K (which leads from one of the trunnions) into the wrought iron cylinder B, behind the back end of the working cylinder A, and thus keeps it pressed outwards against the crosshead D, which is kept in its place or from going forwards by the two cam bars F F, each of which rests against one of the notches G G in the slide bars. It will thus be seen that when the tool has advanced 1½in. into the hole, the end of piston rod (the end of which is allowed to go 1½in. beyond its limit) comes into contact with the cams or curved end of cam bars F F at L, and thus causes them to slip over the notch into the next, and this is repeated for every 1½in. bored till the end notch is reached. This will allow the tool to advance at whatever rate it is cutting, *i.e.*, when the tool cuts rapidly, the cams will slip from one to another rapidly; whilst, when the tool cuts slowly, the cams will be so much longer in slipping from one notch to another.

On the two cam bars, F F, are two diagonal wedges, M M, which are pressed forward by spiral springs between the teeth of slide bars and cam bars. This is to steady the cam bars, and keep them in the positions to which they are raised by the end of piston-rod at each blow, and prevent the spiral springs, H H, from pulling the cams to the bottom of the notches. When the cam bars slip over, the ends of the diagonal wedges come against the next teeth of notches, and are pressed back into their normal positions again.

The cross-head D, is provided with two copper breaks N N, pressed upon the side of slide-bars by a powerful spiral spring, regulated by a screw fitted with double handles O O, for the purpose of enabling the break to be regulated by hand. This is to prevent the cylinder with cross-head and cam-bars from slipping too violently from one notch to another. The above double handles O O, serve also to pull back the whole, by hand, when necessary to change the tool.

The chamber into which the air is admitted into the iron cylinder B, and behind the cylinder A, serves to contain a portion of air to act as a cushion to prevent crystallisation of the parts exposed to the direct concussion of the blows, and also to relieve such shocks upon the carriage generally.

At the back end of working cylinder A, is the circular valve P, with six or more inlet ports and six or more exhaust ports. This valve is turned by a double spiral cam Q, which is carried into end of piston and rod, in which are four rollers R R R R, which bear on both sides of the spiral wings of the cams Q. These spiral wings are so sloped that upon the reciprocation of the piston it is gently turned or twisted, and with it the valve to which it is connected. The slopes on spiral wings of the cam Q are so placed as to cause the valve P to open the inlet ports, to admit air to act upon the large area of piston, and to allow it to exhaust again after the piston has struck a blow, when it will return, by a constant pressure upon the small area maintained, through the two ports X X, and *vice versâ*.

FIG: 1.

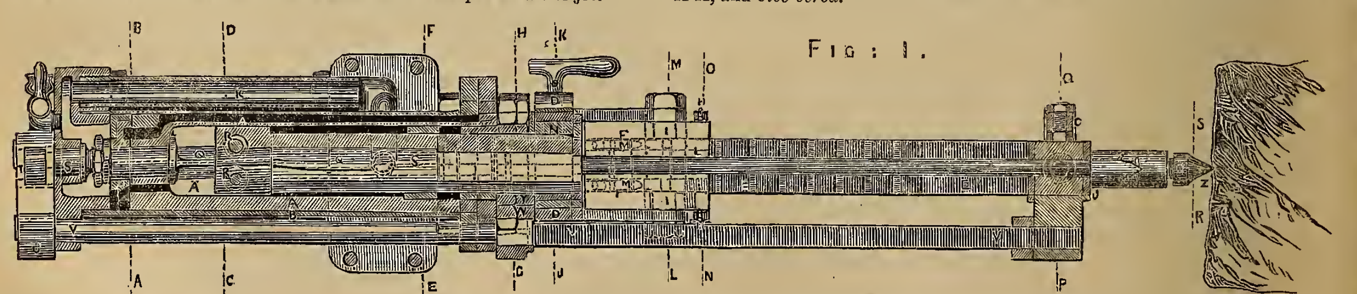
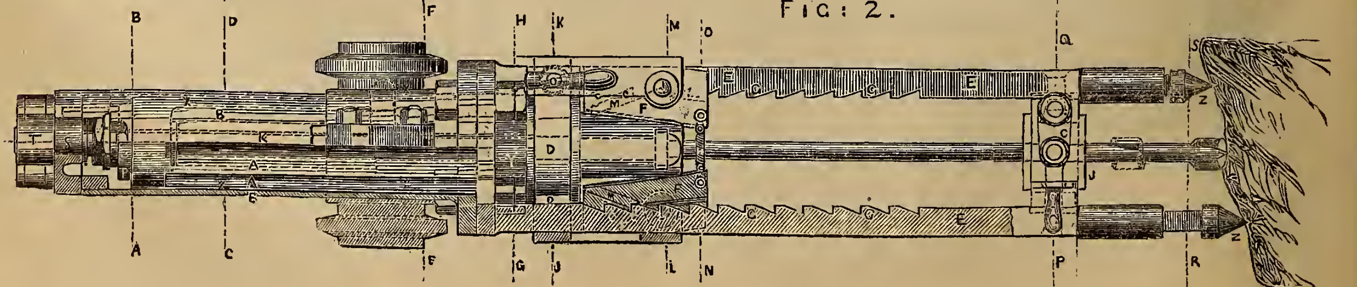
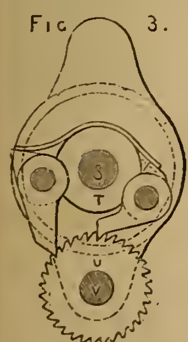


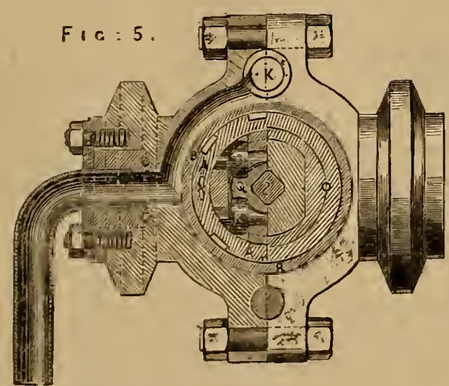
FIG: 2.

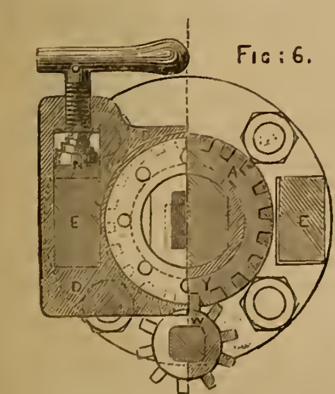


The piston is prevented from turning in the cylinder by means of two flats, planed on each, which fit into corresponding flats on the bush and stuffing glands of cylinder. The rotary motion of cylinder A, with piston and tool, is affected by a square bar S, working inside the cam or spiral bar Q, which receives the same turn at each stroke of piston as the valve. On the end of the square bar, outside the end of cylinder B, through which it is carried, is a double lever T, at each end of which are two palls, working into a ratchet wheel U, on end of shaft V, and are so arranged as to give a continuous motion to the same. This shaft V is provided with a square part, on which is a brass pinion wheel W, which works into a geared portion of working cylinder A at Y, and so causes it to rotate with the piston and tool by the ratchet U aforesaid. On end of shaft V, the brass pinion slides along the square part of shaft V, as the cylinder A, advances by the cams F F, slipping over the notches.

It, is, however, preferred, as aforesaid, to turn the shaft V by hand, either by means of a hand-wheel and mitre-wheel working into a mitre-wheel on shaft V, or by double levers with palls, giving a continuous motion to the two ratchet-wheels on shaft V. At the end of the two slide-bars E E, are two screws with steel points Z Z, for the purpose of steadying the end of machine against the rock. The end of the tool is steadied in a bearing J J, accross the end of the two slide-bars, in order to compel the tool to bore straight, and it is so arranged that upon turning the lever C, the top bearing or step can be easily lifted out when the tool requires changing.







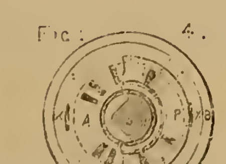


FIG. 7.

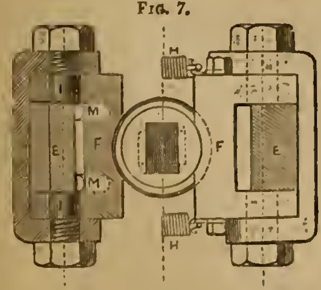


FIG. 8.

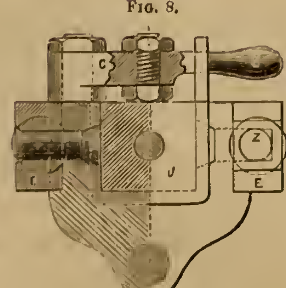


Fig. 3 exhibits the motion for turning the boring tool; Fig. 4, a section of the disc valve at A B; Fig. 5, sections on C D and E F; Fig. 6, sections on G H and J K; Fig. 7, sections on L M and N O; and Fig. 8, sections on P Q and R S.

MANCHESTER ASSOCIATION FOR THE PREVENTION OF STEAM BOILER EXPLOSIONS.

The monthly meeting of this association was held on the 4th ult., when the chief engineer presented his report, of which the following is an abstract :—

"During the last month 136 engines have been examined, and 273 boilers. Of the boiler examinations, 160 have been external; 15 internal; and 98 thorough or entire. The following defects and omissions have been found in the boilers examined: Furnaces out of shape, 4; fractures, 3; blistered plates, 8; internal corrosion, 5; external corrosion, 19; internal grooving, 5; external grooving, 2; feed apparatus out of order, 7; water gauges ditto, 19; blow-out apparatus ditto, 6; fusible plugs ditto, 5; safety valves ditto, 15; pressure gauges ditto, 11; boilers without glass water gauges, 3; without blow-out apparatus, 7; without feed back-pressure valves, 4.

"ENTIRE," OR "THOROUGH" EXAMINATIONS.

"During the past Whit Week, when many of the works have been stopped, every endeavour has been made to examine internally, and in the flues all the boilers of those members who made application.

"EXPLOSIONS.

"Three explosions have occurred during the past month, from which two lives have been lost and sixteen persons injured.

"TABULAR STATEMENT OF EXPLOSIONS FROM MAY 27TH, 1865, TO JUNE 23RD, 1865, INCLUSIVE.

Progressive No. for 1865	Date.	General Description of Boiler.	Persons Killed.	Persons Injured.	Total.
26	May 30.	Particulars not yet fully ascertained ...	0	5	5
27	June 1.	Ordinary single flue, or Cornish internally fired	2	7	9
28	June 6.	Locomotive	0	4	4
		Total	2	16	18

"No. 27 Explosion, which was of a very disastrous character, two persons being killed, and seven others injured, occurred at a brewery on June 1st, to a boiler not under the inspection of this association. I made a personal investigation a day or two after the explosion had occurred, and found that it arose simply from collapse of the furnace flue, a subject to which this association has called such constant attention in its reports.

"The boiler was of ordinary Cornish construction, having a single furnace flue, internally fired. It was 32 feet long, 7 feet in diameter in the shell, and 4 feet in the internal furnace and flue tube, which was $\frac{7}{16}$ of an inch thick, while the safety valves were loaded to a pressure of 50lb. and upwards.

"The flue tube collapsed from one end to the other, rending at the angle iron at the back end of the shell, as well as at some of the other ring seams of rivets. The boiler was moved forward away from the chimney for several feet, and the greater part of its setting torn down, while the rush of water from the furnace end carried away a considerable portion of the engine-house wall, and scalded the workmen near the boiler.

"The explosion was attributed, as usual, by general report, to shortness of water, but examination of the plates showed no evidence of overheating. There could be no doubt that the explosion resulted entirely from the weakness of the flue, which was insufficient for any pressure above 30lb., but could have been made perfectly safe at 60lb., or even at a much higher pressure, by the introduction of flanged seams, or encircling hoops of T iron, or bridge rail section, applied at the ring seams of rivets. There are also other means for strengthening furnace flues, such as water pockets, or water tubes, &c.: but since these strengthening pockets or water tubes connot extend into the furnace, it is well to supplement them at that part with flanged seams or T iron hoops. After boilers are completed and set to work, the furnace tubes can readily be strengthened with angle iron hoops made in segments so as to be passed into the boiler through the manhole, and fixed to the tube when in place. Full particulars of this method of strengthening furnace tubes were given in the report for June, 1862, and a considerable number of boilers under the inspection of this association, have been strengthened in this way.

"It seems difficult to understand how any maker could have constructed a boiler within the last few years without adopting any one of the simple means to provide against collapse, which have just been enumerated above, and are now so generally known. The explosion clearly shows the importance of an independent system of periodical inspection for boilers of even first-class firms, where they suppose themselves to be perfectly free from danger; and had the boiler in question been under the charge of this association, not a day would have been lost in apprising its owners of the dangerous position they were in.

"The jury found that the deceased met with their deaths from the accidental bursting of the boiler, adding that they considered that the furnace flue had not been of sufficient strength for the pressure.

"Particulars, for which there is not room in the present report, have been obtained of three other explosions, which resulted from the collapse of furnace flues, and all of which might have been prevented had the flues been strengthened as recommended by this association. By these three explosions eight persons were killed, and eleven others injured."

STRENGTH OF BOILERS.

In another column, our readers will observe the reported explosion of a large Cornish boiler, and as this appears to have been due to deficiency of strength originally in the flue tube, it appears to us not inappropriate to offer some remarks as to what course should have been adopted in order that the boiler might be competent to withstand the ordinary pressure to which it was intended to subject it. The locus of failure was in the internal tube, which was far too weak to bear the strain, which was "50lbs. and upwards per square inch," the dimensions being as follows:—Internal tube, 4 feet in diameter; 32 feet in length; and 7-16th of an inch in thickness. This tube collapsed completely from one end to the other, as the calculations given below will show was the result to have been anticipated.

There were two ways in which the flue might have been made stronger—first, by using thicker plates in its construction; second, by attaching stiffening rings to support it, virtually, in fact, dividing it into a series of shorter tubes, and so increasing its strength.

The formula used below is a *practical* one for *working* strength based upon the data obtained by Mr. William Fairbairn, C.E., from his experiments upon the resistance of tubes to collapse under external pressure.

Let t = thickness of metal in inches.
l = length of flue in feet.
d = diameter of flue in inches.
p = pressure in lbs. per square inch.

then,

$$t = \sqrt{\frac{p.\ l.\ d.}{161200}}$$

First, taking the flue as not being stiffened by rings, the thickness of metal requisite would be thus determined.

$$t = \sqrt{\frac{50\text{lbs.} \times 32\text{ft.} \times 48\text{in.}}{161200}} = \sqrt{\cdot476\text{in.}}$$

and

$$\sqrt{\cdot476.} = \cdot6902 = \frac{10\cdot04}{16}\text{in.}$$

whereas the actual thickness, as stated above, was but $\frac{7}{16}$in.

The actual pressure which might have been safely put upon the flue may be determined by transposing the formula thus:—

$$p = \frac{161200.\ t^2}{l.\ d.}$$

in the present case,

$$p = \frac{161200 \times .49}{10 \times 48 \times 256} = 20\text{lbs. nearly}$$

and this is, probably, as high a pressure as such a flue should have been regularly exposed to.

If the thickness of $\frac{7}{16}$in. had been retained, and the tube strengthened by the second method, inserting stiffening rings, so as to reduce the effective length of the flue as regards its resistance to external pressure to 10ft. in each length, the safe working pressure would have been—

$$p = \frac{161200 \times 49}{32 \times 48 \times 256} = 64\text{lbs. nearly}$$

It is here worthy of comment that there appears to be a great tendency to overstrain the materials used in the manufacture of boilers, which does not occur in the construction of other works wherein the same materials are used, although, as in the case of iron bridges, the risks would, probably, be less in reducing the strength, than in making boilers too weak; but, then, it is to be remembered that iron railway bridges are always subjected to severe tests, and undergo a rigid examination by a Government inspector before they are allowed to be applied to public use; and it seems very desirable that some similar course should be adopted in regard to boilers, whereby a considerable diminution of loss of life, &c., might be effected.

It is tolerably certain that there are many cases of boiler explosions in which the boiler itself has been amply strong, the accidents being due to a combination of circumstances quite unanticipated and beyond control, but such an explosion as that above alluded to can only be traced to neglect of the proper precautions which should have been adopted in the construction of the apparatus.

Furthermore, in the comparison of bridges with boilers it is evident the latter are much more liable to deteriorate in the strength of their materials than the former, as the influences to which they are subject are of a more destructive character than those which affect the former, while their depredations, being out of sight, they are exceedingly liable to be overlooked, until they have progressed to such an extent that they render themselves evident by giving rise to some appalling accident.

Of course, a frequent systematic examination will do much towards the diminution of the number of explosions, and it is not improbable that in the accident above referred to some depression in the tube might have been noticed previous to the total collapse, in which case, by the application of proper means—such as stiffening rings—the catastrophe might have been avoided and the flue rendered safe.

Such occurences supply valuable experiences which *ought not* to be lost upon manufacturers and users of steam apparatus, but it is to be feared that, as a rule, they produce but temporary impressions passing away with the remembrance of the accidents creating them.

PRICES CURRENT OF THE LONDON METAL MARKET.

	July 1.			July 8.			July 15.			July 22.		
COPPER.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
Best, selected, per ton	90	0	0	89	0	0	89	0	0	89	0	0
Tough cake, do.	87	0	0	86	0	0	86	0	0	86	0	0
Copper wire, per lb.	0	1	0	0	0	11½	0	0	11½	0	0	11½
„ tubes, do.	0	1	1	0	1	0¼	0	1	0¼	0	1	0½
Sheathing, per ton	90	0	0	91	0	0	91	0	0	91	0	0
Bottoms, do.	93	0	0	92	0	0	96	0	0	96	0	0
IRON.												
Bars, Welsh, in London, per ton	8	0	0	8	0	0	7	15	0	7	15	0
Nail rods, do.	8	10	0	8	10	0	8	10	0	8	10	0
„ Stafford in London, do.	8	15	0	8	15	0	8	15	0	8	15	0
Bars, do.	8	15	0	8	15	0	8	15	0	8	15	0
Hoops, do.	9	15	0	9	15	0	9	17	6	9	17	6
Sheets, single, do.	10	7	6	10	7	6	10	10	6	10	10	0
Pig, No. 1, in Wales, do.	4	10	0	4	10	0	4	10	0	4	10	0
„ in Clyde, do.	2	15	3	2	15	6	2	15	3	2	15	0
LEAD.												
English pig, ord. soft, per ton	19	5	0	19	5	0	19	5	0	19	5	0
„ sheet, do.	20	5	0	20	5	0	20	0	0	20	0	0
„ red lead, do.	22	0	0	22	0	0	22	0	0	22	0	0
„ white, do.	26	0	0	26	0	0	26	0	0	26	0	0
Spanish, do.	18	10	0	18	10	0	18	10	0	18	10	0
BRASS.												
Sheets, per lb.	0	0	8½	0	0	8½	0	0	8½	0	0	8½
Wire, do.	0	0	8¾	0	0	8¾	0	0	8¾	0	0	8¾
Tubes, do.	0	0	9½	0	0	9½	0	0	9½	0	0	9½
FOREIGN STEEL.												
Swedish, in kegs (rolled)	13	0	0	13	0	0	13	0	0	13	0	0
„ (hammered)	14	15	0	14	15	0	15	0	0	15	0	0
English, Spring	18	0	0	18	0	0	18	0	0	18	0	0
Quicksilver, per bottle	8	0	0	8	0	0	8	0	0	8	0	0
TIN PLATES.												
IC Charcoal, 1st qu., per box	1	8	0	1	8	0	1	10	0	1	10	0
IX „ „ „	1	14	0	1	14	0	1	16	0	1	16	0
IC „ 2nd qua., „	1	6	6	1	6	6	1	7	0	1	7	0
IC Coke, per box	1	3	0	1	3	0	1	4	0	1	4	0
IX „ „	1	9	0	1	9	0	1	10	0	1	10	0

NOTICES TO CORRESPONDENTS.

J. Wanford (Carlisle).—You can determine the height of your lighthouse by the formula

$$h = \frac{4\ l^2}{7}$$

where h = the height of the lamp in feet, and l = the distance in miles, to which it is to be visible. The radius of curvature of the lens at the centre is to be found from the formula

$$R = (m - 1).\ \left\{f + \frac{t}{m}\right\}$$

where R = radius of curvature, m = index of refraction for the glass used, and t = thickness at centre.

Engineer.—Spring water from the cretaceous strata does not require filtration previous to its being supplied to a town. The object of filtering water through sand is to remove the organic matter held in suspension, which is generally most abundant and difficult to eliminate about autumn, when decayed vegetable matter falls into and pollutes the stream.

Physicist (Exeter).—We believe that the centrifugal force imparted by the revolution of the earth to bodies on its surface has not been considered in any work on the measure of gravity, which is ordinarily taken as producing in one second a falling velocity of about 32·2ft. per second; if the centrifugal force overcome at the equator be added, the measure of attractive force will be increased to about 32·22ft. per second.

Builder.—The number of rods of brickwork in your wall may be found by multiplying the height into the length (both in feet), and the product by the number of bricks in thickness and by ·00245.

A. C. (Newcasle).—The adhesion of locomotives to the permanent way is now in some localities increased by the use of electric coils which renders the tyres at the point of contact with the rails electro-magnetic. It is stated that the increased resistance to slipping amounts to 40 per cent., but it yet remains to see how it will answer in continued use, so it would be premature to recommend the adoption of this system.

Leba.—Steam pipes, cylinders, and boilers may be coated to prevent radiation with "Aikin's composition," or a mixture of loam, chopped straw, and manure made into a paste. Felt will also answer the purpose. For boilers the plan usually followed is to lay a bed of ashes about two feet thick on the exposed parts. Cylinders, where there is room, are cased with ashes or wood-shavings. If there is not sufficient space for this, we can recommend the above mentioned compositions, covered by a casing of sheet iron. There is also a patent composition invented by Mr. Jas. Spence, late of Her Majesty's Dockyard, Portsmouth, which has proved very valuable.

M. D. (City).—To measure the power of a steam engine you cannot do better than use a Macnaught's Indicator attached to the steam cylinder, to register the force of the steam throughout the stroke, from which the mean pressure may be calculated, and at the same time applying a counter to register the number of revolutions of the engine. From these data the power may be calculated in the usual manner. The power requisite to work one or more shops will depend upon the nature and quantity of work to be done in each. We cannot find drawings of the invention to which you refer without a complete account of it, as to inventor, time and place of invention &c.

CORRESPONDENCE.

We cannot hold ourselves responsible for the opinions of our Correspondents.

STEAM EARTHQUAKES, VOLCANOES, &c.

To the Editor of THE ARTIZAN.

SIR,—In a letter published in the recent number of the *Popular Science Review*, a really admirable and highly interesting one, on "The Eruption of Etna," the author of that paper (S. J. Mackie, Esq., F.G.S.) speaks of underground caverns as "favourite receptacles of imaginative geologists" (p. 448), at the same time that he himself exhibits in an ideal section of a volcano (p. 452) four sections, which he calls "pockets of the solid earth roof," or "huge bladders," far down in the bowels of the earth.

Scientific men and the public will probably soon have an opportunity of deciding, each for himself, between the arguments in favour of *gases* and *steam* respectively, as to which (if either) is the cause of earthquakes and volcanoes. The author of the interesting paper in the *Popular Science Review*, in common with the undersigned, is evidently desirous to get at the truth, by ventilating the subject of volcanoes and their causes, &c.

Jersey, July 8, 1865. R. A. PEACOCK.

THE ROYAL SOCIETY.

ON THE ELASTICITY AND VISCOSITY OF METALS.

By Prof. W. THOMSON, LL.D., F.R.S., F.R.S.E.

Among the experimental exercises performed by students in the physical laboratory of the University of Glasgow, observations on the elasticity of metals have been continued during many years. Numerous questions of great interest, requiring more thorough and accurate investigation, have been suggested by these observations; and recently they have brought to light some very unexpected properties of metallic wires. The results stated in the present communication are, however, with one or two exceptions, due to the careful experimenting of Mr. Donald Macfarlane, official assistant to the Professor of Natural Philosophy, whose interested and skilful co-operation have been most valuable in almost everything I have been able to attempt in the way of experimental investigation.

The subject has naturally fallen into two divisions—viscosity, and moduli of elasticity.

Viscosity.—By induction from a great variety of observed phenomena, we are compelled to conclude that no change of volume or of shape can be produced in any kind of matter without dissipation of energy. Even in dealing with the absolutely perfect elasticity of volume presented by every fluid, and possibly by some solids, as, for instance, homogenous crystals, dissipation of energy is an inevitable result of every change of volume, because of the accompanying change of temperature, and consequent dissipation of heat by conduction or radiation. The same cause gives rise necessarily to some degree of dissipation in connection with every change of shape of an elastic solid. But estimates founded on the thermodynamic theory of elastic solids, which I have given elsewhere *, have sufficed to prove that the loss of energy due to this cause is small in comparison with the whole loss of energy which I have observed in many cases of vibration. I have also found, by vibrating a spring alternately in air of ordinary pressure, and in the exhausted receiver of an air-pump, that there is an internal resistance to its motions immensely greater than the resistance of the air. The same conclusion is to be drawn from the observation made by Kupffer in his great work on the elasticity of metals, that his vibrating springs subsided much more rapidly in their vibrations than rigid pendulums supported on knife edges. The subsidence of vibrations is probably more rapid in glass than in some of the most elastic metals, as copper, iron, silver, aluminium †, but it is much more rapid than in glass, marvellously rapid, indeed, in some metals (as, for instance, zinc) ‡, and in india-rubber, and even in homogeneous jellies.

The frictional resistance against change of shape, must, in every solid, be infinitely small when the change of shape is made at an infinitely slow rate, since, if it were finite for an infinitely slow change of shape, there would be infinite rigidity, which we may be sure does not exist in nature.* Hence there is in elastic solids a molecular friction which may be properly called viscosity of solids, because, as being an internal resistance to change of shape depending on the rapidity of the change, it must be classed with fluid molecular friction, which, by general consent, is called viscosity of fluids. But, at the same time, it ought to be remarked that the word viscosity, as used hitherto by the best writers, when solids or heterogeneous semisolid-semifluid masses are referred to, has not been distinctly applied to molecular friction, especially not to the molecular friction of a highly elastic solid within its limits of high elasticity, but has rather been employed to designate a property of slow continual yielding through very great, or altogether unlimited, extent of change of shape, under the action of continued stress. It is in this sense that Forbes, for instance, has used the word in stating that "Viscous Theory of Glacial Motion," which he demonstrated by his grand observations on glaciers. As, however, he, and many other writers after him, have used the words plasticity and plastic, both with homogeneous solids (such as wax or pitch, even though also brittle, soft metals, &c.), and to heterogenous semisolid-semifluid masses (as mud, moist earth, mortar, glacial ice, &c.), to designate the property † common to all those cases of experiencing, under continued stress, either quite continued and unlimited change of shape, or gradually very great at a diminishing (asymptotic) rate through infinite time, and as the use of the term plasticity implies no more than does viscosity any physical theory or explanation of the property, the word viscosity is without inconvenience left available for the definition I propose.

To investigate the viscosity of metals, I have, in the first place, taken them in the form of round wires, and have chosen torsional vibrations, after the manner of Coulomb, for observation, as being much the easiest way to arrive at definite results. In every case one end of the wire was attached to a rigid vibrator with sufficient firmness (thorough and smooth soldering I find to be always the best plan when the wire is thick enough); and the other to a fixed rigid body, from which the wire hangs, bearing the vibrator at its lower end. I arranged sets of observations to be made for the separate comparisons of the following classes:—

(*a.*) The same wire with different vibrators of equal weights (to give equal stretching tractions), but different moments of inertia (to test the relation between viscous resistances against motions with different velocities through the same range and under the same stress).

(*b.*) The same wire with different vibrators of equal moments of inertia but unequal weights (to test the effect of different longitudinal tractions on the viscous resistance to torsion under circumstances similar in all other respects).

(*c.*) The same wire and the same vibrator, but different initial ranges in successive experiments (to test an effect unexpectedly discovered, by which the subsidence of vibrations from any amplitude takes place at very different rates according to the immediately previous molecular condition, whether of quiescence or of recurring change of shape through a wider range).

(*d.*) Two equal and similar wires, with equal and similar vibrators, one of them kept as continually as possible in a state of vibration, from day to day; the other kept at rest, except when vibrated in an experiment once a day (to test the effect of continued vibration on the viscosity of a metal).

Results.

(*a*). It was found that the loss of energy in a vibration through one range was greater the greater the velocity (within the limits of the experiments); but the difference between the losses at low and high speeds was much less than it would have been had the resistance been, as Stokes has proved it to be in fluid friction, approximately as the rapidity of the change of shape. The irregularities in the results of the experiments which up to this time I have made, seem to prove that much smaller vibrations (producing less absolute amounts of distortion in the parts of the wires most stressed) must be observed before any simple law of relation between molecular friction and velocity can be discovered.

(*b*). When the weight was increased, the viscosity was always at first much increased; but then day after day it gradually diminished and became as small in amount as it had been with the lighter weight. It has not yet been practicable to continue the experiments long enough in any case to find the limit to this variation.

(*c*). The vibration subsided in aluminium wires much more rapidly from amplitude 20 to amplitude 10, when the initial amplitude was 40, than when it was 20. Thus with a certain aluminium wire, and vibrator No. 1 (time of vibration one way 1·757 second), in three trials the numbers of vibrations counted were—

	Vibrations.	Vibrations.	Vibrations.
Subsidence from 40 initial amplitude to 20	56	61	64
And from 20 (in course of the same experiments) to 10	96	98	96

The same wire and same vibrator showed—

Subsidence from 20 initial amplitude to 10 (average of four trials)........ } 112 vibrations.

Again the same wire with vibrator No. 2‡ (time of vibration one way 1·236), showed in two trials—

	Vibrations.	Vibrations.
Subsidence from 40 initial amplitude to 20 ...	54	52
And continued from 20 to 10........	90	90

* On the Thermo-elastic Properties of Solids, "Quarterly Journal of Mathematics," April, 1857.

† We have no evidence that the precious metals are more elastic than copper, iron, or brass. One of the new bronze pennies gives quite as clear a ring as a two-shilling piece tested in the usual manner.

‡ Torsional vibrations of a weight hung on a zinc wire subside so rapidly, that it has been found scarcely possible to count more than twenty of them in one case experimented on.

* Those who believe in the existence of indivisible, infinitely strong and infinitely rigid very small bodies (finite atoms!) may deny this.

† Some confusion of ideas on the part of writers who have professedly objected to Forbes's theory while really objecting only (and, I believe, groundlessly) to his usage of the word viscosity, might have been avoided if they had paused to consider that no one physical explanation can hold for those several cases, and that Forbes's theory is merely the proof by observation that glaciers have the property that mud (heterogeneous), mortar (heterogeneous), pitch (homogeneous), water (homogeneous), all have of changing shape indefinitely and continuously under the action of continued stress.

‡ Of same weight as No. 1, but different moment of inertia.

Again same wire and vibrator—

From initial amplitude 20 to 10 ...... 103 vibrations (mean of eight trials).

This remarkable result suggested the question (*d*).

(*d*) Only one comparison was made. It showed in a wire which was kept vibrating nearly all day, from day to day. after several days, very much more molecular friction than in another kept quiescent except during each experiment. Thus two equal and similar pieces of wire were put up about the 26th of April, hanging with equal and similar lead weights, the tops and bottoms of the two wires being similarly fixed by soldering. No. 2 was more frequently vibrated than No. 1 for a few days at first, but no comparison of viscosities was made till May 15. Then

No. 1 subsided from 20 initial range to 10 in 97 vibrations.
No. 2, the same subsidence in 77 vibrations.

During the greater part of May 16 and 17, No. 2 was kept vibrating, and No. 1 quiescent, and late on May 17 experiments with the following results were made :—

				Time per vibration.
No. 1. Subsided from 20 to 10 after	99 vibrations	in 237	seconds.........	2·4
" " "	98	" 235	"	2·4
" " "	98	" 235	"	2·4
No. 2. Subsided from 20 to 10 after	58	" 142	"	2.45
" " "	60	" 147	"	2·45
" " "	56	" 139	"	2·45
" " "	60	" 147	"	2·45

[Addition, May 27, since the reading of the paper.]—No. 1 has been kept at rest from May 17, while No. 2 has been kept oscillating more or less every day, till yesterday, May 26, when both were oscillated, with the following results :—

		Time per vibration.
No. 1. Subsided from 20 to 10 after	100 vibrations in 242 seconds	2·42
" 2. " "	44 or 45 vibrations	2·495

(*To be continued.*)

BOOKS RECEIVED.

"Society of Engineers. Transactions for 1864." London: E. and F. N. Spon. 1865.

Industrial Exhibition for the City of London.—A crowded meeting has been held in the Sussex Hall, Leadenhall-street, in connection with the proposed Working Classes Industrial Exhibition for the City of London. The Lord Mayor presided. It was resolved, "That a Working Classes Industrial Exhibition for the City of London is most desirable; and that this meeting pledges itself to adopt means for the furtherrnce of this object." A committee was appointed.

The Diseases of English Workmen.—A contemporary, in an article upon the last annual report of the Incorporated Society of Amalgamated Engineers, refers to the enormous death-rate from consumption or lung diseases, amongst the English workmen who are in the prime of years, stating that no doubt its fatal effect is as dependent on the sanitary condition of houses and workshops as is that of the zymotic complaints to which so much attention has been very properly given, and hints that advantage would result if those able and clear-headed men who have assisted in drawing up the report of the Amalgamated Engineers were to form a supplementary health committee who would inquire into those matters. No doubt they would, if needful, be able to get useful information from the medical attendants of the branch societies, &c., and some valuable hints might be given in the yearly reports at but little additional cost to the society.

The Railway over Mont Cenis.—Captain Tyler has made a report to the Board of Trade on the railway proposed by Messrs. Brassey and Co. for crossing the Mont Cenis, and for improving the communication with Italy, Egypt, and the East. The report is a lengthy one, and in it Captain Tyler states that the proposed line will save 233 miles in the route from Paris to Genoa, and 433 miles from Paris to Turin. The new route would save thirty-eight hours in the journey from England to Egypt; and Captain Tyler remarks :—"This would be of importance in faciltating the communication between this country and India, and in the transmission of the Indian mail, though it is to be observed that there would necessarily be a change of vehicles at St. Michel and Susa." In conclusion, Captain Tyler says, "After going with Mr. Fell through the different calculations and considerations which are involved in the undertaking, I find that he has, during three years of labour, treated them with the utmost care and caution; and I have no doubt of his being able, if he obtains—as he hopes to do in the course of a few weeks—the necessary authority from the French Government, to carry it forward to a successful issue.

RECENT LEGAL DECISIONS

AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

Under this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least —less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

Symonds *v.* Foxwell.—This was an action tried in the Court of Queen's Bench, to recover remuneration for services rendered as a skilled or scientific witness in a cause. It was an action by Captain Symonds, who of late years has practised as a civil engineer as the surviving partner in the late firm of Richard Roberts and Co., to recover the sum of £124 15*s*. 6*d*., the amount of their charges as consulting engineers, for services rendered to the now defendant in a suit by him in the Court of Chancery against a Mr. Bostock, in which Mr. Foxwell sought to establish the validity of certain patents for sewing-machines. The particulars claimed that sum. The defendant paid into court £50, and denied any further liability. The present case had arisen out of the "great sewing-machine patent case," which was tried before the Lord Chancellor in the early part of last year. In that case, of course, questions arose as to whether in truth a sewing-machine could be made to work under the specification of Mr. Foxwell, and also, with reference to other and prior patents, whether the process was new and was really his own invention. These questions were necessarily in a great degree, indeed, mainly mechanical, and involved mechanical skill and experience; and, as is usual, various eminent engineers and mechanists were engaged as witnesses on either side. On the part of Mr. Foxwell, the engineers, Mr. Bovill and Mr. Paul Hodge, were engaged. In the course of the hearing, about the date first mentioned in the particulars, it appeared to them desirable that Mr. Roberts should be called to give a governing opinion upon the mechanical questions involved, and he was accordingly called in. At that time, being in weak health, he was, for the purpose of restoration, down at Aberystwith, in Wales, and he came up to London for the purpose of the case, had various consultations, and attended the court from day to day in order to be examined as a witness, if necessary. It occurred, however, to the Lord Chancellor, that the validity of the specification might be determined as a question of law, and legal construction upon the face of it, without resort to external evidence as to mechanical action, and upon that point his Lordship ultimately decided; and, in point of fact, Mr. Roberts was not actually examined in court, though in attendance for that purpose. In the result, the Lord Chancellor decided against Mr. Foxwell that his patent was invalid on account of the insufficiency of his specification. He, of course, had to pay costs, as an unsuccessful suitor, to the opposite party in Chancery, and he would also have to pay his own witnesses at the ordinary rate allowed on taxation of costs—that is, in the case of professional men, three guineas a day. The question, however, was as to their extra charges as "skilled witnesses." Mr. Roberts had since died, and the present action was by his surviving partner, Captain Symonds, who was examined as a witness in support of the claim which he said he had made out partly from the diary of Mr. Roberts and partly from his information, and that there was no distinction between the remuneration to be received as scientific witnesses and the general business of the firm. The jury found a verdict for the plaintiff for the sum of £18 6*s*. beyond the sum paid into court, making altogether the sum of £68 6*s*.

Evidence in Compensation Cases.—At the Lord Mayor's Court, on the 24th ult., in a railway compensation case, "Smee *v*. the Metropolitan Railway Company," a claim was made for some houses in Liverpool-street and Broad-street buildings, in the city, exceeding £33,000, which, with the customary 10 per cent., for a forced sale, would exceed £36,000. On the part of the company, the valuation was, with the 10 per cent., under £14,000. There was a railway tavern on the property which was let at £550, and, as it is near four different railway stations, it was stated to be worth a premium of £5,000. On the part of the company, the evidence was that the rent was excessive, and that it would fetch no premium. Without the railways the house was not worth more than £50 a year. Other evidence was given as to the value of property in the city of London, and it was stated that it was still increasing. Further, it was stated that ground rent which three years ago was worth only £2,000, would now fetch £4,000. Mr. Commissioner Kerr, in placing the case before the jury, declared that it was an extraordinary case, and would form a model compensation case. What were they to think of the value of the evidence in such cases, when there was such a remarkable conflict? The jury retired, and at six o'clock returned with a verdict for £29,000.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

Consumption of Fuel in France.—In a paper addressed to the Academy of Science M. Becquerel gives some curious prrticulars concerning the quantities of fuel consumed in France at various periods, both for domestic and manufacturing purposes taking into account the increase of population, and the relative quantities of each kind of fuel, reducing them all to a common standard, pure carbon, and thus giving the co-efficients by which a certain quantity of fuel must be multiplied in order to obtain the number of metrical quintals of carbon producing the same amount of heat as the combustibles in question. We are told that it was under the Consular period, from 1801 to 1804, the consumption of wood was the most considerable; it fell materially under the Imperial era, rose again under the Restoration, and declined again from 1826 to 1834. The fall continued until 1845, to such an extent as to cause much anxiety to landed proprietors; but from that period a rise began, and has been continuing ever since. The consumption of charcoal increases in proportion to the population, because the poor find it cheaper than sea coal. Nevertheless, the consumption of the latter has rapidly increased. The events of 1830 and 1848 slackened this increase for awhile. In 1821, when pit coal was not yet in common use for domestic purposes, the amount of wood consumed was equivalent to 2·16 quintals of pure carbon. This quantity has been constantly diminishing, so that in 1861 it was only represented by an equivalent of 0·687 of a quintal of pure carbon, the difference being evidently made up by pit coal. Now, if by any chance the production of the latter were to decline, it would become necessary to fetch wood from a great distance in order to satisfy the wants of the capital, and its price would consequently experience a rise; but were the clearing of forests to continue on the same scale as it now does, the price of wood would become exorbitant in a very short time. The great consumption of charcoal induces landed proprietors to cut their wood every fifteen or sixteen years, and even oftener, instead of every eighteen or twenty years, in order to get more wood fit for charcoal, and more bark for tanning, the price of which has doubled. By this means the reserve is destroyed, white wood takes the place of oak, and the quality of firewood degenerates. Great Britain has only 2 per cent. of forest land, Spain 3 per cent., France has still 16·7 per cent. left; but if things continue on the present footing, a few years will suffice to reduce it to the penury of the above-mentioned countries.

MACHINE FOR CUTTING SHEET METAL.—Mr. H. Low, of Waukon, Iowa, U.S., has patented an invention which consists in the use of two pairs of shears adjustable for any desired bevel and length, and applied in combination with a treadle or other suitable mechanism, in such a manner that the bevel end from curved pieces of sheet metal can be cut with little loss of time, with perfect accuracy; it consists, further, in the application of adjustable guages in combination with the adjustable shears, in such a manner that the apparatus can be readily set for pieces of sheet metal of any desired width; it consists, finally, in providing the shears with crooks in the cutting edges, fitting one another in such position that by their action the pieces of sheet metal are notched at the same time the bevil ends are cut off, and each piece, when taken from the shears, is ready for soldering without requiring any further preparation.

THE DALBEATTIE AND KIRKCONNELL GRANITE.—The selection of this granite for the Thames Embankment has led to the announcement that a limited company is being formed, to be called "The Dalbeattie and Kirkconneil Granite Company," with the view of working the quarries on a sufficiently extended scale. The company's capital will be £120,000, in 12,000 shares of £10 each (with power to increase); deposit £1 per share on application and £2 on allotment. The Dalbeattie quarries, of which six are open and in full work, with all the necessary plant and machinery, are situate on the estate of Munches, in the stewartry of Kirkcudbright. Among the numerous large undertakings in the execution of which the stone has been already used, the following are mentioned:—The Liverpool Docks, Graving Docks, Birkenhead, harbour at Trinidad, Maryport Docks, Newport Docks, Swansea Docks, Silloth Docks, Workington Docks, Bank of England Branch, Liverpool, new municipal offices, Liverpool, Brown's Buildings, Liverpool. The interest of the company in the present leases of these quarries will expire in 1896. A preliminary contract has been entered i to for the purchase of leases, railways, and plant, together with the existing contracts for £25,000.

THE LAW OF PARTNERSHIP.—The Act to amend the law of partnership has just been issued. The advance of money by way of loan to a person engaged, or about to engage, in any trade or undertaking, upon a contract in writing with such person that the lender shall receive a rate of interest varying with the profits, or shall receive a share of the profits arising from carrying on such trade or undertaking, shall not of itself constitute the lender a partner with the person or persons carrying on such trade or undertaking, or render him responsible as such. The remuneration of agents by share is not to constitute a partnership. No person being the widow or child of the deceased partner of a trader, and receiving by way of annuity a portion of the profits made by such trader in his business, shall, by reason only of such receipt, be deemed to be a partner of, or to be subject to any liabilities incurred by, such trader. The receipt of profits in consideration of the sale of a goodwill is not to make the seller a partner. In the event of a trader being adjudged a bankrupt or taking the benefit of an Act for the relief of insolvent debtors, or entering into an arrangement to pay his creditors less than 20*s*. in £1, or dying in insolvent circumstances, the lender of any such loan shall not be entitled to recover any portion of his principal or of the profits or interest payable in respect of such loan, nor shall any such vendor of a goodwill be entitled to recover any such profits, until the claims of the other creditors for valuable consideration in money or money's worth have been satisfied. The word "person" is to mean a firm, joint-stock company, or corporation.

A NEW LADDER.—An interesting trial was made lately, in the spacious courtyard of the Archinto Palace, at Milan, with what the inventor, Paolo Porta, calls an "air ladder." It consists of several pieces, which, a sort of carriage as a basis, can be fixed one on the top of another. A height of 90ft. was thus reached in a very few minutes. The apparatus may be bent down to an angle of 45, and is capable of carrying heavy weights. The principle, it is stated, can be adapted to portable bridges, which can be put together in an equally short time.

PRESERVATION OF WOOD BY CHARRING.—The superficial carbonisation or charring of wood, as a preservative means, has long been practised on a small scale, the *rationale* of the process being the formation of an indestructible skin of carbon, which is, moreover, impregnated with the empyreumatic oils and creosote, produced by the carbonisation of the outer layer of wood. About two years ago M. Lapparent proposed to apply it to the timber used in the French navy. Some experiments which were undertaken with the view to determine its practicability have terminated, according to the *Reader*, very satisfactorily; and the Minister of Marine has ordered the process to be introduced into the Imperial dockyards. M. Lapparent makes use of a gas blow-pipe, the flame from which is allowed to play upon every part of the piece of timber in succession. By this means the degree of torrefaction may be regulated at will. The method is applicable to wood work of all kinds, and the charring, it is said, does not destroy the sharpness of any mouldings with which the wood may be ornamented.

THE METROPOLIS SEWAGE AND ESSEX RECLAMATION COMPANY has been announced, with a capital of £2,100,000. The prospectus is introduced to the public by the International Finance Society, and the object is to utilise the sewage of the northern area of the metropolis, the concession of which has been granted to Messrs. Napier and Hope, who have agreed to part with it to the company for £50,000, "in fully paid-up shares of the company, and a small contingent per centage of the net profits." A contract has been entered into with Mr. William Webster (who has constructed more than one-third of the Main Drainage Works of the metropolis, including the Crossness Outfall) for the construction of the works mentioned above, together with the necessary pumping-station for the sum of £1,853,148

COLOGNE EXHIBITION.—STEAM FIRE ENGINE TRIALS.—At the recent competitive trials of steam fire engines at the Cologne International Exhibition there were exhibited four steam fire engines, two being of English, one of American, and one of German manufacture. Messrs. Merryweather, of London, have carried off the first prize of 500 thalers, placed in the hands of the Exhibition Committee by the Colonia Fire Insurance Company to be awarded to the makers of the best steam fire engine, as well as a diploma certifying that they have received the first prize for the best steam fire engine. Messrs. Merryweather's engine raised steam from cold water, and commenced working with 100lbs. pressure in 7 min. 28 sec. from the time of lighting the fire, weighed 1 ton less, and was of considerably less cost than either of the other two competing engines. The German engine was considered out of the contest, as its jet failed to reach the water target efficiently.

THE NEW SEWAGE ACT.—The Act to facilitate the more useful application of sewage in Great Britain and Ireland is issued. It recites that it is expedient to remove difficulties under which local boards and other bodies having the care of sewers labour, in disposing of the sewage in their districts so as not to be a nuisance, and to give facilities to such authorities to make arrangements for the application of sewage to land for agricultural purposes. There are various provisions in the Act. The sewage authorities are to prevent the pollution of streams, and to dispose of the sewage.

NEW THEORY ABOUT PETROLEUM.—A theory which has the merit of being at once plausible and less repugnant with ascertained facts than many which have been suggested, has been proposed in the Pittsburgh *Oil News*. One of the most rational and more generally accepted theories respecting petroleum supposes that substance to be a product of the destructive distillation of coal by means of the earth's internal heat. There is being discussed just now, however, a theory which is the exact converse of this; a theory according to which, instead of petroleum being formed from coal, coal was formed from petroleum. It is well known that "all organic substances which are not themselves volatile, such as wood, flesh, and all other vegetable and animal matters, yield, when subjected to the influence of heat below, dull redness, tarry oils, having in all cases the general character of petroleum, and differing only according to the specific differences in the materials from which they may have been obtained," and the new hypothesis supposes that the materials from which our coal beds were formed were converted in the first instance into such "tarry oils," and that these oils, under long continued action of heat, gradually lost nearly all their oxygen and the chief part of their hydrogen, the residuum gradually becoming solid. The pitch lake in Trinidad is referred to in support of this opinion. It is alleged that the theory of coal having been condensed from a liquid, in the same way as this "asphaltum," accounts better than any other for its purity, seeing that "all impure or foreign substances which did not decompose would most likely be of greater specific gravity than oil, and consequently sink to the bottom." The high state of preservation in which plants frequently occur in our coal beds, and the fact of trees being found erect in them, are easily accounted for upon this theory. Trees grow on the hardened pitch of the Trinidad Lake, within a short distance of other pitch in a state of ebullition, and one can readily conceive of the hardened pitch, in any similar case, being softened by an eruption of the boiling pitch, and of the trees growing on it being thus engulfed, or of the lake overflowing its banks and so submerging adjacent vegetation. The new theory also furnishes a simple explanation as to the "exceeding minuteness of many coal seams, which thin out into mere filaments over extensive areas of solid rock," and might well be due to an oily liquid having overflowed the rock when it was at the surface, and having then, in process of time, in part evaporated and in part solidified. The shape and dimensions of many other coal seams are equally consistent with the idea of the seams in question being the solid residuum of what once were lakes of oil—and, indeed, the great majority of all known coal formations are basin shaped, "with long and sloping sides dipping down to a common and profound centre," a fact which certainly tells with great force in favour of the new hypothesis. On the whole, it must be admitted that the theory that the first step in the formation of coal was the production of "tarry oils" by the destructive distillation, at a comparatively low heat, of vegetable and perhaps animal matter, and that coal consists of the less volatile portions of these oils, solidified and hardened by heat and pressure, is not without plausibility—at least, in respect of certain kinds and formations of coal. There are some coal beds which present phenomena which could scarcely, so far as we can at present see, be accounted on this theory, but further researches will doubtless thrown additional light on the whole matter, and it is not necessary that we should suppose that all the coal that exists was formed precisely in the same way.

COAL TRADE.—The quantity of coals, cinders, and culm shipped and carried coastways from port to port of the United Kingdom rose to 10,970,711 tons in the year 1864, an increase of 382,000 tons over the previous year. 3,116,703 tons of coal were brought coastwise into the port of London, and 2,359,723 tons by inland navigation and land carriage, making in all 5,476,426 tons—an increase of 349,000 tons over the previous year, but the increase was entirely in the quantity arriving by inland navigation and land carriage. 8,809,908 tons of coal, cinders, and culm, of the declared value of £4,165,773 were exported from the United Kingdom to foreign countries and the colonies in the year. This is an increase of 534,000 tons over the previous year.

SOCIAL SCIENCE ASSOCIATION.—At the meeting to be held in Sheffield from the 4th to to the 11th of October next, the special questions arranged for discussion in the departments of Health and Economy and Trade are as follows:—*Health*.—1. In what way can the unnecessary exposure of workmen to dangers of life or health be best avoided, especially in collieries, mines, and manufactories? 2. What are the best means of preventing the spread of contagious diseases? 3. To what extent can the contamination of air in towns be diminished, and by what means? *Economy and Trade*.—1. What are the best means of establishing a system of authoritative arbitration between employers and employed in cases of strikes and outlocks? 2. Can the principles of co-operation be profitably applied to production; and, if so, under what conditions? 3. Is it desirable to consolidate the existing railways of the United Kingdom into one system under Government control? To the department of Education a section of art has been added for the consideration of the following and other questions:—What improvements can be made in the schools, museums, and exhibitions of art, with a view to the development of the public taste and the prosperity of our manufactures?

STRENGTH OF MATERIALS.—It is a remarkable fact, says *The American Artizan*, that one of the most abundant materials in nature—iron—is the strongest of all known substances. Made into best steel, a rod ¼in. in diameter will sustain 9,000lbs. before breaking; soft steel, 7,000lbs.; iron wire, 6,000lbs.; bar iron, 4,000lbs.; inferior bar iron, 2,000lbs.; cast iron, 1,000lbs. to 3,000lbs.; copper wire, 3,000lbs.; silver, 2,000lbs.; gold, 2,500lbs.; tin, 300lbs.; cast zinc, 160lbs.; sheet zinc, 1,000lbs.; cast lead, 55lbs.; milled lead, 200lbs. Of wood, box, and locust, the same size will hold 1,200lbs; the toughest ash, 1,000lbs.; elm, 800lbs.; beech, cedar, white oak, pitch pine, 600lbs.; chestnut and soft maple, 5[illegible]0lbs.; poplar, 400lbs. Wood which will bear a very heavy weight for a minute or two will break with two-thirds the force acting a long time. A rod of iron is about ten times as strong as a hempen cord. A rope 1in. in diameter will bear about 2½ tons, but in practice it is not safe to subject it to a strain of more than about 1 ton. Half an inch in diameter, the strength will be one-quarter as much; a quarter of an inch, one-sixteenth as much; and so on.

PREVENTING INCRUSTATION OF STEAM BOILERS.—Mr. Wm Irwin, of Limerick proposes to mix 6lb. of ochre with a gallon of water, and put the mixture into a boiler, 17ft. by 5ft., to prevent incrustation. In carrying out the patent the inventor employs ochres of various colours—yellow, purple, brown, to suit the eye and taste of the man under whose charge the boiler is placed. A combination of blue with yellow produces a characteristic effect.

Prevention of Steam Boiler Explosions.—This invention of Mr. Peter Riordan, of the United States, consists of an apparatus which combines in itself the steam gauge, water indicator, safety valve regulator, alarm and blow-off. It is urged by the inventor that the ordinary spring balances or weighted levers, as regulators for the safety-valve, are liable to several objections, which arise from the nature of the spring, and the lever as applied to them. The spring balance is too slow to act in cases of any sudden or undue generation of steam in the boiler, and, consequently, always requires the watchful eye of the engineer, in such cases requiring both tripping by the hand, and often a lessening of its tension. Should the engineer be called away it will allow an escape of steam long after the pressure has come down to its nominal standard. This is both dangerous and annoying. It is claimed that the improved machinery not only entirely overcomes these difficulties as a safety-valve regulator, but is also a superior pressure gauge, that will indicate the varying pressure of steam from one pound up to what the regulator is set at, beyond which the pressure cannot get. It is also an accurate and delicate water indicator, showing the varying heights at which the water stands in the boiler. Should the water, through neglect, get very low, it will sound an alarm whistle that cannot fail to attract the engineer's attention. Should the alarm be neglected, and the water fall to a dangerously low level, it will allow the steam to escape through the safety-valve at a very rapid rate, so as to reduce its elastic force immediately, and thus ensure the safety of the boiler.

Our Coal Exports.—The shipments of coal to France presented a very large augmentation in May last, as compared with May, 1864, having been 155,910 tons, against 114,165 tons. For the five months ending May 31st this year, our coal shipments to France were 656,940 tons, as compared with 636,907 tons in 1864, and 555,373 tons in May, 1863 (corresponding periods). The aggregate exports effected in May showed a large increase as compared with the corresponding months of the two previous years, having been 863,295 tons, against 711,144 tons in May, 1864, and 694,975 tons in May, 1863. In the five months ending May 31st this year, the total exports of coal from the United Kingdom were 3,501,090 tons, as compared with 3,385,193 tons in 1864, and 3,160,269 tons in 1863 (corresponding periods). The shipments to Prussia fell off very considerably in the spring of 1864, but in the first five months of this year they more than regained the level at which they stood in the corresponding period of 1863. The exports have declined this year to Spain, Sweden, Prussia, Italy, and the United States but they have increased to the Hanse Towns, Holland, Brazil, British India, &c.

How to make Good Iron.—The importance of employing a flux thoroughly suited to the iron ore under treatment has been carefully pointed out by Professor Fleury, of New York, who remarks that the flux serves a threefold purpose. Firstly, it facilitates the elimination of the iron by forming easily fusible compounds with the silica and alumina in the ore; secondly, it protects the iron from being oxidised again while passing the blast down the hearth; and, thirdly, it serves to deprive the iron of most of its impurities, such as silicon, phosphorus, sulphur, arsenic, &c. The quantity and quality of the flux should be adapted to the kind of ore used. Burnt lime gives a great saving of fuel and an excellent quality of iron with some ores, while with others common limestone and shale, free from quartz veins, give equally good results. The advantage of an occasional chemical analysis of the ores and fluxes used cannot be too much recommended to the ironmaster's attention. Professor Fleury has seen instances, and he is not, probably, the only observer of them, where ironmasters were entirely ignorant of the nature of the flux they used. He saw furnaces worked with the most refractory magnesium limestone that could be found, using at least one-third too much, and, of course, delivering a most excellent quality of *red and cold short pig-iron*. To his question as to the reason of their inferior quality of iron, they answered by accusing the ore: a bad boy, they said, will never make a good man. They little dreamed that by using a better flux, and in much smaller quantity, their iron could be made of good quality and at much less cost.

Preventing Oxidation of Iron and Steel.—According to the patent of Mr. J. B. Chambeyron, of Paris, it is proposed to prevent the oxidation of iron and steel by the forced incorporation of volatile metals having little affinity for oxygen. Tinning, zincing, and leading only give incomplete results, and Mr. Chambeyron has discovered that it is only by incorporating into the iron itself, and to a certain depth, a metal or an alloy little affected by the action of oxygen, and considered practically inoxidisable, that iron and steel can be protected from oxidation in sea and other acidulated waters. The means he employs are to introduce zinc alone in the state of vapour into the iron or steel when they are only to be exposed to the contact of oxygen, and to a volatile alloy or compound composed of tin, lead, and zinc in suitable proportions. The proportions are about one-fifth of lead, one-fifth of tin, one-fifth of zinc, but they may vary when the iron is to remain in corrosive waters. A high temperature being necessary to vaporise the metals to be incorporated. The operation is performed in cementing chambers. To each of the cast-iron heads of the upper retorts is adapted a tube, the lower extremity of which is immersed in the retort, and the upper extremity is terminated by a funnel, which has underneath a spheroidal reservoir, furnished above and underneath with a tap for shutting off communication either with the retorts or with the interior of the reservoir. The metals to be incorporated are poured in a state of fusion into this funnel, whence they fall into the retort, the high temperature of which converts them very quickly into vapour. In case the pressure obtained by the vapour is not strong enough to produce the incorporation, he causes a part of the gas to flow from the gasometer, where it is held in reserve, into the retorts. When the metallic vapours have been incorporated in the pores of the iron and steel they will be condensed there by a lowering of the temperature, which is preceded by the introduction of a certain quantity of borax, which by its volatillisation in the apparatus will fix the incorporated metals. The retorts will then be opened, after having ascertained by means of a pyrometer that the temperature has fallen below that at which the volatilisation of the most volatile metal takes place.

Longevity.—The mortality returns for England in the year 1863, which have recently been completed, record the death of 213 men and 430 women registered as 95 years old or upwards when they died. Twenty-one of these men had reached 100 or upwards, and one at Chelsea was 109; 62 of the women had also completed a century of life or more, and one in the district of West Derby (Liverpool) was 112 years old. Five men and five women died in the year 1863, who, if the register may be relied on, were born before George III. was king. Of the 83 persons who had reached 100, 8 died in London, all on the Middlesex side. The north-western division, with its 2,900,000 people, had 7 of these centenarians in its bill of mortality; the west-midland division, with its 2,100,000, had 11; Yorkshire, with its 2,000,000, only 4; the south-eastern division, with its 1,847,000, had 5; but the south-western, with its 1,835,000, had 11; the Welsh, with its 1,300,000, had no less than 20; the south-midland, with nearly as large a population, 9; the north-midland, with 1,288,000, only 2; the northern, with 1,150,000, also 2; and the eastern counties, with 1,140,000 4.

Price of Land in London.—A piece of freehold ground forming an area of 2,500ft. in Cannon-street, at the corner of Swithin's-lane, was sold recently at auction by Messrs. Fuller and Horsey for £30,600.

Imports of Metals.—While in 1854 the computed value of copper ore and regulus imported into the United Kingdom was £1,236,132, in 1864 it had risen to £2,054,674. Unwrought and partly wrought copper was imported, in 1854, to the extent of £388,090, while in 1864 the imports were valued at £2,206,525. In 1854, unwrought iron, in bars, was imported to the value of £528,074; in 1864 the corresponding value was £625,283. The receipts of silver ore were valued, in 1854, at £521,330, and in 1864, £251,568. Lead, again, was imported to the value of £254,947 in 1854; while last year's imports were value at £611,273. With the exception of silver ore, every metal is now imported in larger quantities than it was ten years since.

The Paris Exhibition.—The *Moniteur* states that the Imperial Commission, after having examined most carefully the numerous projects which have been submitted to it for the Paris Exhibition, has, according to the report presented in the name of its committee of Plans and Constructions, by M. Dumas, definitely adopted the preliminary project prepared by the commissary-general, as answering completely to the different requirements of the Universal Exhibition of 1867. The execution of this plan has been confided to M. Krantz, engineer in chief of bridges and roadways.

Photography.—Mr. John Pouncy, of Dorchester, the inventor of photographic-carbon printing, who has already received the medals of the French and Scottish photographic societies, has just been awarded the medal at the International Photographic Exhibition at Berlin for his photographs in printer's ink. Mr. Pounccy gave a demonstration a few weeks since before the Professor of Photography, the Demonstrator of Chemistry, and a select party of *savants*, all of whom expressed their unqualified praise and approbation and of Mr. Pouncy's method, which Sir David Brewster, before a numerous audience in Edinburgh, at a meeting of the Photographic Society of Scotland, designated as one of the most interesting and important ever submitted to the institution.

Money Coined.—In the year 1864, the large number of 8,656,352 sovereigns were coined at the Mint, 1,758,490 half-sovereigns, 1,861,200 florins, 4,518,360 shillings, 4,253,040 sixpences, 4,158 fourpences, 1,335,048 threepences, 4,752 silver twopences, 7,920 silver pence, 3,440,640 copper pence, 537,600 halfpence, 2,508,800 farthings. The gold coinage of the year amounted to £9,535,597; the silver to £535,194, which was £14,191 over the cost of the metal; the copper to £18,069, which was not very far from double the purchase value of the copper. In the last ten years, 52,696,355 sovereigns have been coined at the Mint, 12,692,316 half-sovereigns, no crowns or half-crowns, 14,380,157 florins, 24,154,339 shillings, 20,200,444 sixpences, 41,580 fourpences, 18,359,110 threepences, 133,445,760 pence, and 152,686,237 halfpence. The work of withdrawing worn silver coin from circulation goes on constantly; it was done in 1864 to the extent of £123,500 (nominal value of the coin), and there was a loss of £16,693 by its recoinage.

Masters of the Royal Navy.—The memorandum submitted to the Admiralty by the Duke of Somerset proposes with regard to officers hereafter entering the service that the separate class of officers employed on navigation duties be gradually abolished. With this view all further entries of second-class cadets have been stopped, and this will allow the master class by degrees to die out of the service. As this effect takes places, executive officers who have passed the examinations which will be required (under the direction of the hydrographer) will be eligible for appointment as "navigating officers" with special rates of pay. The superintendence of the warrant officers' duties with regard to stores and the care of the rigging, now devolving upon the master, will pass to the senior executive officer. The accounts of the expenditure of stores will be examined and checked by the officers appointed for gunnery and navigating duties. The superintendence of holds will be performed by officers selected by the officer in command under the general direction of the senior executive officer. Master's assistants and second-class cadets to have the option of qualifying and passing to the rank of lieutenant, when they would be placed on the sub-lieutenants' list.

Thames Conservancy.—The report of the proceedings of the Conservators of the Thames in 1864 states that since the month of March, 1864, the Conservancy dredgers have been placed in convenient positions ready to supply the materials required for the new Thames embankment, and that it was the manifest intention of the Legislature, as shown by the Thames Embankment Act, that the embankment should be formed of materials dredged from the bed of the river. Unfortunately, owing to difficulties raised by the Metropolitan Board of Works and by their contractors, a portion only of the materials which the dredgers were capable of raising has been taken for the purpose, whereas a considerable quantity of the materials used in forming the embankment has been obtained from the land. The Conservators regret that they have, in consequence, been prevented from compensating by dredging for the volume of water which has been displaced by the construction of the embankment. The Conservators report that eighty-four vessels have been sunk in the river during the year, all of which were raised. Six additional Conservators have been elected to serve on the Board, in pursuance of the Act of 1864, two to represent the owners of shipping, two the owners of lighters and steam tugs, one the owners of passenger steamers, and one the occupiers of docks, legal quays, and sufferance wharves. The Conservators have adopted such measures as they deemed necessary to prevent any accident from explosions of gunpowder on board vessels navigating the river. The receipts of the year amounted to £65,216, whereof £21,903 came from tonnage dues, and £20,093 from the Metropolitan Board of Works for land taken for the Thames embankment. The Conservators are unable to give a favourable report of the result of their application to the Court of Chancery for an injunction to restrain the corporation of Kingston from passing into the Thames the entire drainage of that town and neighbourhood.

Mont Cenis Tunnel.—M. Sommeller, engineer, has prepared a report on the works now going on at the Mont Cenis tunnel. The length of the tunnel between Bardonnèche and Modane is 12,220 metres. By the end of 1864, 2,322 metres were completed on the side of Bardonnèche, and 1,763 on that of Modane, or 4,085 metres in all. Since then, up to the 10th of June, 644 metres more have been bored, so that more than a third of the work has been completed.

Commissioned by the Imperial Government of France.—M. Scrafour and a committee recently visited Woolwich dockyard, attended by a scientific engineer officer from the firm of Messrs. Penn and Co., of Woolwich, and inspected the working of Bray's traction-engine belonging to the dockyard. The committee were officially received by Commodore Dunlop, C.B., Admiralty Superintendent, who accompanied them to see the working of the engine in its ordinary duties at the yard. The object of their visit was to satisfy themselves of the superiority of the engine, as they are commissioned to purchase largely for the French Government should their inspection prove satisfactory.

Sewerage in Paris.—An immense main sewer has been constructed on the right bank of the Seine, which receives the contents of the various sewers on that side of the river, and discharges them into the Seine at Asnières. By this arrangement, a double advantage was attained. The Seine water used by the inhabitants is no longer polluted by the filth from numerous sources, and the shortest possible line was drawn for the main sewer. The work accomplished for the right bank was not, however, applicable to the left, where the sewers discharge into the Seine above the fortifications. It was at first intended to cast the contents into the main sewer at Asnières by means of a pipe crossing the Seine. But, as it was desired to absorb the waters of the Bièvre, which are polluted by tanners and dyers, the main sewer at Asnières was found insufficient. It was, therefore, resolved to construct a second main sewer on the right bank, which would receive exclusively the waters of the left through a siphon placed under the bridge of the Alma. The new main sewer is to open on the Quai de Billy at the Bridge of the Alma, to follow the Avenue Josephine to the corner of the triumphal arch, then the Boulevard de l'Etoile to the Rue de Courcelles, and thence to the Seine. The main sewer to be opened on the left bank will commence at the fortifications near Ivry, continue through the Rue du Chevaleret, absorb the Bièvre at the corner of the Rue Cerisier, descend the Quai St Michel, and cross the river at the Bridge of the Alma.

NAVAL ENGINEERING.

THE ROYAL NAVY.—The annual returns show a list of fourteen iron-plated ships completed, twelve more to be completed in the course of this year, four more, of which the building is still unfinished, but which will be completed in 1865 or 1866, two more designed, or the design in preparation, and five floating batteries long since completed. The first cost of the *Achilles*, including engines and fittings, is stated at £457,614; of the *Minotaur* £426,358; of the *Agincourt* £423,684. There are twelve vessels not armour plated, building or ordering to be built in 1865; one (tank vessel) is complete, four others are launched, three to be launched in 1865, and one in 1866.

THE MACHINERY FOR WORKING THE GUNS OF THE "BELLEROPHON," is exceedingly simple, and will be so arranged as not to interfere in the least degree with the comparatively limited space on the gun-deck. The apparatus for working each gun is placed on the lower deck, while a simple arrangement of wheels and screws will enable a couple of men to manœuvre and train the heaviest guns. Some of the machinery for the 300-pounder guns is now in the fitting-shop, and will be completed in the course of a few days, when it will be subjected to a series of trials under the superintendence of the officials of the establishment. The chief advantage of placing the machinery for working the guns on the lower deck, is that it will be below the water line of the frigate, and consequently quite beyond the reach of hostile shot.

THE "OCTAVIA," 35, screw wooden frigate, 3,161 tons, 500 horse-power, made her official trial over the measured mile course in Stokes Bay, on the 21st ult., preparatory to sailing on her experimental cruise with the frigates *Constance* and *Arethusa*. All three frigates were fitted some three years since with experimental machinery by different engineering firms, and without limit to first cost of the machinery or design of the engines, the object being to ascertain the best form of marine engine, combined with economy in the consumption of fuel, steam, and boiler space. The engines of the *Octavia* were manufactured by Messrs. Maudslay, Sons, and Field, and their chief noticeable features are—the employment of three cylinders, with their cranks placed at an angle of 120° with each other to render the power exerted uniform in its motion, the surface-condensing system adopted, the superheating of the steam, and a peculiar arrangement of working the slides without eccentrics. The details have been fully explained on previous occasions in THE ARTIZAN. The engines drive a Maudslay-Griffiths screw of 18ft. 2in. diameter, 20ft. 3in. pitch, a length of 3ft. 2in., and an immersion of the upper edge of 3ft. 3in. on starting from her anchorage on this occasion for the measured mile, the ship's draught of water at the time being 20ft. 10in. forward, and 23ft. 10in. aft, with 248 tons of coal on hoard, and complete in stores for sea service. The wind was very light from about south-west, and the condition of the weather altogether as favourable for developing the ship's speed at its highest possible rate as could be wished for. The general results of the day's trial were as follows, full boiler power being used:—No. 1 run, time 4 min. 41 sec.; speed of ship, 12·811 knots; steam, 24 lbs.; vacuum, 26 in.; revolutions of engines, 67. No. 2 run, time 6 min. 6 sec.; speed, 9·830 knots; steam, 25½lbs.; vacuum, 26 in.; revolutions, 68½. No. 3 run, time 4 min. 31 sec.; speed, 13·284 knots; steam, 26 lbs.; vacuum, 26 in.; revolutions, 69. No. 4 run, time, 6 min. 8 sec.; speed, 9·783 knots; steam, 25½ lbs.; vacuum, 26 in.; revolutions, 69. No. 5 run, time, 4 min. 28 sec.; speed, 14·432 knots; steam, 26 lbs.; vacuum, 26 in.; revolutions, 69. No. 6 run, time, 6 min. 10 sec.; speed, 9·729 knots; steam, 26 lbs.; vacuum, 26 in.; revolutions, 68½. The mean speed of the ship by the six runs was 11·536 knots. The temperature of the superheated steam during each of the six runs was 325°, 323°, 325°, 326°, 326°, 326°. Two circles were made, also with full boiler power, with these results:—Helm to starboard. Time in getting helm up, 1 min. 13 sec.; angle of rudder, 23°; turns of wheel, 2·5; men at wheel, 10; half circle made in 2 min. 58 sec.; full circle made in 5 min. 46 sec. Helm to port.—Time in getting helm up, 1 min.; angle of rudder, 25°; turns of wheel, 2·5; men at wheel, 13; the half-circle was made in 3 min. 6 sec.; the full circle in 5 min. 52 sec.

NAVAL APPOINTMENTS.—The following appointments have taken place since our last:—G. S. Newton and J. Smith, Acting Second-class Assist.-Engineers to the *Indus*, as Supernumeraries; J. H. Smale, Chief Engineer to the *Scorpion*; R. Widdecombe and W. T. Bray, First-class Assist.-Engineers to the *Scorpion*; J. A. Kitts and J. Davis, First-class Assist.-Engineers to the *Gannet*. The following Engineer officers of Her Majesty's navy have successfully passed in their educational examinations before Dr. Joseph Woolley, the Admiralty Director of Education:—First-class certificates—George James Barber and Ebenezer E. Lucas, as First-class Assist.-Engineers. Second-class certificates—Joseph Lovering and John Rosser Allen, Assist. Chief Engineers; Joseph Dearden, Richard Biddle, and Walter Thomas Fry, Engineers; James Duffield, Acting Engineer; Charles Hetherington, John Hill, Henderson Leslie, Andrew Lloyd, John William Nott, Joseph Rotheray, Thomas W. Saunders, Nathaniel Stearn, and Samuel Swan, Engineers; Matthew Black, Edwin Cowley, James Hook, William Robson Henry, Robert H. Holme, George Macleod, and George Thomas Ludlow, Assist.-Engineers of First-class; Charles Platt, Engineer; Arthur Shanks and John W. Warner, Assist.-Engineers of First-class; Henry Scott, Assist.-Engineer of Second-class. The following Engineers and Assist.-Engineers, belonging to the Sheerness Steam Reserve, have also received second-class certificates of efficiency for having successfully passed the half-yearly examination:—William Dark, Engineer, to the *Fearless*; William Ross, Engineer, to the *Icarus*; Richard E. Taplin, Engineer, to the *Pigeon*; S. J. Bird, First-class Assist.-Engineer, to the *Collingwood*; George Sullivan, First-class Assist.-Engineer, to the *Bellerophon*; James Bell, First-class Assist.-Engineer, to the *Orestes*; O. T. V. Forster, First-class Assist.-Engineer, to the *Cumberland*; James Mutter, First-class Assist.-Engineer, to the *Thrasher*; James J. Conway, First-class Assist.-Engineer, to the *Cumberland*; and J. W. Dupen, Second-class Assist.-Engineer, to the *Adder*. The following naval engineer students have received their examination tickets at Woolwich, from Dr. Wooley, by order of the Board of Admiralty:—Mr. J. T. Trickett, Mr. J. M'Garahan, Mr. Robert Madge, Mr. William Milln, Mr. William Giles, Mr. Peter Baldwin, Mr. Thomas Parker, Mr. John Mather, Mr. William Hardee, Mr. William Nicholson, Mr. William Stewart, Mr. Thomas Hatton, Mr. Joseph Jefferies, and Mr. William Harris. The examinations were conducted with great secrecy. The questions were transmitted to each candidate under a sealed cover, and the answers were returned to Dr. Wooley in a like manner.

STEAM SHIPPING.

SHIPBUILDING AT WATERFORD. The *William Penn*, screw steamship, was launched on the 10th ult. from the building yard of the Neptune Iron Works, at Waterford. Her dimensions are—Length, 330ft.; breadth, 38½ft.; depth, 29ft.; tonnage, 2,800 tons; burthen, 4,000 tons. The *William Penn* is the property of Messrs. Malcolmson Brothers, Waterford, and Mark-lane, London, and is intended for the London, Havre, and New York line. She is fitted with all the modern scientific and mechanical appliances for working the ship and cargo. Her cabins are elegantly fitted and ventilated, and nothing has been left undone to ensure comfort for passengers. Her engines are fitted with Horn's patent valves and condensers, and she is in every respect well fitted for her station. This splendid ship was designed by Mr. John Horn, of Waterford, superintendent for the company, and is the twenty-second steamship he has added to their extensive fleet.

STEAM SHIPBUILDING ON THE CLYDE.—Mr. J. G. Lawrie, of Whiteinch, has launched a screw named the *Baron Ricasoli*, intended to trade in the Mediterranean, and built to the order of Messrs. Pellas, of London. Mr. Denny, of Dumbarton, has launched a powerful tug named the *Court Hey*, intended to form part of the towing flotilla of Messrs. Gladstone, Wylie, and Co., of Liverpool. Her dimensions are as follows:—Length of keel and fore-rake, 160ft.; breadth of beam, 25ft.; depth moulded, 15ft. 8in. Messrs. Denny and Brothers have launched the *Martaban*, a screw of 610 tons, for the Irrawaddy and Burmese Steam Navigation Company; she is being fitted with engines of 120-horse power. Messrs. A. Stephen and Sons, of Kelvinhaugh, have launched a screw of 450 tons, named the *Sarah Garcia*, and intended to be employed in the Mediterranean fruit trade by Messrs. Simon Garcia and Co., of Glasgow; the steamer is being engined by the Finnieston Steamship Works Company. Messrs. W. Symons and Co., of the London Works, Renfrew, have launched a screw named the *Count Von der Bosh*, of 120-horse power, and 900 tons burden. She has been built for the Netherlands Steam Navigation Company. Messrs. Tod and Macgregor, of Patrick, have launched a seventh steamer constructed by them for the Glasgow and Stranraer Steam Company. This steamer has been constructed to meet the special requirements of the Stranraer trade, and she is being fitted with a pair of direct-acting surface condensing engines of 60-horse power nominal, with inverted cylinders of 30in. diameter and 22in. length of stroke.

LAUNCHES.

THE LAUNCH OF THE "RUHR," from the yard of Messrs. J. Wigham Richardson & Co. at Low Walker, took place on the 15th ult. The *Ruhr* is intended for one of the Prussian Government railways, and will carry trains of carriages across the Rhine, and for that purpose has three lines of rails on deck, and the space below the deck is handsomely fitted up with cabins for passengers. Her dimensions are—length, 183ft., beam 27ft., depth, 9ft. Her engines have been constructed by Messrs. Thompson, Boyd, and Co., at their Spring Garden Works, Newcastle.

TELEGRAPHIC ENGINEERING.

THE MALTA AND ALEXANDRIA TELEGRAPH.—The Malta and Alexandria line has been leased to the Telegraph Construction and Maintenance Company for a period of 46 years. The lessees oblige themselves to pay Government £15,000 a year for the rent of the line, and to keep it in proper repair, and deliver it over to Government, after the expiration of the above term, in good working order.

THE ATLANTIC TELEGRAPH CABLE—A comparison between this cable and the last may be interesting. The last had seven wires, and this has seven; but there the resemblance ceases. The seven wires in the one case weighed 107lb. per nautical mile; in this instance, 300lb. The insulation in 1858 was by three layers of gutta percha, weighing 261lb. per knot; the present insulator is in four layers, weighing 400lb. The external covering then was by 18 strands of the spiral wires; now it is by 10 solid wires of homogeneous iron, each wire "served" with Manilla yarn, saturated with a preservative compound. The weight in air then was 20cwt. per mile; this is 35¾cwt. The weight in water was 13·4cwt. per mile; now it is 14cwt. The breaking strain was 3¼ tons; now it is 7¾ tons; and while the strength of the former cable was 2·05 times the strength required for the deepest water, this is 4·64 times stronger than is deemed absolutely necessary. Finally, the length shipped for 1858 was 2,174 nautical miles; now it is 2,300 knots.

THE UNITED KINGDOM TELEGRAPH COMPANY have announced the abandonment of the uniform shilling rate, after a four years' trial; the public, they say, not having supported it to a sufficient extent. Henceforth the charges are to be, for 100 miles, 1s. for 200, 1s. 6d.; and for all distances above 200, 2s.

THE ANGLO-INDIAN LINE OF TELEGRAPH now brings Sydney within twenty-three days of London. The first message to Australia by this route is stated in the *Railway News* to have been despatched from London on the 20th of March, and received in Melbourne on the 19th of April: it would have arrived as early as the 13th, but for the breaking down of the *Madras*.

THE NEW SUBMARINE TELEGRAPHIC line just laid down from La Calle in Algiers to Bizerte and Marsala in Sicily, has now been opened for public and private despatches. The tariffs are reasonable, being for twenty words between any office in Algeria and any office of France, Corsica, or the Roman States, 6s. 5d.; to Italy, 4s. 9½d.; Bavaria, Belgium, Duchies of Baden and Luxemburg, 8s.; Prussia to the west of the Weser, 8s. 5d.; ditto to the east of the Weser, 8s. 9½d.; Spain, 8s. 9½d.; Portugal, 10s. 4½d.; beyond these places the prices vary according to the telegraphic treaties of Berne and Brussels. For every ten words above the twenty allowed by the above rates, the charge is increased by one-half.

RAILWAYS.

LONDON BRIDGE TO EUSTON SQUARE.—The new railway route from London Bridge to Euston-square, by way of Waterloo and Kensington, which is intended to afford direct communication between the South Coast and the North of England and Scotland, has been opened. There will be ten trains each way daily (Sundays at present excepted), between Kensington and Waterloo, Blackfriars, and London Bridge stations direct, while there will be fourteen trains each way daily (on week days only) between Waterloo, Blackfriars, and London Bridge stations.

THE METROPOLITAN DISTRICT RAILWAY, one of those sanctioned in the last session of Parliament with a view to connecting lines in London, has been begun at several points. Among these, that in Earl-street, Blackfriars, is 30ft. below the London, Chatham, and Dover Railway; from thence it will pass beneath the new street to the Mansion House, and in a westerly direction along the new embankment of the Thames. The line, which will relieve the London and Brighton Railway Company's main line of the sole charge of traffic to and from the Crystal Palace, will soon be completed. It will use the terminus which is just opposite to the central transept of the palace.

METROPOLITAN RAILWAYS.—The *Railway News* considers it a moderate estimate to put the various railway work now in hand, or shortly to be commenced, in and around London, at an aggregate length of 120 miles, and involving an outlay of £30,000,000.

A REDUCTION IN FARES on the North-Eastern Railway has taken place. Their summer arrangements, which date from the 1st ult., not only include a greater amount of express trains, but the fares are reduced over the whole system by sums which will affect the receipts at first fully 30 per cent. The third-class and the Government are now uniformly 1d. per mile; the old third-class, 1¼d. per mile, is abolished; the second-class fare is reduced from 2d. to 1½d. per mile, and first-class from 3d. to 2d. per mile.

RAILWAYS IN INDIA.—Mr. Juland Danvers, the Government director of the Indian Railway Companies, has to state in his annual report, just issued, that the present system of guaranteed railways comprises a length of 4,917 miles, of which 3,186 are now open for traffic. The net profits in the year ending the 30th of June, 1863, on 2,151 miles of railway, amounted to £690,834; and to £915,077 in the year ending the 30th of June, on 2,489 miles. The number of passengers conveyed in the latter year was 11,781,683, compared with 9,212,540 in the former. The total expenditure of capital on the lines which are open, or in course of construction, amounted on the 1st of May, 1865, to £54,942,029. The expenditure this year, it is estimated, will amount to rather more than £5,100,000—about £1,800,000 to be expended in England, and £3,350,000 in India.

The total amount estimated to be required for the undertakings, as now sanctioned, will reach £77,500,000. The number of shareholders at the end of the year 1864, was £29,303 in England, and 777 in India, the latter number consisting of 384 Europeans, and 393 natives. There were also 6,453 debenture holders. Up to the end of 1864, the Government had advanced £13,160,539 to the railway companies for guaranteed interest, but about £3,300,000 had been paid back out of the earnings of the railways, leaving nearly £10,000,000 still due to the Government. The charge upon the Government was £2,567,743 in the past year, and by the 1st of January next it will probably have increased to £2,700,000; but the receipts from the traffic which go in diminution of this, and which in the year 1863-64 amounted to about £1,000,000, will in 1864-65 probably reach £1,300,000. Year by year the revenues will approach nearer and nearer to the amount of the guaranteed interest, and at last the Government will not only be relieved of the annual payment altogether, but the railways will begin to earn more than the guaranteed rate, and to discharge their debt for previous advances out of half the excess profits above 5 per cent. Although it will be some time before the Government will receive back the large sum due to them, there is enough in the present condition of the lines to encourage the hope that ultimately it will be paid, and in the meantime the State obtains advantages which fully compensate for the liability it has incurred. Mr. Danvers holds that no country in the world will derive greater advantages from railways than India; that the traffic on the main lines may be expected to be enormous, and when they earn 6, 8, or 10 per cent. the difficulty which now exists in inducing capitalists to promote public works in India will be removed.

RAILWAY ACCIDENTS.

An Accident to the Express Train to Norwich on the Great Eastern Railway, took place on the 1st ult. The train, which was somewhat behind time, had approached within about two miles of Norwich, and had just passed under what is known as the Lakenham viaduct, when the driver felt the engine give a violent jerk. He had just previously shut off steam, but was running at from 30 to 40 miles per hour. When he felt the jerk he at once gave three whistles to the guard to apply his break, and the fireman proceeded to put in force the tender break. The leading wheels of the engine remained on the line, but the driving wheels tore up the permanent way, breaking the chairs and ploughing up the ballast. After running about 120 yards the train approached a long wooden bridge which carries the line over a shallow steam and some swampy ground on either side. On reaching the bridge all the wheels of the engine left the metals, and a scene of confusion ensued. The locomotive plunged across the bridge; but although the rails were torn up and bent, and the driving wheels ploughed and ground into the timbers, the engine was landed on the other side, where the ballast recommenced. Then it flung itself across the up-line, the wheels became embedded in the ballast, and its progrsss was at last stopped. The train had been dragged somehow across the bridge, notwithstanding the tearing up of the rails by the engine, and, marvellous to relate, not one of the carriages was thrown into the stream below, and no one seriously hurt.

Accident on the Great Western Railway.—An accident occurred on the 22nd ult. near the Twyford station, and but for the precaution of the engine driver might have been attended with serious consequences. It appears that the through train for Exeter, leaving Paddington at two o'clock, and which is not timed to stop until it reaches Reading, at 2·55 proceeded safely until within two hundred yards of the Twyford station. At that point a gang of platelayers were employed on the down line, and they had out some cross timbers, known as "transoms," when the train came in sight, running at full speed. The engine driver saw there was danger, and his presence of mind prevented what must have been a serious accident, for no less than eight carriages ran off the metals and tore up the permanent way, but the train was brought to a standstill before the platform was reached, and the carriages which had been dislodged were thus prevented from coming into collision with the stonework of the platform. The passengers were much shaken, but not injured.

DOCKS, HARBOURS, BRIDGES.

Opening of the Ramsdale Valley Bridge, Scarborough.—The greatest processional demonstration ever made in Scarborough was on the occasion of opening the Ramsdale Valley Bridge, which recently took place. The fallen girders of the iron lattice bridge across the Ouse at York were used in its construction. The contract for the work was taken by Mr. Ald. Cabry, of York, under the direction of Mr. E. Clarke, the engineer. The bridge is now completed, with the exception of a few minor details, and it has been opened as a public toll-bridge.

The New Bridge at Blackfriars.—This new bridge which is about to span the Thames at Blackfriars will be a very stately edifice, resembling in its general features and in its great width and easy inclination that at Westminster, but differing in ornamentation and in some respects in the mode of construction. It will be of five arches, and 963ft. in length from bank to bank, the width being 75ft., or 9ft. less than that of Westminster-bridge. The entire waterway available for navigation will be 844ft., as compared with 787ft., which the old bridge gave, and below the centre arch there will be 25ft. of headway above Trinity high-water mark. The steepest inclination will be 1 in 40, that of the old bridge being 1 in 18, and it will be 40ft. wider. The footways on each side will be 15ft. wide, or exactly double the width of those of the old bridge, while the carriage-way will be 45ft. broad, as compared with 27ft. 6in. It is estimated to cost in all about £320,000 including £30,000 in respect of the erection and eventual removal of the present temporary structure. The foundations of the new bridge will be laid by means of iron caissons, of which there will be six in each pier, four of them 36ft. in length by 18ft. wide. All the principal caissons will be sunk to an average of more than 20ft. below the bed of the river, and 44ft. below Trinity high-water mark. The cutwater part of each pier will also be borne on caissons. The piers will all be of granite, ornamented with columns of red polished granite, having bases and capitals of Portland stone. The massive abutments at either end of the bridge will also be constructed of granite and enriched with cornices of Portland stone. Each of the two land arches will have a span of 155ft., the two next of 175ft. each, and the centre arch one of 184ft. The bridge will be precisely parallel with the new viaduct of the London, Chatham, and Dover Railway, and the piers of each will correspond in position, so as to offer the least possible obstruction to the navigation. The arches will be wholly of wrought iron. The bridge will be surmounted by an iron balustrade, 3ft. 9in. in height, from the foot pavement, on each side, from end to end.

A Portion of the Double Bridge at Paris by which the Auteuil Viaduct of the circular railway traverses the Seine, at the Pointe du Jour, was opened for the traffic of vehicles on the 1st ult. The structure consists of two series of arches, one over the other, the upper one carrying the railway, and the lower one serving for general circulation. The latter is composed of five semi-elliptical arches, of 99ft. 1in. span each, and two land arches, one at each end, of 65ft. 7½in. span. Above this stands the viaduct, the level of rails being 67ft. 3in. over the water: it commences at the Auteuil station, and terminates on the left bank of the river, about a kilometre from the bridge, and throughout its whole length there is a double arcade for foot passengers. At the base of the viaduct on the lower bridge a roadway on each side, 28ft. wide, bordered by a footpath, 6ft. 6in. wide, has been constructed for vehicles, the bridge being 116ft. 10in. wide between parapets, and 36ft. 5in. high over the water. One of these passages is the portion opened a short time since; it places Auteuil in direct communication with the Route de Sèvres and the military road of the fortifications.

Lighthouses.—The lights on land, or lighthouses which are at the highest elevation, with the distances they command in clear weather, are given in the following table, compiled from the general return published by the Admiralty:—

	Year when erected.	Height of Lantern above high water. Feet.	Distances at which the lights are seen. Miles.
Lizard	1751	224	20
Needles	1786	469	27
Beachy Head	1828	285	22
South Foreland	1793	372	25
Cromer	1719	274	22
Flamborough Head	1806	214	19
Inchkeith	1804	220	18
Isle of May	1816	240	21
Dunnet Head	1831	346	23
Sumburgh Head	1821	300	22
Cape Wrath	1828	400	25
Barra Head	1833	680	32
Kintyre	1787	297	22
Mull of Galloway	1830	325	23
Calf of Man	1818	375	22
St. Bee's Head	1718	333	23
Lundy Island	1820	540	30
Cape Clear	1817	455	27
Clare Island	1806	349	27
Skellig's Rock	1826	372	25

MINES, METALLURGY, &c.

Coal in Algeria.—It is reported that a large vein of coal, 14 kilometres (nearly 8½ miles) in extent, has been discovered near Philippeville. If this be true, France may reap much greater benefit than ever she expected from her colony; and, perhaps, only as a beginning of this, coals via Marseilles will not cost 50fr. a ton in Paris.

Mineral Wealth of Bolivia.—Mr. Vice-Consul Joel states that in the neighbourhood of Calama, 135 miles to the eastward of the port of Cobija, there are almost inexhaustible veins of copper of excellent quality, and of lead containing a high per centage of silver. But the cost of transporting the ore by pack mules to the coast is so great, from there being no vegetation and no water for a distance of 90 miles, that until a road for wheeled vehicles be made, the immense mineral wealth of that locality will lie dormant. The same causes militate against the exportation of borax, fields of which, miles in extent, exist near Ascotan, at the foot of the Andes, about 100 miles east of Calama. The projected railway from Iquique, in Peru, to the interior of the Republic, for which Messrs. Peto and Betts entered into a contract with the Bolivian Government, has been for the time abandoned, in consequence of the late revolution which overthrew the constitutionally-elected President.

The Tin Plate Trade.—The quarterly meeting of the members of the trade was held on the 5th ult. Fifteen or sixteen makers were either present or represented. It was reported that the trade upon the whole was in a more satisfactory state than for several years past, and confident hopes were expressed that before long there would be an active demand from the United States, which formerly were such large customers in tin plates. Buyers were represented to show remarkable readiness in giving out orders, which was an encouraging feature in the trade. Stocks in the hands of makers have been materially reduced, and are at present smaller than for the past four or five years, and this fact, coupled with the increased demand and the decrease in the make in consequence of the hot weather, was considered of sufficient importance to justify an advance of 2s. per box.

The Precious Metals.—The following interesting items are from M. Roswag's new work on the subject, entitled *Les métaux précieux*. From the year 1500 to 1848 America yielded 27,122 millions of francs in silver, and 10,028 millions of francs in gold. These numbers comprise 13,774 millions of silver drawn from Mexico, 43,059 from Peru and Bolivia, 230 from Chili, and 58 from New Grenada. As to gold, the share of Brazil was 4,625 millions of francs; that of Grenada, 1,952; of Mexico, 1,341; of Peru and Bolivia, 1,172; of Chili, 862; and of the United States, 76. Europe during the same period only produced 2,330 millions of francs in silver, and 1,600 ditto in gold. Africa yielded 2,500 millions from Guinea. Hence the total quantity of precious metals existing in 1848, including 1,000 millions supposed to exist before 1500, formed a total of 44,578 millions of francs—viz., silver, 30,152, and gold, 14,426. From 1848 to 1857 the stock of precious metals has been increased by 2,170 millions of francs of silver, and 6,004 of gold. Of the latter, California has produced 2,508 millions, and the rest of America 445. Australia has yielded 1,695, and Europe 743, including Russia for 678 millions. Asia has contributed 505 millions, and Africa 108. Of silver, Australia has yielded 9 millions; America, 1,827; Europe, 321; and Asia, 22, forming a total of 2,179 millions of francs. There consequently exist at present in the world 32,331 millions of francs of silver, and 20,430 of gold. The ratio of gold to silver, which before 1848 was as 1 to 2, is now as 2 to 3. In weight there existed before 1848 about 31 kilogrammes of silver for every kilogramme of gold; in 1856 this proportion had fallen to less than 24 kilogrammes of silver for one kilogramme of gold. Since 1856 the total annual increase of the precious metals may be stated at 240 millions of francs of silver, and 500 of gold, being more than double the former.

A Mountain of Silver.—Silver Peak, states the *New York Journal of Commerce*, is believed to be as pre-eminent over all silver mountains as the Iron Mountain of Missouri is superior to all other iron deposits. Silver Peak is situated east of San Francisco, on the eastern side of the Sierra Nevada, and nearly one degree south of the city of Austin. It is some two miles from Castle Mount, an old extinct crater about 5,000ft. above ocean level. Near Silver Peak is an extensive deposit of salt, and not far distant a hill of pure sulphur. The whole country has a naked appearance, being quite destitute of vegetation, and bristles with mountains scattered over a plain of great extent. The dreaded "Valley of Death," upon the plains of which, along the "old Spanish trail," travellers have suffered so much, lies but a short distance to the south-east of the crater of Silver Peak. Little Salt Lake, in Southern Utah, lies directly east of Silver Peak. At first the searchers after deposits of the precious metals confined their searches to the Pacific side of the Sierra Nevada, but discoveries in New Mexico, Arizona, and Virginia city induced a thorough examination of the east side of the Sierra Nevada. This resulted in great success, the most brilliant of which is found in the neighbourhood of Austin, on the line of the great overland mail, where a city has sprung up within three years which, Senator Nye says, contains a population of 10,000. From along this line of exploration the miners are rapidly extending their operations, both north and south. Recently (within six months) they came upon this immense deposit near Castle Mount. Twelve exceedingly rich lodes, or "ledges," as the miners call them, were discovered on that single mountain. This discovery in an unexpected region is believed to be the most valuable yet developed. The specimens—a great number of which have been brought to New York by Colonel Catherwood—are certainly very remarkable, and merit the attention of the whole financial community. If there is no mistake—and with the specimens actually before us we do not see how there can be—a new deposit, superior even to the Comstock lode, which has furnished so many millions of silver, is about to pour into our market its limitless supply of this precious metal.

ACCIDENTS TO MINES, MACHINERY, &c.

EXPLOSION OF THE "ANTI-EXPLOSIVE POWDER" MILLS.—On the 4th ult., a conflagration occurred at Kellow and Short's powder mills, resulting in an explosion which demolished one entire block of buildings and damaged several others, but no lives were lost. The cause of the explosion, as of five or six others which have happened during the two or three years that the manufacture has been carried on, appears to be enveloped in mystery. A large quantity of sulphur and nitrate of soda was in stock, yet but little chlorate of potash. No powder had been manufactured on the premises for some months, the company being about to wind-up.

GAS SUPPLY.

THE JEDBURGH GAS COMPANY have resolved on a dividend at the rate of 10 per cent. on the year's transactions, and also to reduce the price of gas from 7*s.* to 6*s.* 10*d.* per 1,000ft.

THE TOWYN PEOPLE have resolved to construct gasworks without delay. At a meeting held at the Town Hall, it was proposed and carried, that Mr. W. E. Crake, C.E., of London, be the engineer of the works during the progress of erection, and that tenders for building, laying the mains, &c., be solicited, as soon as the plans and specifications are prepared.

AT LYNN, Mr. Malam, the proprietor of the gasworks, has determined to reduce the price of gas to private consumers to 4*s.* per 1,000 cubic feet, by allowing 1*s.* per 1,000 discount from the price charged if paid within a month.

AT WHITEHAVEN, a very unusual case has occurred, which tends to define the lowest limits of price under favourable circumstances. The Whitehaven gas company, who had been selling their gas at 2*s.* 6*d.* per 1,000 cubic feet, have felt obliged to raise the price again. Considering, however, that 2*s.* 9*d.* is a price which has been proved at Plymouth to be capable of yielding the highest allowable profit, the Whitehaven directors are probably erring now on the other hand in raising their price to 3*s.* 4*d.* to all consumers of less than 75,000ft., and *s.* to all above that quantity. The two companies have companies have combined to charge the same prices. Had there only been one company, perhaps even 2*s.* 6*d.* might have been found sufficient.

THE HINCKLEY GAS-LIGHT and Coke Company's directors have reduced their price from 5*s.* 10*d.* to 5*s.*

THE WOLVERHAMPTON GAS COMPANY have commenced additions and improvements at their works. In addition to an enlargement of the retort-house and other improvements within the Stafford-road works, a new 24-inch main is being laid along the turnpike road.

A COMPANY FOR LIGHTING MADRID with gas has been formed by some Franco-Spanish capitalists, through the medium of the Spanish Crédit Mobilier. The company begins its operations on excellent conditions, as, from the opening throughout of the Northern of Spain Railway, the price of coal has experienced a notable fall at Madrid. The working of coal mines in Castile, which belong to the Mobilier Espagnol, is being developed, and presents good results.

IN THE CITY the public meeting of ratepayers and gas consumers convened by the Lord Mayor of London, has been held, and resolutions unanimously passed to the effect that the supply of gas ought to be placed in the hands of local authorities, so that, after lighting the public lamps, the private consumer might get gas at cost price; and that the Gas Act of 1860 ought to be repealed. The meeting also urged the necessity of steps being taken towards that end, and approved of the measures adopted by the Corporation with the view of applying to Parliament for powers to make gas for the citizens.

COMPOSITION OF THE GAS OF SOME CONTINENTAL CITIES:—

	Heidelberg.	Breslau.	Bonn.
Hydrogen	41·05	40·70	39·80
Marsh gas	10·71	39·82	43·13
Carbonic oxide	7·64	4·01	4·66
Condensible hydrocarbons	7·28	4·96	4·75
Carbonic acid	0·58	0·41	3·02
Nitrogen	2·75	10·10	4·65

The analysis were made according to Bunsen's method.

WATER SUPPLY.

WATERWORKS.—The Select Committee of the House of Commons to whom the Waterworks Bill was referred last Session reported to the House that in their opinion, in consequence of the great danger to life and property attending the storing of water for manufacturing and other purposes in large reservoirs, it is expedient that the plans for the construction of any such reservoir should be submitted to the Home Office or the Board of Trade, and a competent person be sent to report upon the site and plans; and also that when the works are being constructed, and when they are completed, they should be inspected, and it should be competent to the Home Office or Board of Trade then to prohibit water being let into the reservoir. The committee recommend that an adequate supervision be maintained over all large reservoirs from time to time after their construction, lest they should be allowed to decay and become dangerous. The committee do not propose that the responsibility of undertakers of waterworks to pay damages should be diminished by this inspection and supervision; but, on the contrary, that the law upon this subject should be stringent and completely unambiguous. Believing that it would require much time and great consideration to give effect to these suggestions by legislation, the committee determined to proceed no further with the Bill referred to them. They recommend that a measure embodying their views should be submitted to the new Parliament by the Government.

OPENING OF THE NEW CORNISH ENGINE OF THE LEEDS WATERWORKS.—For some time past complaints have arisen with respect to the short supply of water in the borough, and the corporation, very properly, took steps towards providing additional pumping power, in order to increase the said supply. Up to 1862, the corporation had power to pump from the river Wharfe two and a-half million gallons of water per day, but the extraordinary prosperity of the borough in its various industrial branches had at that time nearly absorbed the supply, and in 1862 it was found necessary to go to Parliament to obtain powers to pump from the Wharfe three and a-half millions additional, thus making the amount of water which can be supplied to the borough six millions a day. To distribute this to the inhabitants fresh pumping power was necessary, and in 1863 contracts were entered into by the corporation with Messrs. Whitham and Son, who had erected the engines of 1856, for the construction of a large engine at Arthington, and with Messrs. Longley and Son for the erection of the building for its reception. The engine has now been erected, and formally opened. It is an engine of 300 horse-power, with a cylinder of ninety inches diameter and eleven feet stroke, the pump being thirty inches diameter. The engine, which is massive and ponderous in its proportions, is a Cornish engine, and is distinguished above every other for its economy in the amount of coal consumed; and attached to it are five boilers, 34ft. long and 6ft. 6in. in diameter. A conception of the immense power it can exert may be gathered from the fact that at every stroke it pumps 330 gallons of water, and that eight strokes are recorded every minute, so that fully three and a half million gallons are pumped daily, or one million gallons more than the two engines already at work. The cost has been about £10,000, exclusive of the building, the entire expenditure having been about £16,000. Some idea of the gradual progress of the demand for water will be gathered from the fact that while in 1856 the daily consumption was 1,596,000 gallons, it is now considerably more than 4,000,000 gallons per day. It was owing to this immense increase that the supply has been to some extent restricted; but now that the new machinery has been got into operation, in a very brief space the water will once more be turned on both day and night.

APPLIED CHEMISTRY.

SILICIUM IN THE MANUFACTURE OF STEEL.—Dr. T. L. Phipson has ascertained by a series of careful experiments that the effect produced by the silicium present in pig iron, intended for conversion into steel, varies according as the silicium is free or combined. In support of this opinion, he refers to analyses of three pig-irons—A, B, and C, each containing all its elements in almost exactly the same proportions. The total silicium in A amounted to 4·20 per cent., that in B to 3·96 per cent., and that in C to 4·23 per cent., but the 4·20 per cent. in A was made up of 3·22 per cent. of free silicium and only 0·98 per cent. of combined, while the 3·97 per cent. in B was composed of 2·15 per cent. of free and 1·81 per cent. of combined silicium, and the 4·23 per cent. in C of only 1·63 per cent. in the free state, with as much as 2·60 per cent. in a state of combination. Inasmuch as "A made tolerably good steel, B very indifferent steel, and C steel so bad that it cannot be worked at all." Dr. Phipson, therefore, concludes that the presence in pig-iron of a large quantity of silicium will not prevent its conversion into good steel, "provided the silicium be almost entirely in the free state."

EXTRACTION OF GOLD AND SILVER FROM THEIR ORES.—Dr. J. C. Ayr, a well-known American chemist, has proposed an improved method of disintegrating and desulphurising ore. It is claimed that the process is effectual in the disintegration and desulphurisation of rock and ores by the application of liquid or liquid solutions while in a heated state. The rock or ore is rendered soft or friable, and may be easily reduced to powder, while the volatile metals are, at the same time, expelled, and the base metals oxydised. This leaves the gold and silver free for amalgamation. The great recommendation of the process is that it not only destroys the rock without dividing the gold and silver, but also expels, by chemical action, any volatile metals, such as arsenic, antimony, or bismuth, whose presence forbids amalgamation by mercury; while, if sulphurets are present, the oxygen of the decomposed water used in the process unites with the base metals, which remain as oxides, and the sulphur, uniting with the hydrogen, goes off in clouds as sulphuretted hydrogen. Hence mines that have been abandoned because they could not, although rich, be profitably worked, for any of the above reasons, may now afford a munificent return, and even the "tailings" of the working mines yield more gold than has hitherto been obtained from the mines themselves by the old method. Highly sulphuretted ores are frequently among the richest that are found, but they have been nearly worthless, in consequence of the insuperable difficulties of extracting the metals from them. Now those difficulties appear to be wholly removed—difficulties which have locked within the rocks an untold amount of bullion.

THE EXTRACTION OF SUGAR.—M. Alvaro Reynaso, of Havannah, uses acid phosphate of alumina, which he neutralises carefully with lime for clarifying the cane juice. Alumina and phosphate of lime are precipitated, and carry down effectively the colouring and nitrogenised bodies. The author has also an ingenious way of getting rid of the bulk of the water in the juice. By some process described in his memoir, but not quoted in the *Comptes rendus*, he submits the juice to a very low temperature, and so gets a magma composed of thick syrup and little lumps of ice. He separates the syrup from these by means of a centrifugal machine, and then evaporates quickly *in vacuo*.

THE AMINES OF BENZOIC ALCOHOL.—M. Canizzaro describes the method by which he obtained dibenzylic toluidine:—

$$N\begin{cases}(C_7\ H_7)a\\(C_7\ H_7)b\\(C_7\ H_7)b\end{cases}$$

in which formula $(C_7\ H_7)a$ stands for cresyle, and $(C_7\ H_7)b$ for benzyle. The behaviour of the platinum salt of the weak alkaloid proves it to be isomeric with tertiary bezylamine. The author has made many attempts to prepare primary benzylamine free from the secondary and tertiary amines but without success. He finds that the greater part of the chloride of benzyle is always converted into secondary and tertiary alkaloids—a fact which connects the benzoic with the methylic series. M. Canizzaro intends to continue the comparative study of primary benzylamine and toluidine. Considering phenols as bodies intermediary between alcohols and acids, he regards aniline and similar alkaloids as coming between amines (those properly so called) and amides; and he hopes to show that while toluidine, in acting upon other alkaloids by incomplete substitution, disengages ammonia and replaces hydrogen by the radical cresyle $(C_7\ H_7)a$, benzylamine under the same conditions, will do no such thing.

ON A VOLUMETRIC ANALYSIS OF SUPERPHOSPHATE OF LIME, BY GEORGE JONES, F.C.S.—It has for some time been a desideratum of analytical agricultural chemists, and especially of those connected with the manufacture of artificial manures, to be enabled, by a more speedy method than the one generally pursued, to arrive at a correct estimation of the amount of phosphate of lime existing in a soluble state in the so-called "superphosphate." I have therefore been led to attempt a series of experiments upon a process of volumetric estimation, by the use of a standard solution of ammonia; but at the onset I experienced some difficulty in arriving at any satisfactory result in consequence of the existence of the free or uncombined sulphuric acid, which is invariably present in ordinary commercial superphosphate, it being impossible to present an alkali without precipitating the phosphate of lime. The process I therefore adopt is the following:—Having taken 100 grains of the sample for analysis, it is first of all well mixed with about 50 grains of finely powdered litharge, and introduced along with a small quantity of distilled water into a flask, and boiled for about fifteen minutes. The whole is then made up with distilled water to 7,000 grains (one deci-gallon), agitated well, and thrown upon a filter I then take of the filtrate, by the use of a pipette, 1,500 grains (200 septems), equal to 20 grains of the sample, and add thereto a little chloride of calcium solution, and 200 septems of the standard solution of ammonia; it is then made up with distilled water to a known bulk—say 2,000 grains—agitated well, and filtered. A 1,000 grains pipette of the filtrate will therefore represent exactly 10 grains of the sample, and in this I now proceed to test for ammonia, added over and above that required to separate the phosphate of lime in the sample. Two equivalents of ammonia being required for every equivalent of the tribasic phosphate of lime precipitated. Thus—$CaO, PO_5, + 2CaCl + 2NH_4O = (CaO)_3PO_5$ and $2NH_4Cl$. The standard solution of ammonia I am in the habit of using contains in every septem ·01 of real ammonia, and I employ also a standard solution of hydrochloric acid, 50 septems of which require 202 of the standard ammonia for neutralisation. In order, therefore to estimate the excess of ammonia added to the liquid, I first add 50 septems of the acid, and then test with the standard ammonia, using, of course, a solution of litmus. Supposing, therefore, that 255 measures or septems of the standard ammonia are required to effect a complete neutralisation of the liquid, then say—292 — 255 = 37, and 100 (the number of measures previously added) — 37 = 83 measures of standard ammonia required to precipitate the phosphate of lime, and equal to 63 per cent. of real ammonia. Therefore as—$2(NH_3)$ $(CaO)_3PO_5$ per cent. 34 : 155 :: 63 : to x = 28·72 p.c. of phosphate of lime. By the use of the oxide of lead, the free sulphuric acid of the sample is not only neutralised but separated as insoluble sulphate, leaving the solution but slightly acid, and only from the acid phosphate. By repeated trials upon samples of known composition, I have never found this process to fail. It is both simple and accurate, and the time occupied from first to last is barely one-fourth of that required by the ordinary gravimetrical method.

LIST OF APPLICATIONS FOR LETTERS PATENT.

We have adopted a new arrangement of the Provisional Protections applied for by Inventors at the Great Seal Patent Office. If any difficulty should arise with reference to the names, addresses, or titles given in the list, the requisite information will be furnished, free of expense, from the office, by addressing a letter, prepaid, to the Editor of "The Artizan."

Dated June 23rd, 1865.

1680 A. E. Dobbs—Drags for carriages
1681 C. Ravelli—Turntables
1682 M. D. Rosenthal and S. Gradenwitz—Imitation ivory umbrella tins
1683 L. White—Tobacco pipes
1684 W. J. Murphy—Stopping railway trains
1685 W. Lusty—Needles
1686 E. Finch—Rivets, bolts, spikes, and similar articles
1687 H. S. Snell and F. E. Thomas—Supplying gas to burners

Dated June 24th, 1865.

1688 H. A. Bonneville—Lifeboats
1689 R. Eastman—Castors
1690 M. A. Muir and J. Mcllwham—Preventing noxious exhalations
1691 R. A. Brooman—Portable table or seat
1692 G. Turton—Floating docks
1693 P. A. Le Comte de Fontainemoreau—Horse-shoe and other nails
1694 F. G. David—Composition for the manufacture of printer's rollers
1695 J. Solomon—Preparation of magnesium for illuminating purposes
1696 C. R. Bamber—Apparatus for producing the magnesium light
1697 W. Clark—Consuming smoke

Dated June 26th, 1865.

1698 T. L. Jowett—Bricks
1699 J. Nugent—Communicating signals on railway trains in motion
1700 M. Ashby—Refrigerator or apparatus for cooling liquids
1701 J. E. Spanoghe—Hydraulic apparatus for producing motive power
1702 R. A. Broomon—Machinery for printing in colours
1703 C. Worssam—Treatment of peat as a fuel and gas
1704 S. S. Bateson—Croquet mallets
1705 J. Whittle—Permanent way of railways
1706 J. Medhurst—Punching apparatus
1707 W. E. Newton—Hats and other felted goods and fabrics
1708 W. E. Newton—Pianofortes

Dated June 27th, 1865.

1709 H. M. Kennard—Machinery for riveting and making rivets
1710 H. Shaw—Retarding the velocity of railway and carriage wheels
1711 R. A. Brooman—Apparatus for burning hydrocarbons
1712 J. Pratt—Cutting hay, straw, and other vegetable substances
1713 J. Kirkham—Securing the rails of railways
1714 J. H. Johnson—Cotton gins
1715 W. Brooks—Heating various kinds of iron implements

Dated June 28th, 1865.

1716 H. G. Fairburn—Fuel
1717 W. Ingham—Circular pressing machines for finishing woven fabrics
1718 J. K. Farnworth—Railway and other carriage windows
1719 W. E. Newton—Preparation of amalgams of quicksilver or mercury
1720 W. Bever—Skates
1721 J. Webster—Under vests
1722 W. Percival—Support employed in dressing or finishing cheeses
1723 R. Boot and J. Coxon—Twist lace machines
1724 P. Jacoveno—Decantations and raising petroleum and other oils
1725 W. E. Newton—Shirt front
1726 E. Reynolds—Preventing the opening of sash windows from the outside
1727 W. Botham—Regulator for feeding bottle and other tubes

Dated June 29th, 1865.

1728 R. H. Leese—Cutting, punching, and bending sheet metal
1729 D., T., J., and J. Mercer—Machines for sizing yarns
1730 R. A. Broomon—Printing threads employed in weaving
1731 J. Cox—Oars, seats, and fittings for boats and vessels
1732 G. Lizars—Dry gas meters
1733 A. Prince—Distributing the feeding materials in high furnaces
1734 W. E. Newton—Preventing the incrustation of steam boilers
1735 W. E. Newton—Locks

Dated June 30th, 1865.

1736 P. D. Finnigan—Arresting and stopping the motion of locomotive engines
1737 W. Schofield—Gas retorts and other articles made of fire clay
1738 H. P. Tipper—Gun barrels and tubes of cast steel
1739 F. Delamarre-Deboutteville—Doubling cotton and other fibrous substances
1740 H. W. Rosser—Mechanical arrangement of water closets
1741 R. A. Brooman—Collars and cuffs
1742 R. A. Brooman—Tuning pianos
1743 J. Keighley—Looms for weaving
1744 W. H. Davey—Washing machines
1745 E. Elliott—Steam boilers, furnaces, and engines
1746 L. Faure—Elastic railway carriage

Dated July 1st, 1865.

1747 G. Davies—Knitting machines
1748 W. R. Lake—Pressing and moulding clay for making bricks
1749 J. Atkins—Manufacture of certain kinds of metallic tubes and rods
1750 W. E. Newton—Fire-arms, and in cartridges to be used therewith
1751 W. McGregor—Points and crossings of railways
1752 J. Calvert—Apparatus for propelling ships and other vessels

Dated July 3rd, 1865.

1753 I. Baggs—Submarine telegraphy
1754 G. de Bergue—Locomotive engines
1755 E. Deane—Tubular structures rendering them specially applicable for ships' masts
1756 J. F. Jones—Machines for making paper board
1757 S. Bates—Production of bobbin net or twist lace
1758 G. Hurn and D. Hurn—Mats and matting and brushes
1759 J. Naveaux—Stopping and retarding railway carriages
1760 M. Benson—Steam engines and double acting lift and force pumps
1761 L. H. G. Ehrhardt—Vices

Dated July 4th, 1865.

1762 S. Wright—Axles for carriages
1763 P. Passavant—Linings for ladies' dresses
1764 W. Clatterton—Apparatus for setting up casks or barrels
1765 S. B. Labouret—Bridges, roads, aqueducts, or other ways
1766 J. Dale and R. S. Dale—Printing upon paper and woven fabrics
1767 J. Harrington—Carriages
1768 W. Jenkins—Lamp oils
1769 J. E. Wilson—Locomotive engines and springs of railway carriages
1770 R. A. Brooman—Dissolving pitch
1771 W. E. Gedge—Circular endless railway

Dated July 5th, 1865.

1772 F. N. Gisborne—Apparatus for signalling on board ship
1773 J. Braithwaite—Turning and cutting wood and other substances
1774 W. S. Parfitt—Aerated waters
1775 J. Longbottom & A. Longbottom—Floor cloths and similar fabrics
1776 J. Jobson and J. F. Dickson—Conversion of malleable iron into steel
1777 J. W. Gray—Decorticating rice and other seeds and grains
1778 G. Low—Boring rocks and other hard substances
1779 H. Emmanuel—Improvement in ornaments for personal wear

Dated July 6th, 1865.

1780 H. Beigel—Producing oxygen applicable to various purposes
1781 T. S. Prideaux—Improving draught beer, ale, and cyder
1782 G. Carter—Locks and latches, and in staples and spindles for the same.
1783 J. H. Smith—Harmoniums, organs, or other musical instruments
1784 W. Thomson and C. F. Varley—Electric telegraphs
1785 C. F. Claus—Obtaining sulphates and carbonates of potash and soda
1786 J. H. Johnson—Railway switches
1787 J. F. Jones—Paper board and paper
1788 W. E. Gedge—Automaton lay figure
1789 A. V. Newton—Boxes
1790 A. V. Newton—Manufacture of superphosphate of lime
1791 J. W. Swan—Production of printing surfaces by photographic agency
1792 W. Clark—Cutting files

Dated July 7th, 1865.

1793 J. M. Macrum—Iron
1794 P. M. C. Bezel—Chains, bracelets, and other and other articles of jewellery
1795 A. F. Morelle—Portable pocket gas generator or gazogene
1796 E. H. Waldenstrom—Metallic bolts, rivets, and spikes
1797 I. Peel and W. Hargreaves—Manufacturing grease from soap suds
1798 T. Sheldon—Handles of smoothing irons or sad iron
1799 H. D. P. Cunningham—Improved mode of training guns
1800 T. F. Henley—Material for stuffing seats and other articles
1801 F. A. Wilson—Carriages for breech loading ordnance
1802 J. Hopkinson and J. Whitelock—Harmoniums and other musical instruments
1803 J. Bullough—Looms for weaving
1804 J. George—Coffins
1805 R. Green and J. W. Heinke—Fire-arms
1806 W. Goulding—Ornamental fences to contain flowers
1807 G. Fentiman—Preparation of paints
1808 J. Willis—Portable dark tents or chambers for photographers

Dated July 8th, 1865.

1809 I. Baggs—Production of artificial light
1810 W. E. Newton—Break for retarding the progress of railway wheels
1811 G. B. Woodruff—Gauging and marking the width of tucks and pleats on fabrics under operation
1812 J. F. Heather—Locks and keys
1813 R. A. Brooman—Cast steel
1814 B. Collins and J. Butterfield—Cutting fustian and like fabrics
1815 J. Byford—Reaping machines
1816 H. A. Dufrene—Obtaining a circulation of volatile liquids
1817 C. O. Popengouth—Construction of ships and vessels
1818 G. T. Livesey—Treating ammoniacal liquids for purifying gas

Dated July 10th, 1865.

1819 H. Schooling—Pearling and ornamenting confectionary
1820 W. A. Lyttle—Increasing the mechanical effect of steam
1821 R. A. Brooman—Steam engines
1822 D. Cowan—Lifts for transferring passengers' goods
1823 F. Taylor—Fountains
1824 W. S. Underhill, A. H. Corden, & J. Corden—Reaping machines
1825 J. Jones—Manufacture of making up of trousers
1826 R. Hineson—Food for horses, and in the preparation of the same
1827 H. Fearnley & C. Smith—Washing and drying clothes
1828 G. Firmin—Treating and preparing flax for scutching

Dated July 11th, 1865.

1829 J. Soutter and T. Christie—Marking progress in the game of croquet
1830 F. Massey—Ships' logs
1831 H. A. Dufrene—Treatment of copper and nickle ores
1832 H. A. Dufrene—Obtaining motive power
1833 H. A. Dufrene—Obtaining oxygen
1834 N. Jenkins—Steam and water valves
1835 B. Fothergill—Controlling the power of sewing machines
1836 M. H. Keene—Traction engines

Dated July 12th, 1865.

1837 T. C. McKeen—Diving apparatus for submarine purposes
1838 T. C. McKeen—Elevating ships or boats in the water
1839 S. B. Howlett—Registering the direction and force of the wind
1840 A. Denayrowse—Equipments used by persons employed under water
1841 H. Blair—Production of gases from aqueous vapours
1842 J. E. Wilson—Permanent way of railways
1843 J. Saunders and J. Piper—Manufacture of tin and terne plates
1844 G. C. Collyer and C. L. Roberts—Utilising the waste of tobacco
1845 A. Mackie and J. P. Jones—Composing type for printing

Dated July 14th, 1865.

1846 H. A. Bonneville—Copying letters and other manuscripts
1847 W. Meadowcroft—Construction of rollers for window blinds
1848 J. B. Chatterley—Cruet frames
1849 J. Clayton—Ingot moulds, and in the casting of metals
1850 D. Fulton and J. Fulton—Mandrils for rollers used in printing or embossing
1851 J. M. Murphy and J. M. Murphy—Staining woods
1852 W. P. Baylis—Locomotion of trains by atmospheric pressure
1853 S. Tripp—Securing envelopes for enclosing letters
1854 G. Clark—A drawing instrument, called the parallelograph
1855 A. E. Molin—Separating gold from ores containing copper and gold
1856 A. de Metz and T. W. Fry—Improvements in railway signals

Dated July 15th, 1865.

1857 R. V. Tuson—Preservation and preparation of food for animals
1858 S. Hingley—Making skelps for iron or steel tubes direct from the tubes
1859 W. Hughes—Presses
1860 J. C. Walker—Springs for railroad and other carriages
1861 W. R. Lake—Improvements in flexible gas tubing
1862 A. H. Platt—Lamps

Dated July 17th, 1865.

1863 S. Dunmere—Mattress or palliasse for the use of invalids
1864 R. A. Broomon—Pumps

Dated July 18th, 1865.

1865 J. Thornton—Straightening wool, cotton, and other fibres
1866 J. P. B. le Patourel—Improvements in ventilators
1867 J. Armitage—Drills for sowing seeds and depositing manure
1868 J. P. Wint—Instrument used in cutting the soles of boots
1869 A. Barclay—Improvements in steam boilers or generators
1870 T. W. Wood—Construction or arrangement of sluices
1871 W. A. Richards—Pouch or receptacle to hold tobacco

Dated July 19th, 1865.

1872 J. B. White and T. Pillings—Cleaners for winding cotton
1873 H. A. Platt—Paper as a substitute for carpets and oilcloth
1874 J. E. F. Ludeke—Motive power by capillary attraction
1875 T. Metcalf, H. Metcalf, & T. Clayton—Cooling liquids
1876 M. Knowles—Looms for weaving
1877 D. McCrummen—Production of artificial manure
1878 C. Henderson—Connecting rails for railways and tramways
1879 C. Nicholas—Supplying disinfecting liquids to waterclosets
1880 J. G. Rowe—Improvements in signal and alarm apparatus
1881 H. E. Gilles—Producing fibres suitable for being spun from rags
1882 D. Caddick—Construction of furnaces for melting metals
1883 W. Edwards—Springs for leggings and similar fastenings
1884 G. Nimmo—Crucibles or pots for heating or melting of metals
1885 G. Nimmo—Uniting different metals, such as iron and copper
1886 J. Miles—Vermin traps
1887 T. H. Ince—Shoeing horses

Dated July 20th, 1865.

1888 C. Rosson—Portable charge holders for breech-loading guns
1889 W. Trantner—Fire-arms
1890 C. H. Simpson—Improvements in propelling vessels
1891 H. A. Clum—Instrument for indicating atmospheric changes
1892 T. Swinburne—Mechanism for propelling and forcing purposes
1893 R. C. Bristol—Improvements in the manufacture of slide valves
1894 W. La Penotiere—Improvements in breech-loading fire arms
1895 R. Smyth and W. E. Evans—Organs and harmoniums
1896 A. V. Newton—Improvements in envelope machines
1897 M. L. Parry—Condensing apparatus for steam engines
1898 J. H. Wray—Producing sound for signals and alarms

Dated July 21st, 1865.

1899 S. J. V. Day—Improvements in the propulsion of ships
1900 L. A. M. Chaulin—Process for rendering wood incombustible
1901 G. Taylor and J. Crossley—Covers for rollers used in spinning cotton
1902 J. Watson—Locks and in latch bolts for locks and latches
1903 R. M. Wanzer—Certain improvements in sewing machines
1904 A. Smith—Sewing machines
1905 J. H. Chaudet—Manufacturing salts, sulphates, and acetates of chrome
1906 E. Schaub—Sizing material to be employed in sizing or dressing yarns preparatory to weaving
1907 C. Gardner—Improvements in apparatus for cleaning windows
1908 J. W. Robertson—Detonating cap made of paper or any other material
1909 W. S. Yates and A. Freeman—Folding fabrics on to card boards or metallic plates for the purpose of hot pressing

Dated July 22nd, 1865.

1910 E. Perre—Certain improvements in the method of obtaining motive power and in apparatus connected therewith
1911 W. Diaper—Safes or receptacles for the protection of property
1912 G. Wilson & J. Goodfellow—Bedsteads, sofas, and chairs
1913 W. E. Newton—Valves for steam and other engines
1914 J. P. Gillard—Manufacture of soda and carbonate of soda
1915 M. P. W. Boulton—Obtaining motive power when heated air is employed
1916 S. Boyd—An invention of an improved cotton press
1917 W. Wapshare—An improved apparatus for cooking, a portion of the same being applicable to washing and ironing
1918 W. E. Gedge—An improved windmill for raising water

Dated July 24th, 1865.

1919 J. McCroft—Improvements in the steering of ships
1920 H. W. Hart—An invention of an improvement in metal pins
1921 R. A. Brooman—Examining and facilitating operations in the throat
1922 J. Leetch—Improvements in the article of dress worn by ladies, to be called the expanding and collapsing crinoline

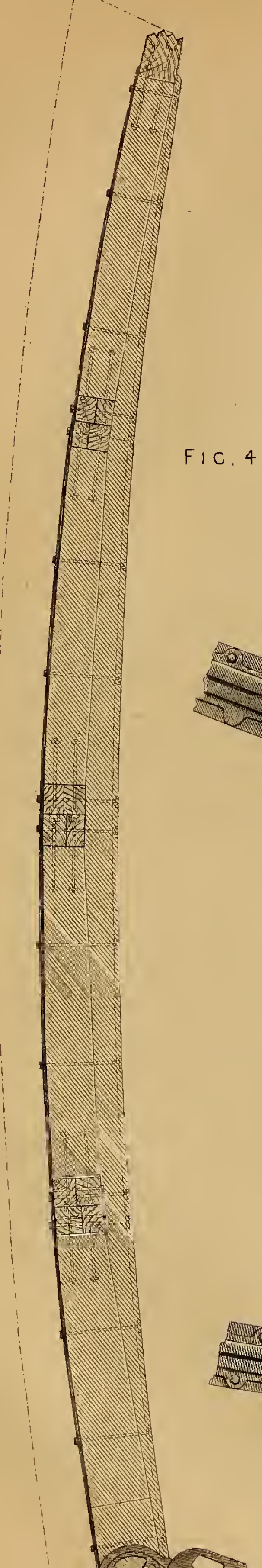


FIG. 4.

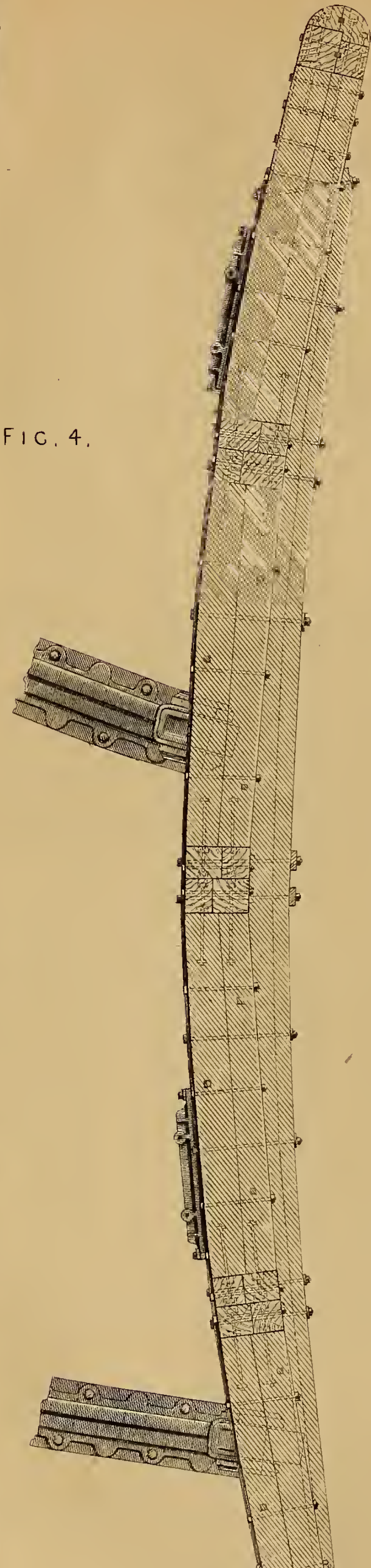
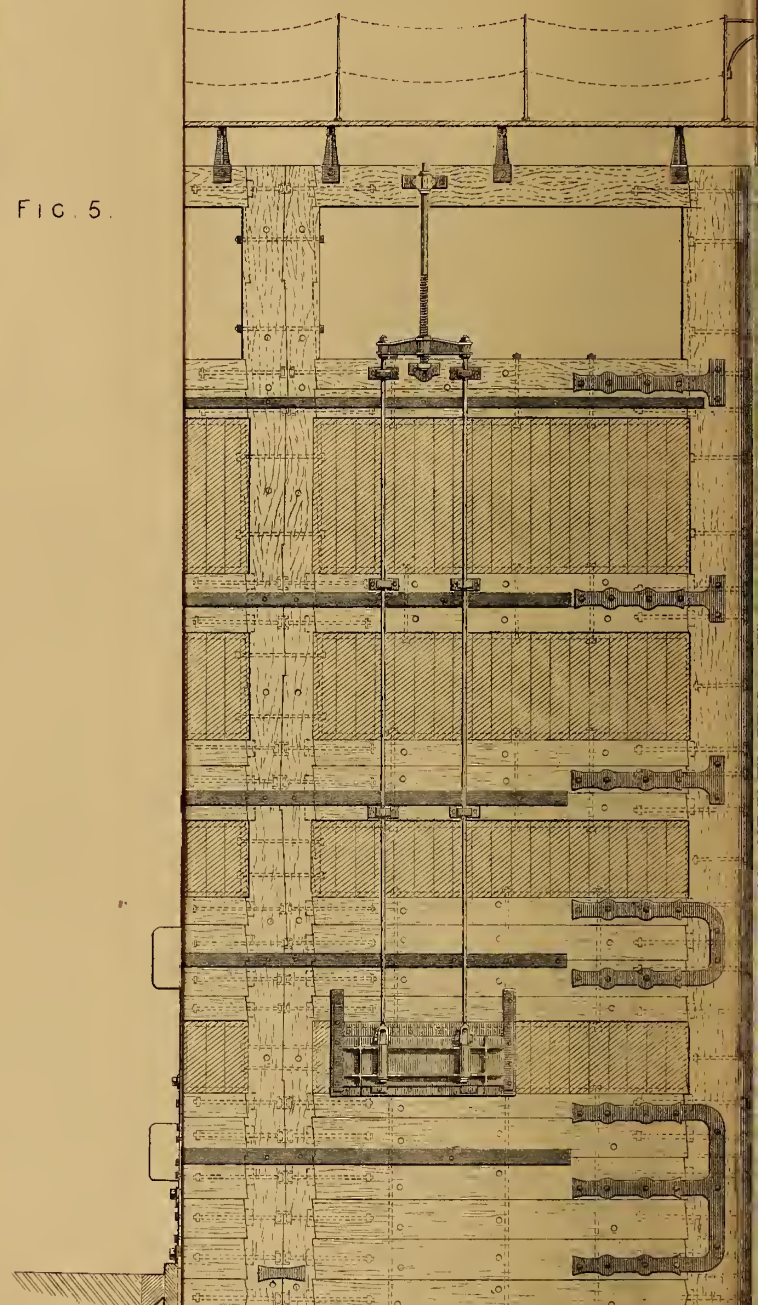


FIG. 5.



W. Smith, C.E. direx

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HISTORICAL AND DESCRIPTIVE SKETCH OF THE MERSEY DOCKS AND HARBOUR.

By J. J. Birckel.

(*Illustrated by Plate* 285.)

So far, we have had occasion to refer to the Birkenhead Dock scheme only while treating of the estuary proper, and in connection, more especially, with the question of high tide levels. The establishment of those docks, however, has been a subject of so much controversy both on technical and on purely local matters, that we now purpose giving a short sketch of their origin and growth, as well as of the technical vicissitudes through which, as a whole, they passed, until they finally were made to assume their present shape. We shall afterwards illustrate those structural details which give them their special and distinctive features.

These docks, the reader probably remembers, occupy the site of a creek of the estuary of the Mersey, formerly known as the Wallasey pool, on the Cheshire shore, immediately opposite Liverpool; and upon looking over a map of the western coast and of the Irish Channel, the reader will readily perceive that *that* shore happens to be the weather shore of the estuary, or, in other words, the one protected against the storms which usually visit this port. It is chiefly, or at any rate partly, owing to this circumstance that the water is deeper on that side of the river just opposite Liverpool, and this circumstance was held to be such conclusive evidence of the natural advantages of Birkenhead for the establishment of docks, that Telford, the eminent engineer, when viewing the entire district from the top of Bidston Hill, is reported to have exclaimed, that "*Liverpool had been placed on the wrong side of the Mersey.*"

The late Mr. Laird, the father of the member for Birkenhead, had a keen appreciation of the supposed advantages of the place; and as early as 1824 and 1826, he, with Sir John Tobin, purchased extensive tracts of land on the south side of the pool, having in view, no doubt, its increase in value in after-years, and Mr. Laird, subsequently, also established his shipbuilding yard there. In 1827, Messrs. Telford, Nimmo, and Stevenson of Edinburgh, were called upon by the above gentlemen to survey the pool, and to report as to the practicability of constructing docks there; and these authorities then proposed a plan, the main feature of which was a large dock with a canal entrance from the river Dee, near Hilbre island. This plan, which with various others subsequently proposed we shall illustrate in our next number, would effectually have created Birkenhead a distinct port if it had been carried out, and entirely ignored the great advantage above pointed out; the course of events in the bay outside tending to the gradual silting up of the mouth of the Dee, as has been shown in a previous paper, however, leaves no room for doubt that such a plan, if carried out, must have ultimately resulted in failure, and Birkenhead, therefore, may congratulate itself upon the non-success of these preliminary steps.

Towards 1837 Mr. Laird again seriously agitated in the matter, and then proposed a system of works generally speaking similar to those afterwards matured by Mr. Rendel; and as it had now become evident that the Birkenhead interest was bent upon carrying out the cherished idea of establishing what Liverpool then considered a rival port on the Cheshire shore, the Corporation of Liverpool bought 192 acres of land on the south side of Wallasey pool for the sum of £155,000, which yielded a return of one per cent., while they had borrowed the money at the rate of $4\frac{1}{2}$ per cent., thus clearly showing that they then looked with a suspicious eye upon the projected shipping accommodation there, and desired, by acquiring the proprietorship of the land adjoining the pool, to render themselves masters of the situation there.

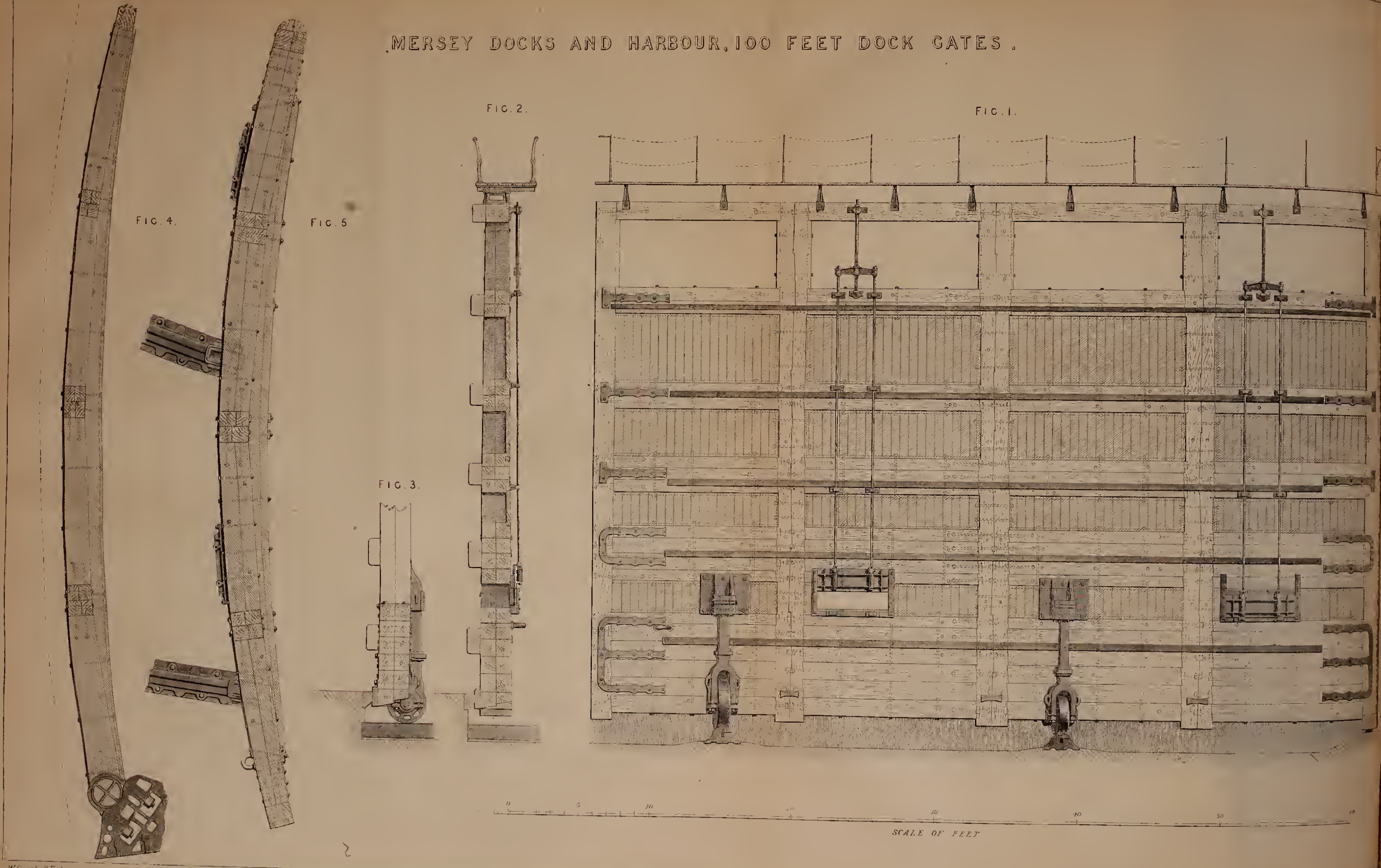
In 1843, however, their financial requirements and the chances of effecting a good bargain induced them to sell that property on a lease of 75 years, with the privilege to the purchasers to build docks thereon, to a company of gentlemen, headed by Mr. Laird and Sir John Tobin, who at once called in the assistance of the late Mr. Rendel to design a dock and survey the pool. It appears, from Mr. Rendel's statements before a committee of the House of Commons, that the object of these gentlemen at first was only to build a small dock; but that upon an examination which he then made of the locality, such a project did not appear to him at all upon a fitting scale with the great capabilities of the place. He states that upon looking over the whole site very carefully, and upon perusing the report of Messrs. Telford, Nimmo, and Stevenson, it appeared to him that the locality afforded considerable facility for an entrance basin, into which vessels might run out of the stream of the tide. He also had noticed the increase of trade in the river craft, and all that description of trade which required facilities at low water, and that it was most important to have, what the site appeared to afford the means of giving—a low water basin. He therefore intimated to those gentlemen that unless the scheme was made more comprehensive than the one contemplated, he should decline to act as their engineer; and upon having stated to them the capabilities which Wallasey pool seemed to afford for extending both the area and the kind of dock accommodation, they yielded to his views upon the subject, and directed him to mature a scheme for taking advantage of the entire capabilities of Wallasey pool and its river channel. Thus it becomes evident, upon Mr. Rendel's own statement, that he is the chief author of the Birkenhead Dock scheme as it now stands with its special distinguishing features; and when we have stated that he embarked £10,000 of his own money in that undertaking, our readers will share with us the belief that he was both sincere in his objects, and thoroughly convinced of the correctness of his views.

On the 25th of October, 1843, he submitted his plans to the representatives of the then Birkenhead Dock Company, together with the following explanatory report, which we produce nearly in its entirety, because it shows in its very opening paragraph that Mr. Rendel looked upon the subject from a much more elevated point of view than, we believe, is generally admitted in Liverpool, and certainly from a much more elevated point of view than was assumed by the shipping interest of this place, since he foreshadows the possibility, or rather the probability, of such an increase of trade as would necessitate an extension of dock accommodation at Liverpool, in spite of anything that might be done at Birkenhead. This report runs as follows:—

"Wallasey pool, from its great capacity and admirable position, offers advantages for the extension of shipping accommodation in the port of Liverpool of a very commanding position—*not in the shape of rivalry to the magnificent docks now in existence, or even hereafter to be made*, but as affording those adjunct conveniences which the want of space and absence of natural facilities make unattainable in any other locality within the port."

"The area of Wallasey pool, within its headlands—viz., Seacombe Point on the north, and Woodside Point on the south—is about 340 acres. The borings made for this inquiry show that the entire creek once formed a deep low water lake, but, like all similar lakes in such localities, when

MERSEY DOCKS AND HARBOUR, 100 FEET DOCK GATES.



left in their natural state, it has become silted up, and will be entirely lost if not made available to shipping and maintained by adequate funds."

"The accompanying design will show that I propose to construct a wall along the low water margin of the river Mersey, from Seacombe Point to the head of Woodside ferry pier. This wall, practically speaking, will be parallel with the opposite defence wall of the Liverpool Docks. It will, consequently, have the effect of giving a truer current than now exists to the flood and ebb tides in their passage through this part of the harbour; *probably*, therefore, it will be the means of deepening the channel on the Liverpool shore, and *certainly* it will prevent the further increase of Pluckington Bank northward."

"About the middle of the wall I propose to leave an opening of 300ft. wide as an entrance to a basin of upwards of thirty-seven acres area, excavated to a depth of 12ft. below low water spring tides, walled with convenient wharves, and in every respect made suitable as a place of refuge for the numerous vessels now so frequently obliged to seek shelter by running aground on the sandbanks which constitute its site. Such a basin as this would obviously be a vast convenience added to the port for the accommodation of steamers, especially as they would be able to run to and from it at all times of tide, and obtain within it wharfage completely protected from wind, sea, and tides."

"At the head of the basin, and as shown on the design, extending across the pool from the patent slip yard on the Birkenhead shore to the smalt works on the Seacombe shore, it is proposed to build a masonry dam for the object of retaining in the pool above a sufficient quantity of water to form it into a floating dock. Three communications are proposed between this float and the great basin, viz.: a pair of gates 70ft. of opening, one lock of 50ft., and one of 30ft., and the sills of each entrance to be not less than 6ft. below the Liverpool Dock datum.

"Within this dam, Wallasey pool contains an area of upwards of 150 acres, and a frontage of 8,000 yards lineal. The shores are flat, and in every respect suitable for trading and commercial establishments, whilst the proximity of excellent sandstone quarries affords the means for the economical construction of wharfs, and the like necessary conveniences."

"Enormously large as this dock may be deemed for commercial purposes, it is not too large as a reservoir to contain water for scouring the basin, which is large and deep. The requisite scouring is proposed to be effected by a daily discharge of water equal to the difference between the level of the tide of the day and that at which it is to be permanently retained in the dock, and for which, I think, 13ft. above the Liverpool datum would be most suitable—the discharge to be during low water, by means of adequate sluices through the dam, laid at the proper level for acting with the best effect. My experience in such matters enables me to state with confidence that the power derivable from so extensive a reservoir taken in connection with the great rise and fall of the tides in the Mersey, will be quite sufficient for the attainment of the object in view. The design cannot be more favourable for bringing all parts of the basin under the direct action of the scour of the sluices, whilst from their frequent use and the disturbance caused by the steamers and other vessels resorting to the basin, accumulations will be displaced before they have attained a solidity that would require further means for their removal."

"As there would be no in-draught till the flood-tides had risen to the level of the water in the dock, the quantity of silt brought into the basin and dock would be considerably less than is at present brought into the pool, which is important with respect to the expense of maintaining the requisite depth for the dock and basin.

"As regards the loss of back water which the Mersey will sustain in carrying out the design now proposed, it is to be observed that a mere comparison of the quantities of cubic feet of water, at any given time, passing into and out of Wallasey pool in its present and in its embanked state, would be a very superficial view of the question. At present the backwater passes off at a time of tide when it can have but little, if any, good effect or scouring influence; when retained till low water, though the quantity discharged will be less than at present, the power gained will be vastly in excess, and will be permanently secured; for, in reference to this point, I must repeat a remark already made, that the capacity of the pool for backwater is yearly diminishing, and if left in its present neglected state, will, at no distant period, be entirely lost.

"The level at which it is proposed to retain the water in the dock will give a depth of 19ft. just within the dam, and 13ft. at Wallasey bridge, in the present deep water channel. The soil forming the bed of the pool is now even of a kind to be dredged with facility, and the deepening of its whole area to an average of 17ft. may be reasonably hoped for as an ultimate measure, seeing that the soil could be easily removed to, and used in raising and making marketable the 120 acres of land on the sides of the great basin."

"In addition to the works already described, I have shown on the design a basin of nearly 10 acres area (afterwards increased to 16 acres), immediately north of the present Woodside ferry pier and public slipway. This basin would amply accommodate in safety all the river and coasting craft that now at some risk discharge their cargoes whilst lying aground on the open sandbanks which constitute its site, and the strand or beach which it includes could be, from its then sheltered state, maintained in a perfect condition for the vessels to ground on."

Mr. Rendel's plans were, in their general features, approved of by the Lords Conservators of the river Mersey, and the whole scheme was viewed so favourably by the Board of Trade that the Commissioners of Woods and Forests, the late Duke of Newcastle then acting as Chief Commissioner, gave about 280 acres of land to the Commissioners of the township of Birkenhead for the public objects aimed at, and on the 7th of May, 1844, the plans were submitted to a committee of the House of Commons, before which it had to be taken to enable the Dock Company to obtain the necessary powers for carrying out the work. Here, however, the scheme had to encounter a most strenuous opposition on the part of the Liverpool interest generally, and of the Dock Committee in particular, who, as we have just seen, had manifested feelings of uneasiness respecting it at a very early date, and the technical grounds upon which they opposed the measure were—

1st, and chiefly. That the abstraction of so much back-water from the total available scouring power, as would be caused by damming off the Wallasey pool, would prove permanently injurious to the sea channels.

2nd, and incidentally. That it would be impossible to keep open, by means of sluicing operations, the intended low water basin with a depth of 12ft. below low water of spring tides; and inasmuch as that basin constituted the principal feature of the scheme, if divested of it the proposed docks at Birkenhead would offer no advantage over any docks that might be constructed at Liverpool.

In support of their respective views, both parties brought forth such an array of scientific and professional witnesses as seldom, if ever, has been summoned together on behalf of what was, after all, only a local question; but the voluminous evidence which they gave, conflicting as it was, must have left the said committee of the House of Commons pretty much in the dark as to the real merit of the technical questions raised and defended with equal assurance and ingenuity, and, as a natural consequence, the measure received the assent of Parliament.

With reference to the principal ground of opposition, we have shown in its proper place that, in the main, the river channels have improved during the last twenty years, and that injury to and changes in the sea channels are to be traced to the influence of storms and of heavy freshets, rather than to the ordinary action of the tide unaided by extraneous causes; and as we then analysed very carefully that portion of the evidence in question which had reference to the main ground of opposition, we might now pass it over entirely, but that we find a very lucid *exposé* of the whole case, together with a few special facts, in a report to the Lords Conservators of the Mersey, in reply to a letter of Mr. J. Bamley-Moore's to their lordships, and at their request, by Captain, now Admiral, Evans, R.N., acting conservator, certain portions of which cannot fail to be interesting to our readers, and which, therefore, we shall here place before them—Capt. Evans says, "In compliance with your lordships' instructions, I have examined the evidence given before a committee of the honourable the House of Commons, on the Birkenhead Docks Bill, in order to ascertain if the objections to the proposed works, stated in a letter of Mr. Bramley-Moore's to your lordships, were sustained by eminent civil engineers.

"After a careful perusal of the evidence *pro.* and *con.*, I find it of such a conflicting nature that I think I shall best meet your lordships' views by a simple statement of the facts of the case, leaving your lordships to draw your own conclusions.

"The objections of the trustees of the Liverpool Docks appear to me to be as follows, namely, that if the proposed works at Wallasey Pool be carried into effect, the abstraction of the water contained in the pool will to a serious degree endanger the navigation of the river Mersey, but most particularly the sea channels of the port. This seems to me to be the vital question at issue, but I think Mr. Bramley-Moore's chief objection is easily disposed of on the known principles of tidal action in estuaries.

"In the first place, your lordships will perceive, on reference to the plan, that the river wall to be constructed across Wallasey Pool, does not contract or narrow the inlet of the estuary, inasmuch as Seacombe Point extends further into the river than the proposed wall. The tidal wave, entering the narrows at Seacombe, will, if confined by this wall, increase in velocity and tend to keep the channels above and below Liverpool clearer of deposit than they are at present, for the following reasons:—When the tidal volume now passes the narrows at Seacombe Point, it suddenly expands into Wallasey Pool, thereby diminishing the velocity and creating an eddy, which past experience shows will, in the course of time, silt up the pool, with the exception of a narrow channel sufficient to discharge the water of the land drainage.

"I do not think that, in approving of the plan of those works, your lordships looked for compensation for the water abstracted from Wallasey pool, to any quantity that may be reserved in those works for the purpose of being sluiced out at a later period of the tide, for the more effectual scouring of the sea channels, as the quantity so sluiced out would be barely sufficient to carry away the silt with which it would be charged, but that your lordships were guided in your approval by the same motives that influenced your decision in favour of the Liverpool Dock Bill, namely, that the river wall would, in both cases, compensate for the displacement of the tidal waters, by giving a more direct course and greater velocity to the tide, and thus improving the navigation of the river."

"In the course of the evidence it has been asserted by some, and denied by other engineers that an increased velocity in the narrows would force a greater quantity of water into the estuary above Liverpool; but as your lordships, in approving of the plan for both sides of the river, never expected any compensation from such a source, I shall, as the subject has been mooted, simply state my views of the case. It is a well-known fact in all parts of the world that a tidal wave, if obstructed or confined in its progress, will rise in height and proportionately increase in velocity. Seamen find this law universal; but, to those unacquainted with the theory of tides, the river Severn and the bay of Fundy afford convincing practical proofs of it. In both those estuaries we find a greater volume of tidal wave admitted at the entrance than at that of any other known estuary; and we also find that, in its progress to the summit of both, the tidal wave is confined and obstructed. The result is well known, namely, that at Chepstow it is heaped up to 60ft., and above Anapolis Royal to 75ft.:—

SPRING TIDES.

Chepstow	60ft.	Chigneto Bay	75ft.
Lundy Isle	27ft.	Grand Manan	25ft.
Difference	33ft.	Difference	50ft.

This shows that, in both those instances, the water is forced to more than twice the height at the summit of the estuary to what it is found to rise at the entrance, without taking into consideration the difference of level between the entrance and the summit."

"In stating these facts, I do not presume to say that similar results will take place in consequence of the increased velocity obtained by walling in Wallasey pool; but I am quite certain that the increased velocity will compensate for the loss of water which the erection of docks on both sides the river will occasion. I think your lordships will feel that I am justified in this conclusion when I state that all parties admit, in the evidence recently given before the Liverpool Dock Committee, that, judging from ancient surveys, the channels into Liverpool are in a better state than they ever have been, notwithstanding that, in the construction of the Liverpool Docks, 10,000,000 cubic yards of tidal water were displaced, the entrance of the river considerably contracted, and a pool, similar to that of Wallasey, dammed up."

"A great portion of the evidence relates to the novel plan Mr. Rendel has introduced for scouring the tidal basin. On this subject the greatest diversity of opinion exists amongst the most eminent of the civil engineers, but as the plan has never been tried there can be no certainty as to its results, therefore I shall not trouble your lordships on the subject more than by stating that Mr. Rendel's object, as appears from his evidence, is to keep up such a state of agitation as not to let sediment subside, but holding it in suspension until the ebbing tide allows it to escape out of the river. The effect which the water to be sluiced into the river by this novel plan may have on the general scour is described in a great variety of ways by the engineers; but, as I have already informed your lordships, it will be of very little use as a scour, owing to its being so charged with silt, for thus the benefit which the additional volume of water might cause to the scouring effect of the ebb tide will be neutralised by the deposit of silt it contains, as occurs in scouring out the tidal basins of Liverpool.

"Mr. Walker states, and every engineer agrees on this subject, that there is no place in Liverpool where docks would be made without abstracting water; and Mr. Page's late experiments on the set of tides, which I myself witnessed, prove that it is the water on the Liverpool side that passes through the Victoria Channel, all his floats from Wallasey pool having passed out of the Rock Channel or over the banks. These facts are very material, as it appears that, independent of the beneficial effects, as already described, attending a continuous river wall along the front of Wallasey pool, it will prevent any further displacement of water ever taking place, should the necessity of commerce require dock extension at Birkenhead, as all docks hereafter made at that place will *add* to the water space, for they must be made within the line of the river wall where there is ample room and the ground peculiarly adapted for such purposes."

This very lucid report, of which we have reproduced those portions only which minister to our immediate objects, shows at any rate that the conservators of the Mersey treated the matter wholly as an imperial question, and steered clear of or ignored all local or party squabbles, and we point this fact out more particularly, because we do not think that Parliament took as wise a course in the legislation which was necessitated upon this same subject at a later period. To the conservators of the Mersey it was of little importance whether the proposed low water basin could be kept clear by means of scouring, or whether it would require dredging: that was a question which affected only the financial prospects of the Dock Company, hence it is referred to incidentally only, and there very properly considered as a novel experiment; it was eminently one however for the serious consideration of Parliament. Mr. Rendel's argument that the sea channels would derive some benefit from the volume of water drawn out of the float at low tide for the purpose of scouring the low water basin is very well disposed of by Captain Evans, but it is somewhat remarkable that that argument was not met, either by him, or before the committee by the engineers, by this most incontrovertible answer that the Victoria Bar being thirteen miles distant from Wallasey pool, the actual difference of time between similar tidal periods in the estuary being 1 h. 45 min. in 25 miles, or about 55 min. in 13 miles, according to Captain Denham, the tide would be running in over that bar at a velocity of about two miles per hour, while at Liverpool the period of dead low water had only just set in. Granted, therefore, Mr Rendel's extraordinary proposition were true, as enunciated by him before the Parliamentary committee, that the effects of the scour must be felt *immediately* at the bar when the operation begins, as he reckoned only on a velocity of from2 to $2\frac{1}{2}$ miles per hour, the effect at the bar must have been *nil*, since two currents of equal intensity that meet in opposite direction can only neutralise each other.

Upon Plate No. 285, herewith, we now have produced the wing of 100ft. dock gates, as promised in our last issue, and we purpose giving in an early issue a plate of the survey of Liverpool Bay made in 1813, by George Thomas, Master, R.N., which our readers will recollect we promised to give if we should be able to obtain it. For the original copy of this survey we are indebted to our friend Mr. Joseph Boult.

(*To be continued.*)

THE RAILWAY SYSTEM.

It might be concluded that the management of a railway is a very simple matter, from the fact that numbers of people who have had no experience of railway affairs are ever ready to suggest some means of preventing accidents, insuring regularity of trains, and, in fine, establishing a system that shall be faultless. A railway accident is capital to many of these individuals, who, with characteristic magnanimity, make public their views for the benefit of "railway companies and the public;" but it very seldom comes to pass that advantage is taken of their advice, and, probably, for the reason that, as in the generality of instances, they know absolutely nothing of the practical details of the subject they have taken up, their suggestions are accordingly useless.

If we have merely to deal with a trunk or main line, the organisation of the traffic is tolerably simple; but it is when branches and junctions accumulate that difficulties arise which can only be met by one thoroughly experienced in traffic management, and then a very efficient method of signalling is indispensable. With the present extension of railways great complicity has been introduced, and this is in a great measure due to the fact that the lines, as originally designed, were not so arranged as to afford facilities for the junctions and combinations which have recently been brought into operation. Let us take, for instance, the South Eastern Railway, and consider its working at London Bridge. There is probably no station in the United Kingdom offering so many difficulties; but yet not only is the regular traffic conducted with safety and punctuality, but even, while the line was being made, it was not interrupted, although the form of the station has been by degrees entirely changed. The mode of running the Greenwich trains involves peculiar complication, because they travel on the right-hand track, whereas, on other lines, the left-hand road is kept; thus the up Greenwich trains must, at London Bridge, cross the down rails, upon which all the through traffic is worked, including the greater part of that on the South Eastern main line, the North Kent, Mid Kent, Chislehurst, and Greenwich lines, to which is added a portion of the London and South Western traffic. Taking all these matters into consideration, it appears to us that very great credit is due to those who have the management of the line now, as well as to the author of the system of signalling adopted, which has proved its efficiency in preventing accidents for a sufficient length of time to allow an opinion of its merits to be formed.

Passing to another part of our subject, we come to the consideration of the future working of metropolitan lines, which are now so rapidly increasing in number.

It is evident that quick trains cannot be run on the same metals as those which start at short intervals, and stop at all, or nearly all, of the stations, as do those on most of the metropolitan extension lines. The question, therefore, is—how is this difficulty to be overcome?

One method which has been suggested consists in laying separate lines for the metropolitan traffic; but this system would be attended with a great disadvantage as to cost, for the extra land would be required just in those localities where its value is greatest, and it is otherwise most difficult to obtain it, for, in many instances, lines are run as close as possible to certain properties which it has, in the original construction of such lines, been considered absolutely necessary to avoid, and which, it is evident, must, in many instances, be encroached upon by increasing the width of the formation level. Were it not for such obstacles as these, the addition of extra tracks to accommodate the local traffic might not have been particularly objectionable; but, after all, the only real advantage derived would be that of enabling passengers travelling on the trunk lines to get over the last five or ten miles of their journey as rapidly as over the main portion.

It has been proposed that all main line traffic should terminate where the metropolitan district lines commence, dividing, in fact, the entire railway system into two distinct branches—the one to convey paseengers rapidly over long distances, the other to distribute them to the various localities to which they may be desirous of going in London and its suburbs. By this mode the only extra expense involved would be that necessarily incurred in increasing the accommodation at those stations which might be determined upon as the boundaries of the two systems, where of course sundry changes of trains would be necessitated. Of course, in any of these arrangements, the comfort and expedition available to the passengers would be exactly proportional to the degree of co-operation existing between the various companies, and to insure the greatest concurrence amongst them would be of the utmost importance, for even now on some of the midland lines, where the press of traffic certainly cannot be urged as a reason for so doing, the trains of one company are at some junction stations timed to leave a few minutes before a train on another line, bringing passengers who have to change, arrives at the platform, the result being frequently a very considerable loss of time, which, to business men, is serious in the day and annoying at night. We have ourselves had the satisfaction, on more occasions than one, of having to wait at a large northern station upwards of three hours without the slightest possibility of obtaining any refreshment, except what we might have furnished ourselves with previous to starting. Of course, instances like this are numerous enough, and probably attract but little attention on the part of regular travellers, but we will refer to an instance illustrative of the autocracy of railway companies, in dealing with the passengers who entrust themselves to excursion trains. A few years back a train on one of the northern trunk lines proceeding southward was a few minutes too late to catch the train which, at a certain station, should have taken the passengers on to London, The railway officials settled the matter by shunting the train into a carriage shed, full of passengers as it was, and closed the door upon it until a convenient opportunity should occur to forward it to its destination; so the passengers were left to amuse themselves, locked up in the dark for about an hour and a half. But perhaps too much stress should not be laid upon incidents of this sort, as much allowance is understood to be made in regard to excursion trains. Mentioning excursion trains naturally causes us to recur to the subject of railway accidents, which are mostly heard of in the seasons during which they run. The cause of a good many may be attributed to the almost mechanical action of the class of men employed as pointsmen and signalmen. When we say mechanical we refer to the exactitude in doing that work which is ordinarily set out for them, and their lack of efficiency when any deviation from that ordinary course of life is requisite. Thus, if an excursion train is timed very near to a regular one at a station where the traffic is considerable, it is not unlikely that a mistake may arise. It may be well here to refer to two methods of acquainting signalmen at junctions of the destinations of trains approaching them, viz., by whistle signals, and by means of signals attached to the locomotive, consisting of painted signals for day and lamps at night. The latter system we think by far the best, as it trusts nothing to the memory of the driver, beyond warning any signalmen of his approach by the ordinary whistle; and in addition to this, on local lines, it is convenient to passengers, who may in a few minutes, without any trouble, if they travel habitually on any line where such a mode of signalling is used, make themselves acquainted with the characteristic signs of the particular trains by which it is their custom to travel, and thus obviate the possibility of getting into the wrong carriages.

Concerning the question of communication between the passengers, guards, and engine drivers, of late an enormous amount of discussion has taken place, but very little, comparatively speaking, has been done; and perhaps it may be thought that amidst the vast number of inventions brought under the notice of railway authorities, it is as well to take time to consider which is best. From the number of which we hear it might appear a very simple matter, but there happen to be many points of practical working with which the inventors are unacquainted. Some have lately energetically advocated the construction of the carriages with a continuous communication from end to end; but we think that such an arrangement is scarcely consonant with English ideas, however much so it may be with those of our transatlantic brethren, amongst whom there is apparently more equality. Under these circumstances it becomes absolutely indispensable to fall back upon some mode of telegraphy, and a thorough ventilation of this subject would, in a very great degree, tend to ameliorate the difficulties by which railway managers are beset in endeavouring to decide upon what course to take. The subject is rather too lengthy for us to enter upon in the present article, but in our last issue we gave an account of a very simple form of telegraph for the purpose, and in another column of our present number will be found a description of a somewhat different method, which possesses considerable merit.

Another subject which has been started comprises such suggestions as, further legislative interference in the management of railways, centralisation, and similar projects; but we very much doubt if a Government would care about the extra responsibility of undertaking the control of such a system of lines as traverse the length and breadth of the United Kingdom, nor would the amalgamations of traffic between the lines be easily or rapidly effected; and, in addition to this, there would, probably, be at once a check put upon further railway extension. Had the entire system been from the commencement in the hands of one executive body, there is no doubt centralisation of management might have been useful; but as it is, various members have, from time to time, sprung up without any regard to even subsequent connection with others, and opposition interests have further complicated matters; hence the production, or rather elimination, of a complete and perfect system of railway intercommunication from the elements at present available must be a work of time—one which can only be effected piecemeal, and with great caution. This work finished, such a system would be of immeasurable value in the hands of a Government; but such a monopoly would be decidedly objectionable to private interests, and, perhaps, injurious to commerce.

It is to be anticipated that the recently enacted regulations as to the liabilities of deposits will put at least a temporary check upon railway speculation, and in one way it will certainly have a good effect—that is, by keeping out of Parliament all such schemes as are not *bonâ fide*, as henceforth the deposit must come out of the pockets of the promoters, and then it also runs some chance of being lost, which has not hitherto been the case.

Some slight astonishment has been created lately by the asserted importation of foreign locomotives, and we cannot leave our present subject without commenting upon it. In one case, at least, the machinery, although made in France, is certainly manufactured by an English engineering firm, hence we think it may be regarded as of the English class; and as the types of locomotives have been originally set in England, we do not consider that the giving away of a few contracts to makers out of the country indicates more than that, perhaps, on account of their not being so fully employed as our own manufacturers of locomotives, they are prepared to undertake the work at a lower price.

THE SOLUBILITY OF GRANITE IN PURE WATER and in hydrochloric acid are among the tests of its value. An indifferent granite was found to lose 0·25 per cent of its weight in the former and 5 per cent. in the latter.

CALORIC ENGINES.

No scientific endeavours appear to have been more energetically followed up by those interested in the attainment of the object in view, than such as have been directed towards the development of the caloric engine from its theoretical into a thoroughly practical form; but hitherto the ingenious inventors who have devoted so much time and labour to this branch of engineering have not met with the success which their exertions would appear to merit.

The advantages attendant upon the production of a thoroughly efficient hot-air engine have been so often set forth, that it is unnecessary for us to reiterate them in this place. The disadvantages which have hitherto militated with so much effect against their general adoption are due to their bulk, cost, want of durability, and inferior economy of working.

Hot-air engines have always been supposed, before they have been actually made, to be sure to work with a small consumption of fuel which, however, has not been realised, either from erroneous construction or from the calculations being based upon erroneous theories. Per indicated horse-power, some caloric engines would, it is true, compare very favourably in point of economy with ordinary steam engines; but then there are great losses by friction, on account of the large size of the cylinder, feed pumps, &c. Furthermore, in many cases, more is lost in the rapid deterioration of the machinery than is gained by the saving of fuel.

With regard to the actual consumption, we may give the following data:—Mr. Stirling is said to have succeeded in obtaining as low a consumption as 2½lb. of coal per indicated horse-power per hour. Capt. Ericsson's engines, of from 1 to 4 horse-power, which have, to some extent, been practically applied in America and Germany, have not yielded results nearly so favourable, giving a consumption of from 8 to 12lb. of coke per horse-power, as measured by Prony's brake. It must be borne in mind, in comparing these two engines, that the latter statement is given for *effective* horse-power; whereas, in the former case, the gross indicated horse-power appears to have been taken, and between these two there will be a very considerable difference, on account of the loss by friction already alluded to; but even after making this allowance, the Ericsson engine will bear no comparison with Mr. Stirling's, or with an ordinary steam engine.

Mr. Gill proposed to use a mixture of air and steam as the medium or vehicle of thermo-motive power, expecting thereby to increase the facilities for heating the air, and also for keeping the working parts efficiently lubricated so as to prevent the undue wear by friction. The first idea of his engine he embodies in these words: "An engine actuated by compressed air always saturated with moisture, which should be heated by injection of steam, and cooled by injection of cold water—to give and remove such portions of the heat as might not be transferred by the metallic lungs of the machine." The results obtained from preliminary experiments are stated to have been extremely favourable, but we are not aware that the principle has been tried upon any extensive scale; it certainly merits some attention.

One of the latest productions worthy of consideration is, that known as Messer's hot air engine, and the results obtained from it are certainly promising. We inspected one of these machines which was exhibited some months back, and thereupon formed our opinion.

Air engines have been called condensing and non-condensing, the former being so arranged that the heated air, after doing its work in the cylinder, is contracted by external cooling influences, thereby reducing the back pressure. The non-condensing being constructed in such a manner that the air escapes directly and without any external cooling influence being applied to reduce its pressure, although a regenerator may be used to recover some of the waste heat.

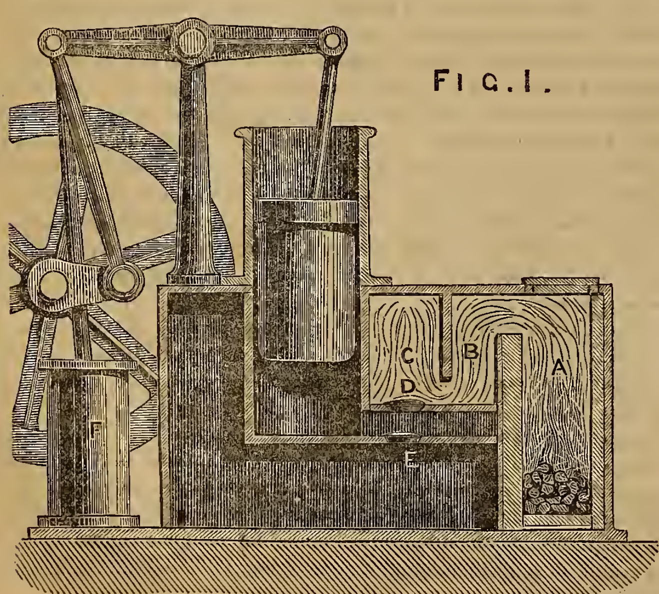
The engines of Stirling and Gill may both be regarded as condensing engines, but that of Ericsson as non-condensing; and from the description we are about to give, it will be observed that Messer's engine is non-condensing and non-regenerative.

The fuel, by the combustion of which is developed the heat necessary for the production of motive power, is euclosed in an air-tight vessel, the air neccssary for comhustion heing forced into it upon the fuel by an air pump worked by the engine; the air, after passing the surface is, together with its attendant products, passed into the working cylinder, where it acts upon the piston, heing subsequently discharged direct into the atmosphere. The engine which we inspected was single acting.

We will now proceed to consider the advantages of this engine, commencing with the mode in which the heat is developed hy the combustion of the fuel under pressure.

When combustion occurs in an open furnace, a considerable portion of the heat-giving elements of the fuel is lost, and, in addition to this, much waste heat is carried off in the gases escaping from the chimney. In the first instance, as soon as the air entering the furnace comes in contact with the incandescent fuel it is heated and expanded, from which two results proceed—first, from the greater rarity of the air its containcd oxygen is less accessible to the hydro-carhyls, and carhyls of which the fuel consists; and second, hy reason of its levity it tends to escape with a rapidity that does not leave it a sufficient timc in contact with the combustible matter, to allow of the absorption of all the oxygen in it; subsequently, the air passing away with the gases into the atmosphere, carries off with it a vcry considerable portion of the total heat generated, and the only results produced consist in heating the surrounding atmosphere and raising particles of carbon as smoke, which particles would, if the action of the furnace were perfect, he themselves consumed, and generate heat instead of being thus uselessly cast away. When the fuel is consumed under pressure, the results are widely different from those above mentioned. The air supplied to feed the furnace is compressed, so that at the moment of its contact with the coal, the quantity of oxygen requisite for the perfect decomposition of the hydro-carbyls and carhyls is far more accessible, and it is hy the pressure held in contact with them, so that facilities are thus offered for effecting perfect combustion, which, under ordinary circumstances, do not exist in an open furnace; and, moreover, heat is not lost by being carried away up the chimney without any work being derived from it.

Thus is obtained a very great economy of fuel at once, for the smoke from it is consumed, and the heat commonly lost in the draught saved. The general form of Messer's air engine is shown in the accompanying



diagram, Fig. 1. A is the furnace into which the fuel is fed, and from whence the hcated gases pass through passages B into the valve box C; it is thence admitted through the valve D into the working cylinder, where it comes in contact with the piston, which is protected in the usual manner hy a heat intercepter, and at the termination of the stroke passes through the valve E into the atmosphere. F shows the air pump which feeds the furnace.

We are inclined to helieve that the ecouomy of this engine depends principally upon the *modus operandi* of the furnace, for the only peculiarity of the engine is that it has neither condenser nor regenerator. But with regard to the latter the henefit derived from it when used dry, as in Ericsson's systems, is doubtful, as against that benefit must he set the loss hy back prcssure due to the friction of the air in passing through the wire gauze which is used to regencrate or absorb the heat from the exhaust air to be suhsequently imparted to the air entering the cylinders, or rather the heaters.

From the descriptions of Ericsson's caloric engine of 1852, it would appear that the regenerators were so proportioned as to allow a surface of about 16 square feet of wire ganze per horse-power, and for a fifty horse engine this would amount to,

$$16 \times 50 = 800 \text{ square feet,}$$

$$= 115{,}200 \text{ square inches,}$$

which, taken at 100 meshes per square inch gives 11,520,000 cells in the regenerator, and the friction of the air in passing through these must be something considerable.

Messer's engine, on the whole, appears to be the most practicable machine of its class yet hrought forward, and it is worthy of notice that the packings which are of leather appear to he very durable—a very important point in hot air engines—and the other working parts do not appear to suffer much from the heat. The engine is moreover very compact.

If these machines can be made sufficiently durable, safe, and economical there can he no douht they will rapidly come into use; and if they can he adapted to locomotives, there will be a very great saving in weight, as of course there would he neither hoiler, tender-tank, nor the weight of water to be carried, and longer journeys might be run without stopping, the supply of elastic fluid being drawn from the atmosphere.

One matter yet remains to be settled, which is the point of prime cost. Messer's engine must cost more in proportion to its power than a steam engine *per se*, hut there is no hoiler required, so it may turn out that the former are not more expensive than the latter with all necessary adjuncts, and the space occupied by the motive power is also smaller in the case of Messer's engine.

It may, in conclusion, be desirahle to observe that the engine we inspected was working at the low pressure of fourteen pounds per square inch, but even then was exhibiting a very fair economy of fuel for the work done.

THE ATLANTIC TELEGRPH CABLE.

Now that the expedition to lay the Atlantic Cable has terminated, not in all probability, to he renewed this year, it appears desirahle to record the facts which have been supplied. While the fate of the attempt was unknown conjecture could be of no practical utility, although its extent and variety, while news was heing waited for, sufficiently evinced the strong interest generally felt in the undertaking; and this was somewhat enhanced, douhtless, hecause two of the greatest works contemplated in the present century were for a time associated together—the *Great Eastern* and the Atlantic Cable. Unfortunate as the former has heen as a commercial speculation, it offered peculiar advantages when applied to the purpose for which it has heen, and now is, engaged. Its safety, even in stormy weather, among the waves of the Atlantic has been well established. On this poiut we can have no more reliable opinion than that arrived at by those engaged in the late expedition, and they unanimously arrived at the conclusion "that the steamship *Great Eastern*, from her size and consequent steadiness, together with the better control obtained over her by having both the paddles and screw, renders it possible and safe to lay an Atlantic cable in any weather."

We will now state very briefly the history of the laying of the present cable as far as it has already proceeded:—

On the 21st July last an earth cable, according to Mr. Varley's plan, was laid from the telegraph station at Foilhummerum, and on the 22nd July the thick shore end of the Atlantic Cable was carried on shore from the *Caroline*, over a bridge formed of 25 fishing yawls. The *Caroline*, veering out the cable, in the track buoyed by Lieutenant White dropped the end 26 miles W.N.W. of Valentia, at 10.30, and stood by the buoy all night. The *Great Eastern* was signalled off Valentia at 7.45 next morning, and from her the end of the main cable was passed on board the *Caroline*, the terminus of the shore end being hauled up, the splice was made and subjected to rigid tests, and found to be satisfactory. At 4.50 p.m. the testing of the splice being complete, the *Great Eastern* prepared for her course to the west, and at 7.16 p.m. the first fathom of the cable was paid out. The working of the paying-out machinery was very satisfactory, and after a while the speed of the vessel was increased from 2½ to 3½, and ultimately to 6½ miles per hour, the electrical condition of the cable all the time being perfect, at 10.47 p.m., 50 miles of cable had been paid out. July 24th, 3.15 a.m., when 84 miles of cable had been paid out, the electrician engaged in signalling to the shore, observed an aberration of the index-light, indicating a disturbance of the current, and some tests showed that there was a "fault" in the cable. The *Great Eastern* was stopped and a gun fired, to call the attention of the *Terrible* and *Sphynx*, attending her. Much difficulty was experienced by the electricians in endeavouring to come to some conclusion as to the position of the fault, although they were aided by the best testing instrument. However, Mr. Canning at length resolved to cut the cable, and haul it up until the fault was found; it was cut at 9.50 a.m. Some dissatisfaction arose from the fact that the boiler intended to work the engine of the hauling-in machinery proved scarcely equal to its duty; the strain varied from 22 to 36 cwt. The rate of picking up at no time exceeding one mile and a-half per hour and one mile per hour was considered very good. Meantime, Mr. Saunders and Mr. Varley conjointly arrived at the conclusion that the fault could not be more than 10 or 11 miles away, but they could not state this with certainty. At midnight 6 miles of cable had been hauled in, and the fault was still overboard. At an early hour, July 25th, the *Hawk*, which had been telegraphed for, was observed coming up, and at 9.15 a.m. 9½ miles had been recovered. At 9.45, when a little more than 10 miles of cable had been picked up, the fault came on board, it's cause was due to a piece of iron about 2 inches long and rather crooked, having run into the cable until it came in contact with the wire. At 2.50 p.m., the splicings having been completed, the *Great Eastern* again turned westward, and re-commenced the paying out. At 3 o'clock, when about 1½ miles had been dropped over, the signals from shore ceased, and again preparations were made for taking up the cable. Presently, however, the index light re-appeared, and at 4.15 p.m. the ship again resumed her course at from 6 to 6½ knots, which was reduced about midnight. The cause of the fault this time could not be determined, but was supposed to exist at the station on shore. July 26, at 1.45, the *Terrible* signalled that the great ship was going too fast for the *Sphinx*, but as the cable was running well, it was not thought desirable to slacken speed. The inconvenience of leaving the *Sphinx* so far behind was felt when soundings were required as the *Terrible* had not sounding machines on board. On the 27th, the *Sphinx* was lost sight of. All went well till 1.10, ship's time, July 29th, when all insulation was lost, and it was again necessary to commence picking up the cable, the strain was sometimes indicated to be as high as 2½ tons, at 11.15 p.m. the defective part of the cable was got on board At 10.8 p.m., July 30th, the cable was again running over the ship's stern. An examination of the injured part of the cable led to the painful conclusion that the mischief was the work of some malefactor hired to destroy the cable, and, accordingly, the gentlemen on board formed a corps of supervisors, who undertook to watch the tanks by turns. July 31st, at 3 a.m., the screw engines were stopped, and, at 3·30 ship's time, the paddles were slowed to allow the last coil of the after tank to be run out, and the operation of paying out transferred to the fore tank. Subsequently the progress was satisfactory, until about 8 a.m., August 2nd, when orders were given from the electrician's room to reverse the engines, a fault having been detected. At 9·55 a.m., the cable was severed to be hauled in at the bows, so that it might be picked up. At this time 1,186 miles had been paid out. At this time defects occurred in the steam machinery, which caused considerable delay and much strain upon the cable, and, when the picking-up was fairly commenced, the cable parted, and the end sank in the Atlantic. It was decided to fish for the cable, and the *Great Eastern*, after the necessary preparations, succeeded in drifting over it, and seizing it in the grapnels, the hauling-in commencing August 3rd, 6·40 a.m. At 3·30 p.m. ship's time, the hawser parted, one of the swivels breaking, and again the cable was lost.

As there yet remained cable enough on board for another trial to regain that lost, the determination to once more "fish" was arrived at. Aug. 7, the cable was again grappled, but a little after 7.30 a.m. Aug. 8, the hauling tackle again broke, and the end of the cable returned to its resting-place. After some deliberation with Captain Anderson, Mr. Gooch and others, Mr. Canning again determined upon making another trial to recover the cable, which however was unsuccessful, the chain to which the grapnel-shank was attached having taken a half hitch round one of the flukes, and so preventing the instrument from catching on the bottom. At 11.30, Aug. 11, the *Great Eastern* telegraphed the *Terrible* that a final effort would be made to recover the cable, but at 9.50 p.m., when the cablo had been again grappled and 765 fathoms of the hawser hauled it the rope parted, and so the final attempt failed. Thus terminated for the present season the expedition to lay the Atlantic Telegraph cable, when it was completed, to within about 600 miles of its western terminus. From the opinions of those on board the *Great Eastern*, it is concluded that the practicability of establishing an Atlantic Telegraph is beyond a doubt. The paying-out machinery was found to work perfectly, and thorough confidence could be placed in it; it was constructed by Messrs. Canning and Clifford. The insulation of the gutta-percha covered conductor improved when submerged to more than double what it was previous to starting, and the cable thus proved itself to be superior in insulation to any others yet manufactured.

It has been stated that it will be impossible to drag the cable again to the surface, on the presumption that it will not be able to withstand the strain necessary to trail the end along the bottom, so as to give the requisite quantity of slack; but this is by no means proved, and it at present seems probable that next season an attempt will be made to recover the missing telegraph, and, at all events, the recent endeavours to complete it have shown that the machinery and means employed are greatly improved since the first project for bringing the opposite shores of the Atlantic into communication was entered upon, and there can now be no doubt that if any vessel can successfully lay the cable, that vessel is certainly the *Great Eastern*.

RAILWAY INTERCOMMUNICATION.

A very simple method of communicating between the passengers, guards, and drivers of trains has lately been brought under our notice, and it has also the recommendation of providing the means of enabling passengers in one compartment of a carriage to obtain the assistance of those in the next, which, under some circumstances, is a great desideratum. In the partition between two compartments of the carriage there is a rectangular opening closed by a panel capable of sliding endwise; handles are supplied whereby this panel may at will be moved endwise so as to open a communication between the two compartments divided by the partition in which it works, at the same time exhibiting a red signal—a disc by day and a lamp by night—at the side of the carriage, so as to be visible to the guards, drivers, and passengers of the train, and also to the porters at any station the train may chance to be passing; there is also a bell which may be rung when the signal is exhibited. The signal cannot be replaced by the passengers, and the position of the handles by which it is actuated indicate the portion of the compartment from which it has been worked.

This contrivance is the invention of Mr. E. Barber Bernard.

ON THE DETAILS OF WATERWORKS.

Introductory.

In the ensuing series of papers on the details of waterworks, our object is not to give an exhaustive account of the general arrangements of waterworks, as this course of procedure has been sufficiently often taken in works touching upon the subject; but we propose to treat of specialities, showing by what means particular circumstances are met, so, as in fine, to set forth rather the best ways of overcoming those difficulties which constantly beset hydraulic engineers, than the first principles by which ordinary undertakings are dealt with.

In this place, however, it appears desirable to examine the causes of those difficulties with which we have to contend when executing hydrulic works of any extent. In many localities the sources of supply have, within the last few years, changed remarkably; thus, at the Kent Waterworks, at Lewisham, formerly the supply of water was derived from the Ravensbourne River, and, accordingly, filter beds were constructed, in order to remove such organic matter as might be held in suspension (for it may be well to observe here that the sand filter beds only remove such matters as are held in suspension, affecting in no way the chemical qualities of the water). Now these filter beds are disused, the main supply being drawn from Artesian wells, reaching the cretaceous strata, which at that locality does not lie very deep; thus one well only 100ft. deep yields about one million gallons of water per diem. Hence it is highly important, in constructing waterworks, to consider carefully their ultimate prospects, by which means excessive or useless expenditure may frequently be avoided. For instance, if it had been decided to open Artesian wells at the outset for the supply of the Kent Waterworks, the cost of the filtering beds would have been avoided; and it should have been known that water was easily obtainable, from the cretaceous strata in that locality in almost unlimited quantities.

To pass to another question, many difficulties arise when drainage water has to be dealt with, as its quality varies most notably with the seasons, and in fact, when drawn from peat land, we think it but a very unreliable source of supply. Of course the water may be stored and filtered, but it will in many cases require a very large filtering surface to render it fit for human consumption, more especially in the autumn months, when the decaying foliage contaminates our rivers, crowding them with organic matter which, although in suspension, cannot be easily eliminated. Some years since it was regarded as impracticable to purify Thames water in October, but the practicability was proved by the construction of the Kew Branch of the Grand Junction Waterworks, where, by allowing ample surface for filtration, the organic matter in suspension was most effectually disposed of.

It is now sufficiently evident that in dealing with water supply no general rule can be laid down, as in almost every practical case some peculiarities of either source of supply, or situation arise which require special modes of treatment, and it is our object to supply, as far as possible, such information as may *guide* the engineer in dealing with localities exhibiting peculiar difficulties.

Section I.—Collecting and Storing Water.

There is probably no branch of engineering which for its successful practice requires a knowledge so thoroughly practical as that which deals with water—subtle in its advance, irresistible in its power. The mere leakage through a cranny in a rock may ere long become a current scooping for itself a channel below its point of effluence. Similarly a slight overflow across the top of a dam will commence the work of tearing down the bank, nor will the mischief cease until utter destruction has ensued.

Where water for the supply of towns is collected from a drainage surface it will require filtration, and it must be stored in the rainy seasons in reservoirs in order to maintain the supplies during the months of drought. For large towns it is obvious storage reservoirs of great extent will be required, and in the construction of these the greatest care is necessary to prevent the recurrence of such terrible catastrophes as have from time to time appalled the villages in the vicinity of storage reservoirs.

It may be desirable to give some idea as to the quantity of water requisite as a reserve for the supply of a town of moderate dimension when the source is such as above mentioned. Take the population as 20,000 inhabitants, it is usual to allow 20 gallons of water per head per diem, and 20,000 × 20 = 400,000 gallons per diem, supposing it is decided to store sufficient water for a six weeks' supply, the total quantity will amount to 400,000 × 42 (days) = 16,800,000 gallons, and there being 6·232 gallons to a cubic foot the contents of the reservoir will be nearly 2,700,000 cubic feet, so that if its depth be assumed as 15 feet, the area covered by the reservoir would be about four acres, and taking it to be square each side would be 424 feet, if the reservoir were made upon level ground it would probably have about 7 feet of its depth below the ground level, and 8 feet above in embankment, let us see what would be the pressure on such an embankment.

Water weighs about 62.32lbs. per cubic foot, and the pressure of liquids being equal in all directions, it follows that the pressure per square foot upon the retaining wall or dam at any point will be equal to the weight of a cubic foot of water multiplied by the depth of such point below the surface of the water in the reservoir; hence, in the present case, the pressure per square foot at the bottom of the embankment will be 62.32 × 8 = 498·56 lbs., that at the top of the embankment being *nil*; the average pressure will therefore be $\frac{498·56 + 0}{2}$ = 249·28 lbs. per square foot. The area of one wall or dam is in the vertical plane 424ft. × 8ft. = 33·93 square feet, which, multiplied by the average pressure of 249·28 lbs. per square foot, gives as the total pressure on the embankment 845,558 lbs., nearly which is equal to about $377\frac{4}{10}$ tons. The wall to resist this pressure must be of such weight that it shall not be overturned, of such materials that it shall not be broken, and upon such a foundation that it shall not slide. When the data are given all these points may be easily determined by calculation; but the danger exists of not obtaining accurate information whereon to work, especially as regards the foundation; hence it is very desirable, as a general rule, to keep the embankments as low as possible; but even then it is very necessary to be particular about te substrata, because they have to support the bottom of the reservoir upon which, when full, there is a pressure of about 75,000 tons, being 934·8 lbs. per square foot.

From these observations it will be seen how very important are the forces to which dams for storing large quantities of water are subjected; and the peculiar searching character of these forces demands that the actual execution of the dams should be effected with the utmost care. Thus, the foundations having been carefully bored, so as to ascertain the nature of the soil, it should first, when levelled, be carefully covered with a sufficiently thick layer of puddle, made of stiff clay, and, in applying this, it should not be used very wet, but merely sufficiently moistened to allow the whole mass to become homogeneous when it is well rammed or punned. If it be applied very wet (as is sometimes done, because in that state it works more easily), then, as it dries, large cracks and seams will open in it, which will require to be closed by punning, and, of course, the wider these cracks are the more difficult will they be to close, and the greater will be the danger of leakage. On loose, rocky strata, especially, is it necessary to watch constantly the progress of the puddling, and the subsoil itself offers no resistance to the passage of the water.

As an instance of the serious results accruing from the neglect of this point, we may mention a square reservoir, 200 feet in length on the side, which was constructed upon the top of a hill, about 350 feet above the level of the sea. The substrata was of broken oolite, with large crevices. The engineers resident on the works not being sufficiently attentive only two or three inches of puddle were put down where at least 18 inches were necessary. When the reservoir came to be filled a leak occurred in the bottom and all the water filtered away through the subsoil. The work had, of course, to be taken up and done over again. Upon the layer of puddle is spread a stratum of concrete varying from three to six inches in thickness according to the nature of the work, but this should never be applied until the puddle beneath has become perfectly hard, dry, and solid, all the cracks in it having been closed by punning. When the concrete is applied care must be taken to have it of good quality in order to insure stability, some of our best hydraulic engineers have found that the proportion of 11 parts of gravel to 2 parts barrow lime produces a very good and durable concrete. Upon the concrete in all cases the sides should be bricked, although it is not always necessary so to cover the bottom (which will nearly always have water upon it), for it has been observed that even when the concrete used is of the best quality the alternate exposure to air and water will greatly deteriorate it, and frequently in the course of a few years render it unreliable and rotten. In one or two instances we have observed that brick courses have been laid *dry* (*i. e.*, without mortar or cement), in order to protect the subjacent concrete, but such a proceeding is almost useless as both the water and the air penetrate to the concrete and gradually destroy it. In one instance which came under our notice the concrete at the bottom of the reservoir was perfectly sound, offering a considerable resistance to the pick, but at the water line and thereabouts it was friable, so that a stick might easily be thrust through it into the bank behind.

(*To be continued.*)

MECHANICAL PROGRESS IN AMERICA.

Jackson's Oil Well Pump (Root's Patent).—As far as may be judged from the action of oil wells in America, it appears that the oil frequently if not generally exists in cavities or caverns. In the upper part of such caverns gases accumulate tending to drive the oil out of the cavities into the wells, and sometimes with sufficient pressure to force it up to the surface. As the oil is drawn off, the gases acquire a correspondingly increased space wherein to expand, the result of which is that their pressure is reduced, so that the oil ceases to flow over the well, and then it becomes necessary to apply pumps, by which means oil is obtained until the level of its surface in the well falls below the suction valve of the pump, when of course the supply becomes irregular. The distinctive feature in Root's Patent Pump is the provision for producing a vacuum in the well by pumping out the air or gas, so that the oil may be drawn from all the crevices that communicate with the well, more freely than if its movement depended entirely on the differences of level and pressure, which would exist without such provision. In practical application the pump which lifts the oil is surrounded by an annular pipe which is in communication with an air pump worked by the steam engine—the top of the well being closed air and gas tight. Thus the air and gas being exhausted from the well, the oil flows into it freely, and is thence lifted by the pump. The air pump worked to its full speed delivers a volume of air 300 times greater than the volume of oil, and it may be worked at any rate from 30 to 300 times the capacity of the oil pump, or less if required, or the belt may be thrown off at any time when it is unnecessary to work it. Upon the pipe through which the air is exhausted from the well is a gauge, so that the attendant may observe and regulate the vacuum, in order to keep the level of the oil above the suction valve of the lift pump.

A New Rock Breaker.—Messrs. Hodge and Christie, machinists of Detroit, have completed a new rock breaking machine for the Colorado Gold Mining Company of Philadelphia, which they have patented. It is a rotary machine, having a heavy cylinder, into the periphery of which huge cams and grinders are firmly fixed. These revolve in a side hopper constructed with strong ridges or ribs of iron, between which and the moving cams the masses of rock are crushed to pieces. The fragments are then passed into a second hopper, and ground to powder between a pair of powerful rollers. A heavy fly wheel regulates the speed and equalises the power. This machine can be driven at almost any speed, and it is estimated that it will crush from twenty to eighty tons of rock per hour, and it takes fragments as large as can be conveniently handled by one man. It is to be driven by a 100 horse-power steam engine. The cost of it is £6,400.

Paper Pipes.—The Portage (Lake Superior) *Mining Gazette* says that paper pipes have been adopted, and are now in use in the Pewabic copper mine, to convey air from one portion of the workings to another. Each pipe is six inches in diameter inside, the paper material of which it is composed being one quarter of an inch in thickness. The pipes are quite strong, and can be joined air tight by a strip of canvass and a coating of tar.

The Hoosac Tunnel.—The work at this tunnel is progressing at the rate of 60ft. a month, but new machinery and water power are expected soon to multiply this rate three or four times. The central shaft is about two and a half miles from the eastern entrance in a straight line. The shaft has already been sunk upwards of 110ft., and when completed it will be 1,020ft. in depth. The west shaft has been sunk over 300ft., and on both faces about 400ft. have been tunnelled. The derricks at both shafts are driven by steam, and the stone is raised in elevators suspended by wire ropes, and run off upon rails to the dumping places. The workmen are divided into gangs, and the labour is continued night and day.

Steam Ploughing.—An improvement has been proposed on the Fowler system of steam ploughing. This system, it will be remembered, depended for its success chiefly upon the steel-wire rope. It is now proposed to substitute the rope by a steel belt, which, it is thought, will be lighter and more durable than the rope, besides requiring less power to bend it round the drum. A strip or ribbon of steel, $\frac{1}{16}$ in. in thickness and 2in. in width, will with safety bear a working strain of 6,000 lbs., and will admit of being wound round a drum 20in. in diameter. It is proposed to use a drum of this size, and on each side of it a roller of 6in. in diameter; both rollers will bear on the steel belt; the rollers and drum will be geared, so that they may be driven by the engine; and there will be four contact surfaces for adhesion. In this case, supposing the belt and rollers to be clean, the adhesion will be ·8 of the pressure on the journals.

Novel Well Boring Machine.—On the eastern bluff of Cherry Run there is a novel kind of well-boring machine at work under the auspices of the Rock Drill Manufacturing and Mining Company of Pennsylvania. The derrick carrying the apparatus is 80ft. in height and 30ft. square. The peculiarity of the machine is that the drill, sand pump, and reamer are all combined so as to work together, thereby causing no delay in the actual progress. It is stated by the proprietors that they can put down a well 600ft. deep in twenty-six days. At the particular well alluded to they attained a depth of 150ft. in six days. This machine has also been tested at Burning Springs, West Virginia, with an average progress in the depth of nearly 6ft. per hour. It is stated that, on Cherry Run, the progress made in drilling through slate and soapstone has been $1\frac{1}{4}$in. per minute, the machine being driven by a 10-horse engine. The entire cost of the machine, including tubing, for a well is £1,000.

New Steam Boiler.—Mr. Henry Gerner, of New York, has patented a novel kind of steam boiler, which is so constructed that the steam dome or chamber lies wholly within the water space, so that the boiler can be filled with water up to the top, and the fire allowed to act upon its entire surface. The steam reservoir of the boiler being thus surrounded by the heated water, the radiation of heat from such reservoir is avoided, with the corresponding loss of steam by condensation.

Patent Turbine.—Mr. J. E. Stevenson has invented an improved form of Jonval Turbine. The improvement consists in substituting the helix instead of a large iron case, and so constructing it as to reduce the friction of the water passing through, to a minimum, the water leaving the buckets of the wheel with nearly its full force. The buckets are also so arranged that the water leaves them in its natural course and direction, so that the turbine receives a strong and steady motion such as is not easily affected by throwing machinery on and off. By such arrangements the turbine is rendered suitable for driving all mills where a first-class, smooth, and equable motion is required, and it is moreover very durable.

Walker's Eccentric.—This eccentric (patented) allows of the engine to which it is applied being reversed by a very simple movement. The position of the eccentric is determined by two wedges, one on each side of the shaft, which may be moved longitudinally on feathers by means of a lever acting upon a loose strap, which surrounds a groove cut on the extremity of the piece, to which the two wedges are attached. This apparatus possesses the advantage of being steadier and firmer than the common loose eccentric.

INSTITUTION OF CIVIL ENGINEERS.

LIST OF SUBJECTS FOR PREMIUMS FOR THE SESSION 1865-66.

The council of the Institution of Civil Engineers invite communications on the subjects comprised in the following list, as well as upon others; such as, first—authentic details of the progress of any work in civil engineering, as far as absolutely executed (Smeaton's Account of the Eddystone Lighthouse may be taken as an example); second, descriptions of engines and machines of various kinds; or, third, practical essays on subjects connected with engineering—as, for instance, metallurgy. For approved original communications, the council will be prepared to award the premiums arising out of special funds devoted for the purpose.

The council will be glad to receive, for the purpose of forming an appendix to the minutes of proceedings, the details and results of any experiments or observations on subjects connected with engineering science or practice.

1. On the theory and details of construction of metal and timber arches.
2. On landslips, with the best means of preventing or arresting them, with examples.
3. On the principles to be observed in laying-out lines of railway through mountainous countries, with examples of their application in the Alps, the Pyrenees, the Indian Ghauts, the Rocky Mountains of America, and similar cases.
4. On the principles to be observed in the designing and arrangement of terminal and other railway stations, repairing shops, engine sheds, &c., with reference to the traffic and the rolling stock.
5. On railway ferries, or the transmission of railway trains entire across rivers, estuaries, &c.
6. On locomotive engines for ascending steep inclines, especially when in combination with sharp curves, on railways.
7. On the pneumatic system for the conveyance of passengers and goods.
8. On the results of a series of observations on the flow of water from the ground, with accurately-recorded rain gauge registries in the same locality for a period of not less than twelve months.
9. On the construction of catch-water reservoirs in mountain districts for the supply of towns or for manufacturing purposes.
10. Accounts of existing water-works, including the source of supply, a description of the different modes of collecting and filtering, the distribution throughout the streets of towns, and the general practical results.
11. On the structural details and the results in use of apparatus for the filtration of large volumes of water.
12. On the construction of gas works, the most economical system of distribution of gas, and the best modes of illumination in streets and buildings.
13. A history of any fresh water channel, tidal river, or estuary, accompanied by plans and longitudinal and cross sections of the same at various periods, showing the alterations in its condition—including notices of any works which may have been executed upon it, and of the effects of the works; particularly of the relative value of tidal and fresh water, of the effect of enclosures from the tidal area upon the general regime, of sluicing where applied to the improvement of the entrance or the removal of a bar, and of groynes, or parallel training walls; also of dredging, with a description of the machinery employed, and the cost of raising and depositing the material.
14. On the construction of tidal or other dams in a constant or variable depth of water, and on the use of wrought iron in their construction.

15. On graving docks and mechanical arrangements having a similar object, with the conditions determining their relative applicability in particular cases, as dependent on the rise of tide, the depth of water, and other circumstances.

16. On the arrangement and construction of floating landing stages for passenger and other traffic, with existing examples.

17. On the different systems of swing, lifting, and other opening bridges, with existing examples.

18. On the construction of lighthouses, their machinery and lighting apparatus, with notices of the methods in use for distinguishing the different lights.

19. On the measure of resistance to steam vessels at high velocities.

20. On the results of the employment of steam power on canals, and of other measures for the improvement of canals as a means of conveyance for heavy traffic.

21. On turbines and other water motors of a similar character, and their construction and performance in comparison with water-wheels.

22. On the present systems of smelting iron ores, of the conversion of cast iron into the malleable state, and of the manufacture of iron generally, comprising the distribution and management of iron works.

23. On the manufacture of iron for rails and wheel tyres, having special reference to the increased capability of resisting lamination and abrasion, and accounts of the machinery required for rolling heavy rails, shafts, and bars of iron of large sectional area.

24. On the Bessemer and other processes of steel making, on the present state of the steel manufacture on the continent of Europe, and on the employment of castings in steel for railway wheels and other objects.

25. On the use of steel for the tyres and cranked axles of locomotive engines, especially with reference to its durability and the cost of repairs, as compared with iron of acknowledged good quality, and on the use of steel bars and plates generally in engine-work and machinery for boilers and for shipbuilding, as well as for bridges.

26. On the safe working strength of iron and steel, including the results of experiments on the elastic limit of long bars of iron, and on the rate of decay by rusting, &c., and under prolonged strains.

27. On the transmission of electrical signals through submarine cables.

28. On the present relative position of English and Continental engineering manufactories, especially with reference to their comparative positions in respect of the cost and the character of the work produced.

29. Memoirs and accounts of the works and inventions of any of the following engineers:—Sir Hugh Middleton, Arthur Woolf, Jonathan Hornblower, Richard Trevithick, William Murdoch (of Soho), Alexander Nimmo, and John Rennie.

Original papers, reports, or designs of these, or other eminent individuals, are particularly valuable for the library of the Institution.

The council will not consider themselves bound to award any premium should the communication not be of adequate merit; but they will award more than one premium should there be several communications on the same subject deserving this mark of distinction. It is to be understood that, in awarding the premiums, no distinction is made, whether the communication has been received from a member, or an associate of the Institution, or from any other person, whether a native or a foreigner.

The communications must be forwarded, on or before the 1st of January, 1866, to the house of the Institution, No. 25, Great George-street, Westminster, S.W.

INSTITUTION OF MECHANICAL ENGINEERS.

ON THE CONSTRUCTION OF BLAST FURNACES, AND THE MANUFACTURE OF PIG IRON IN THE CLEVELAND DISTRICT.

By Mr. James George Beckton.

Within the last ten years the blast furnaces which have been erected in the Cleveland district have been gradually increased in size both in diameter and height; and these alterations have thus far been attended with good results, so much so that almost all the new furnaces now in course of erection are being built with boshes ranging from 16ft. to 22½ft. diameter, and from 60ft. to 75ft. in height from the bottom of the hearth to the filling plates at the top. Previously the furnaces ranged from 13ft. to 15ft. diameter at the boshes, and from 45ft. to 50ft. in height, the extreme increase being about 70 per cent. in both dimensions. The maximum diameter of the boshes appears not yet to have been attained; and the limit to the height will apparently be found in the strength of the coke to support the crushing force of the high column of materials in the large blast furnace. The make of pig iron has increased at the same time from 200 tons per week in the small furnaces to 300 tons in the large furnaces.

The average quantity of materials used in the production of one ton of pig iron in the large furnaces is as follows:—

26 cwts. of Durham coke,
70 „ of Cleveland ironstone,
15 „ of limestone,
10 „ of coal for boilers, hot-blast stoves, and calcining kilns.

121 cwts. total,

or about 6 tons of materials per ton of iron made. Formerly the quantity of coke used per ton of iron made averaged 35 cwts. instead of 26 cwts., and the quantity of coal 20 cwts. instead of 10 cwts. The writer does not attribute the whole of the saving of fuel which has taken place to the increased size of the furnaces alone, as there are several other improvements which have combined to produce an economy of fuel in the manufacture of pig iron in the Cleveland district, of which the following are some of the principal:—

First, the more efficient management which has taken place at the different works.

Second, the better adaptation of engine power and hot-blast stoves to the requirements of the furnaces.

Third, the improved system of calcining the ore, which was formerly carried on by clamping in the open air, but is now performed in properly-constructed calcining kilns.

Fourth, the higher degree of temperature of the blast supplied to the furnaces, which was formerly heated in the hot-blast stoves to only 600° or 700° Fahr., but is now very generally being supplied to the furnaces at a temperature of from 800° to 900°.

Fifth, the plan of taking off the waste gas from the furnaces, and burning it at the boilers and hot-blast stoves, in place of using additional coal for this purpose.

The application of the waste gas to the boilers and hot-blast stoves is becoming very general at the different works in the district; and arrangements are now being made at several of the new works in course of erection for applying it to the calcining kilns, for the purpose of calcining the ironstone. The plan in general use for taking off the gas from the blast furnace is the closed furnace top with bell and hopper sufficiently large to charge from 8 tons to 10 tons of materials into the furnace at once, and with an arrangement for raising and lowering the bell by hand. The impression seems to be gaining ground that taking off the gas with the closed top, and in connection with a large chimney double the height of the furnaces, does not interfere with the operations of the large furnace, either as regards economy of fuel or quality and make of iron.

A noticeable feature in the large furnaces is the greater amount of time the materials are allowed to remain in the furnace. The capacity of the Thornaby furnaces, shown in section in the accompanying woodcut, fig. 4, with 20ft. boshes and 60ft height, is 12,361 cubic feet; the area of the boshes is 314 square feet, and the make of iron 300 tons weekly per furnace. The capacity of the small furnaces which were formerly erected, with 14ft. boshes and 50ft. height, is 5,553 cubic feet; the area of the boshes is 154 square feet, and the make of iron 200 tons weekly per furnace. In the large furnace, therefore, there are more than twice the quantity of materials undergoing the process of heating, and also remaining a longer time in the furnace. Moreover, the area of the boshes in the large furnace being double that in the small furnace, while the quantity of iron produced by the large furnace, and consequently the quantity of blast supplied, is only one and a half times as much as in the small furnace, it follows that the ascending gases pass through the materials at a slower velocity and at a lower temperature in the large furnace. This allows the coke to descend to the zone of fusion without losing so much of its carbon in the

Fig. 1.

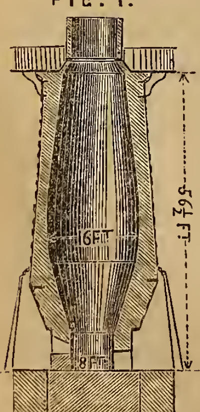


Fig. 2.

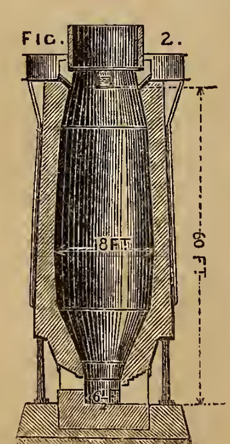


Fig. 3.

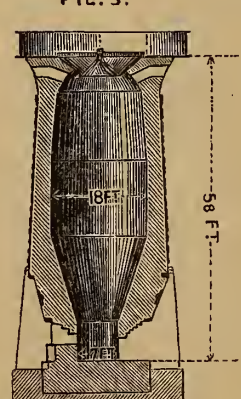


Fig. 4.

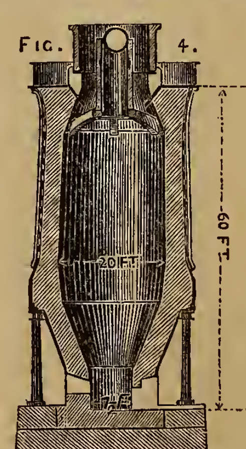
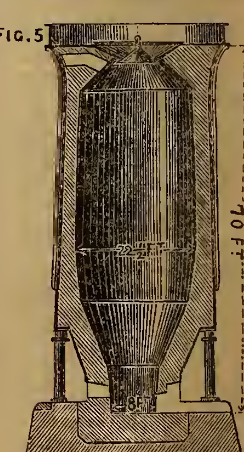


Fig. 5.



formation of carbonic oxide as previously in the small furnace; and hence arises the greater economy of fuel in the large furnace. To produce 300 tons of pig iron per week, the large furnace requires to be supplied with 8,000 cubic feet of blast per minute at a pressure of 3lbs. per square inch.

The accompanying woodcut, Fig. 1, is a vertical section of four furnaces at the Ormesby Ironworks, Middlesborough, belonging to Messrs. Cochrane. These furnaces were erected in 1855, and were the largest in the district at that time; the boshes are 16ft. diameter, and the height is 56½ft. The furnaces are constructed upon land consisting of mud and silt, and piling had therefore to be resorted to in order to secure a good foundation for the furnaces. A bed of concrete was placed on the top of the piles, and six inverted arches were turned on the top of the concrete, and the brick pillars carried up, and strong cast iron bearers fixed across the top for carrying and binding the brickwork of the barrel and boshes. The outer shell is bound with wrought iron hoops, fixed near enough together to prevent the barrel from cracking. The boshes are at an angle of 75° from the horizontal.

Fig. 2 is a vertical section of one of four furnaces erected in 1858 at the Jarrow Ironworks, Newcastle-on-Tyne. There was a good strong clay for the foundations of the furnaces to rest upon; the brickwork was carried up to the floor line, then twelve cast iron columns were erected, and wrought iron casings fixed on the top of these. The casings extend from the top of the five tuyere houses to the top of the boshes, above which the barrel is bound with wrought iron hoops supported by T irons, the latter being carried up to the top, and a flat ring riveted to them sufficiently strong to carry the floor plates. The boshes are 18ft. diameter, at an angle of 66° from the horizontal, and the furnaces are 60ft. high.

Fig. 3 is a vertical section of one of three furnaces at the Normanby Ironworks, Middlesborough, belonging to Messrs. Jones, Dunning, and Co. These furnaces were erected in 1860, and are constructed upon a bed of concrete, on clay of a weak nature; they are supported on brick pillars and hooped similarly to the Ormesby furnaces. The boshes are 18ft. diameter, at an angle of 72° from the horizontal, and the furnaces are 58ft. high.

Fig. 4 is a vertical section of one of three furnaces erected in 1862 at the Thornaby Ironworks, South Stockton-on-Tees, belonging to Messrs. Whitwell. These furnaces are constructed upon piles, in consequence of the land being mud and silt; they stand each upon twelve cast iron columns, and are cased with iron similarly to the Jarrow furnaces. The boshes are 20ft. diameter, at the angle of 68° from the horizontal, and the furnaces are 60ft. high.

Fig. 5 is a vertical section of one of three furnaces which are being erected at the Acklam Ironworks, Middlesborough, by Messrs. Stevenson, Wilson, Jaques, and Co. They are being built on piles, in consequence of the land being mud and silt, and are each supported by twelve cast iron pillars. The brickwork around the boshes is cased with plates, and from the boshes up to the top the barrel is bound with hoops and T irons. The boshes are 22½ft. diameter, at an angle of 68° from the horizontal, and the furnaces are 70ft. high. These furnaces the writer believes to be the largest in dimensions that have ever been erected, and their contents will amount to no less than 1,250 tons of materials per furnace: they are expected to produce each 350 tons of pig iron per week.

ROYAL INSTITUTION OF GREAT BRITAIN.

ON MAGENTA AND ITS DERIVATIVE COLOURS.

By FREDERICK FIELD, F.R.S. L. and E.

Three years ago, in this theatre, Dr. Hofman delivered his celebrated discourse on mauve and magenta, and it might seem temerity in me to trespass upon the premises of so great and distinguished a master, were it not remembered that during that interval rapid strides had been made in organic chemistry, and especially, perhaps, in the direction of aniline colours.

Although I will endeavour to confine myself as much as possible to the immediate subject of the discourse, it will be necessary to glance for a few moments at the history of aniline, the progenitor of nearly all the beautiful compounds you see around the table.

Aniline was discovered, in the year 1826, by Unverdorben, who obtained it from the destructive distillation of indigo. A short time afterwards, Runge and Fritsche observed that by the action of strong hydrate of potash upon the dye, aniline was eliminated in far greater quantity. Indigo in small fragments is heated in a retort with a strong solution of caustic potash, and in the distillate, which consists of many products, there is found a thin and nearly colourless fluid, having a specific gravity of 1·028, a peculiar but not disagreeable odour, and a pungent biting taste. When kept for some time, even in the dark and in stoppered bottles, it assumes a darker tint, and becomes ultimately a very dark brown. Unverdorben called it "crystalline," Runge "kyonal," and Fritsche "aniline."

This substance is a nitrogenised base, and is capable, when combined with acids, of forming those beautiful crystallised salts, nearly all of which have been carefully examined by Dr. Hofmann and other chemists.

There are many other sources besides indigo from which aniline may be obtained. For commercial purposes it is always prepared from nitro-benzol, a substance derived from the action of nitric acid upon benzol.

$$C_6 H_6 + H N O_3 = C_6 H_5 N O_2 + H_2 O.^*$$

Nitro-benzol when agitated with water, acetic acid, and iron, yields aniline.

$$C_6 H_5 N O_2 + 6 H = C_6 H_7 N + 2 H_2 O.$$

* C = 12 — O = 16.

Benzol was originally discovered by Mr. Faraday, in 1825, in his investigations upon the gaseous products from oils subsequently obtained by the decomposition of benzoic acid by means of caustic lime. Mr. Mansfield, however, succeeded in producing it in much larger quantities from coal-tar naphtha. When the lighter portions of this compound are distilled fractionally until a constant boiling point of 180°F. is arrived at, the product consists of pure benzol, identical with the carbo-hydrogen obtained by Mr. Faraday.

From the earliest discovery of aniline it was noticed that certain oxidising agents when mixed with a solution of its salts produced a fine violet tint. Even in minute quantities, a few drops of hypochlorite of lime render it purple. There is another test for aniline, which I will show you, and which, as far as I am aware, has not been observed previously. If the red gases obtained by the decomposition of nitric acid by starch or sugar be passed into an aqueous solution of aniline, the liquid speedily assumes a yellow colour, owing to the formation of a new base—azophenylamine, which is gradually precipitated as a bright yellow powder. It was not, however, until the year 1856 that aniline was applied to any great practical purpose, although from the beauty of its compounds, and from its comparative accessibility, it had from the time of its discovery become a great favourite with chemists.

Mr. Perkin was the first who produced colour on an extensive scale from this base. He added a solution of bichromate of potash to a salt of aniline, and from the precipitate thereby produced he isolated a magnificent purple dye he termed "mauve," which at once became popular, and indeed at the time almost universal. It may truly be said that this discovery has identified Mr. Perkin with the aniline colours, and that he will be always associated with one of the most striking and brilliant passages in the history of chemistry as applied to the industrial arts.

It cannot be supposed that such a discovery would be allowed to rest. A mine had been opened which chemists began to explore, and in such numbers and with such avidity and zeal, as almost to lead us to anticipate that its riches will soon be exhausted. The action of numerous bodies upon aniline and its homologues were found to be productive of colour. Nitrate of silver, nitrate of mercury, chloride of mercury, chloride of tin, arsenic acid, iodine, and many others, when heated with the base, gave a rich crimson colour, in more or less abundance; and although it would be impossible for me to enter into a disquisition on the comparative merits of these various methods for the production of colour, I trust to be able to produce magenta, although in somewhat crude form, at this lecture table, and also to dye this tassel of silk from a solution of its salt. The re-agent I will employ is iodine. A few crystals of this element are placed in a tube with about twice their weight of aniline. Heat is at once evolved, and with the assistance of a higher temperature from the spirit lamp, you will observe that in a few moments intense colour is developed. If a few drops are now poured in spirit and this solution added to water, a fine rose-coloured tint will appear.

It may seem strange to those who have read Dr. Hofmann's beautiful researches upon the aniline substitutive products, his chloraniline, bromaniline, iodaniline, and a multitude of others, that he had not observed this curious reaction; and this leads me to tell you, *en passant*, for time will not allow me to dwell upon this interesting topic to-night, that aniline, when perfectly pure, does not yield any amount of colour with most of the re-agents mentioned above—a most important fact discovered by Dr. Hofmann and Mr. Nicholson, and which has given rise to one of the most difficult questions which yet remain to be answered. I will simply say that it appears that there must be a homologue of aniline present with that base to produce the colour you see before you, although that homologue *per se* will give no colour whatever. Thus, for example, toluidine, $C_7 H_9 N$, when treated with oxidising agents, does not produce colour; let it be mixed with aniline, and the dye is immediately developed.

The tintorial power of the salts of magenta is something marvellous. No dye that I have examined, whether from the animal, mineral, or vegetable world, can bear comparison for one moment with this crimson colour obtained from aniline. One grain in a million times its weight of water gives a pure red, in ten millions a rose pink, in twenty millions a decided blush, and even in fifty millions, with a white screen behind the vessel in which it is dissolved, an evident glow. Magenta has been carefully studied and analysed by Dr. Hofmann, who gives us the following formula—

$$C_{20} H_{21} N_3 O, H_2 O.$$

Although the salts of magenta are possessed of such wonderful colouring capacity, the base itself is colourless; and it is remarkable that the union of base and acid for the formation of a salt does not appear to take place in dilute solutions in the cold, at any rate not immediately. In these two vessels, one containing hot and the other cold water, an equal quantity of magenta base is added, and also an equal amount of dilute sulphuric acid. In the hot liquid colour is instantaneously developed, in the cold solution the liquid remains colourless. If now hot water be introduced to raise the temperature, you will observe at once the characteristic rose tint. It may be imagined, therefore, that having free acid in a solution of base without production of colour, it is possible to have free alkali in a coloured solution of a salt of the base without depriving it of its tint. Such is the case. If to a hot solution of acetate of magenta, for example, caustic soda is added, the colour is immediately discharged, but in a cold solution the colour remains for a long time unchanged.

Dr. Hofmann discovered, about a year ago, that when magenta, or as it is termed in chemical language rosaniline, is heated with iodide of ethyl, a change is effected, and a substitution product formed, which was termed ethyl-rosaniline. The salts of this new base, unlike magenta, dissolve with a beautiful violet colour, and are capable of affording most remarkable manifestations. The dark violet liquid on the addition of sulphuric acid becomes colourless; on adding ammonia the original purple is restored. If hydrochloric acid is added in small quantities the liquid changes to blue; if in larger quantities, to a brilliant green. When this green solution is thrown into water, so as to dilute the acid, the original violet returns.

When aniline is heated with salts of magenta, purple and blue colours are produced, all of which are now extensively employed in commerce, and afford tints of great brilliancy and beauty. The blue is perfectly insoluble in water, but readily soluble in alcohol, and is capable of dyeing both silk and wool with the greatest facility.

Mr. Nicholson patented a method a few years ago for obtaining a beautiful blue dye, soluble in water, which consisted in heating the phenyl blue in strong sulphuric acid until a drop of the semi-liquid thrown into water was found to be entirely dissolved. This compound, however, although very applicable for silks, refuses to impart its colour to wool, which may be exemplified by immersing two white tassels in the liquid—the silk is immediately dyed, while the wool remains unchanged. The effect is still more striking upon cotton. We have here the letters R. I. (the initials of the Royal Institution) worked in silk upon a cotton ground; after dipping it for a few moments in this bath the letters will become blue, and the cotton continue white.

Aniline green, which has lately become so popular, is produced by the action of aldehyde and some other deoxidizing agents upon rosaniline. This is one of the most charming colours yet discovered, but has not been (as far as its chemical nature is concerned) satisfactorily investigated. To judge of its purity of tint, it is only necessary to compare the commercial greens, prepared by various mixtures of yellow and blue, with the dye in question, to observe the infinite superiority of the latter.

Aniline brown may be formed by the action of chloride of aniline upon either magenta or violet, at a high temperature. Great destruction of colour doubtless takes place, but the brown produced is remarkably beautiful. The compound, however, is not definite, nor can it be classed among the true chemical products derived either from aniline or rosaniline.

It has been observed that magenta base is colourless: this may be said, probably, of the bases of most of the colours before you. On this white board I have traced the letters composing the word "Aniline" in seven colourless bases derived from that compound. A, in ethyl-rosaniline; N, in phenyl-violet, approaching indigo in colour; I, in phenyl-blue; L, in aniline green; I, in azo-phenylamine; N, in chrysaniline; and E, in rosaniline. On converting these bases into salts, which is easily effected by sprinkling them with acetic acid and spirit, the seven letters should be visible in the seven colours of the rainbow—violet, indigo, blue, green, yellow, orange, and red.

I will now throw a beam from the electric lamp upon the specimens of silk on the screen, and it will be observed how much their brilliancy is increased under the influence of that pure and beautiful light. I am indebted to my kind friends, Messrs. Simpson, Maule, and Nicholson, for the various splendid specimens of dye and other aniline products, and to Messrs. Hands, Son, and Co., Coventry, the eminent silk dyers, for the array of silks so kindly furnished me for the illustration of my discourse.

SCOTTISH SHIPBUILDERS' ASSOCIATION.

ON CLEANING IRON SHIPS AFLOAT.

By Mr. John Harrison.

I must say that it was with some degree of hesitation that I undertook to appear before you this evening. The idea of a landsman who has never been long enough at sea to find his sea legs, talking about things nautical to nautical men may seem to be something very like presumption. It may be as well, therefore, at the outset to premise that, although I do pretend to demonstrate to you how a vessel may be brought home from the great Pacific or Indian Ocean in a shorter time than formerly, yet that I shall not invade your particular domain of knowledge by entering upon a discussion as to the comparative merits of wave lines with any other lines, the mysteries of bows and quarters, the principles of circle sailing, or the art of going round about to get soon home; nor even of that wonderful physical phenomena which no landsman can understand—the mystical movements of ocean currents and trade winds.

My system is very simple, both in theory and practice. It involves no question of form, for all shapes and sizes are alike subject to improvement upon my plan. It is nothing more nor less than this—keep your ships clean and they will sail fast. Clean them while waiting for cargo in the south tropical ports, and when you come to the equator, where light and variable winds and calms sometimes prevail, give them another scrape with the instrument that I am now able to furnish you with, and we shall hear no more of long homeward passages, which detract so much from the sailing character of many a gallant ship, and dip so deep into the dividends of many an otherwise prosperous voyage. Neither need we hear any more of hundreds of pounds being spent upon peculiar paints, that seem only efficient in the amount of money which they have for some years extracted from the pockets of spirited shipowners, who have felt it incumbent upon them to carry on a series of expensive experiments, hoping that in the long run something would turn up to enable them to defend their property from their unseen enemies of the sea.

Since the change of building ships of iron instead of wood, the superiority of the former material has never been questioned, and had the iron only possessed the quality of preventing the attachment to its surface of marine molusca, or had it but admitted of being covered with yellow metal or copper, or could any other method of preventing fouling have been found out, the building of wooden ships would long ere now have slumbered among the sunny memories of past events, and the modern method of constructing vessels of iron frames and wooden planking would never have seen the light. Long as the wooden walls of old England have held their supremacy upon the mighty deep, iron, after all, if it is less poetical is the more practical material of the two.

In this country the rise and progress of iron shipbuilding has been extremely rapid, and in our own locality, my present audience needs not the information that it has extended itself until its proportions have become gigantic. I find, from an excellent article lately published, that during the year 1851 only 41 iron ships were built upon the Clyde, amounting to 25,322 tons. I also find that during the seven years ending in 1862 the number of iron vessels built at Glasgow, Greenock, and Dumbarton were 636, with an aggregate tonnage of 377,176; being an average of 91 vessels each year, and an annual tonnage of 53,882. In the year 1862 we thought we had done something wonderful when 122 vessels, with an aggregate tonnage of 70,000, were finished and launched during the year. In 1863, however, the number still farther increased to 170 vessels, containing a tonnage of 124,000. But in 1864 the grand total for the year was 205 sailing ships and steamers, with an aggregate tonnage of 179,508—the steamers being supplied with engines to the amount of 27,205 horse-power—so that the mere increase in 1864 over the amount of 1863 numbered nearly as many ships, and more than double the amount of tonnage, than what were built altogether on the Clyde in 1851, the increase being 35 ships with a tonnage of 55,500. These ships have been built for every purpose to which ships are applied, to orders from nearly every part of the habitable globe. During the last year more than 40 vessels, with an aggregate of upwards of 27,000 tons, and engines of 6,650 horse-power, were sent forth from the Clyde to run the blockade. Indeed, the Clyde may now fairly claim to be the greatest shipbuilding river in the world. For nearly 20 miles its banks are covered at intervals with that iron chain of ships that go forth to encircle the earth, and employing in their construction about 20,000 men, representing a population of 100,000 souls.

I mention these statistics of the building of iron ships in our own neighbourhood to show the importance of any invention which is calculated to facilitate their progress on the ocean, for in this iron age speed is time and time is money.

I need not mention in detail the many plans that have been tried to obviate the one grand defect of iron as a shipbuilding material, namely, its liability to receive a deposit of moluscous animals of several varieties, but chiefly composed of two, namely, the ship's barnacle proper, the *Pentalasmis anatifera* of the men of science, or "the five-plated goose-bearer," and the acorn-shell, or the *Balanus*, both of these belonging to a class of moluscs that are called *Cirrhópoda*, on account of the *cirrhi* or *ciliated* arms which form their chief characteristic. The former is called *pentalasmis*, or five-plated, because its shell is composed of five distinct portions curiously arranged, and between them the *cirrhi* are protruded, as seen in the drawing. The word "goosebearing" is given to it because an old writer, named Gerard, who lived in 1638, discovered, or thought he discovered, that the bernicle goose (*Bérnicla Leucopsis*) was produced from the ship barnacle. Along with these, the seeds of several varieties of seaweed also attach themselves to the bottoms of iron ships, and between them they very much impede the sailing of the vessel by the hold they take of the water.

Paints of nearly every kind of composition have been tried to prevent this accumulation on the bottom. They have been mixed with grease, with the idea, I suppose, of rendering the plates so slippery that the barnacle should find no footing. They have been compounded with poisons of every degree of virulence, till the resources of the mineral and vegetable kingdoms have been well nigh exhausted, but to no purpose. I say to no purpose, inasmuch as none of those yet tried have stood the test of a ten or twelve months' voyage in southern latitudes. Nor does it seem to me that they will ever be more successful in this direction. With the *Balanus*, especially, I cannot see that poison can have any effect. By examining the specimens now on the table, it will be observed that it is the shell and not the animal that adheres to the ship. Between him and the ship he builds up this strong calcareous wall, and attaches it is so firmly that no grease can slide it off, and so thick as to be impervious to the most virulent poison. Let us look for a few minutes at the natural history of this cunning architect.

The *Balani* and their sub-class *Cirripedia*, are described by naturalists as animals that are soft and without head and eyes—until the researches of Darwin had proved that this was a fallacy, and that they have both—that they are covered with an adhering shell. They are hermaphrodite and propagate themselves. They are extremely prolific, for even in those northern latitudes the rocks between high and low water mark may be seen completely covered with a crust of the *Balani*. With us they are very small, but in the warm waters of the tropics they grow to an immense size, and there, as here, they take, as it were, possession of the sea shore, and cover everything that enters their dominion, till every rock, stone, wooden pier, or ship's bottom bears a thriving colony of these industrious fishermen. The *Balani* are never found in deep water. It is only between high and low water mark, and a few fathoms deeper, that they abound, and consequently it is not when the ship is in mid ocean that she gets them on her bottom, but only while she is lying in the shallow waters unloading or taking in cargo. And we see, from the fact that all large *Balani* are dead and out of the shell before they come home here, that they die as soon as the ship gets into deep water on her passage home. Now, the question occurs, can we do anything to prevent them from settling down on a iron ship's bottom, or can we poison them when they do settle there, in the earlier stages of their existence. From each of these myriad beds of *Balani* a stream of minute *Sessilia* is constantly issuing till they darken the very water as a cloud of locusts darken the air. For a time, after leaving the parent shell, they are crustaceous, such as the lobster, and are very active in the water, searching for an inch of empty space to serve as a location. When the time for their last metamorphose arrives, in this respect they are in nowise particular, and frequently do make awkward selections, such as upon other shells and on the shells of each other. But even at this early stage of their existence, the infant *Balanus* carries with him the nucleus of his future home. When his preparatory changes have been gone through, and he becomes ready for attaching himself to some foreign object, he is furnished with two calcareous discs, as seen in the drawing, and these discs are furnished with glands and ducts that secrete a highly adhesive cement, with which he attaches himself to the place of his choice. This is the foundation of his future castle; and of such material is it that it effectually protects the living animal from actual contact with any poison that may be compounded with the paint upon which he may happen to settle down. But suppose that he was affected by the poison, and that soon after he adheres to the vessel he dies; say that the first colony of settlers all die, another colony, just as numerous, would immediately settle down on their remains, and before two or three such had perished, the ship would present a perfect covering of them, which would preserve the last comers from harm, so that, even in that case, we should still have a bountiful crop on the ship. Then, his position is always at right angles with whatever he has attached himself to, so that really he is in little danger of even coming disagreeably near it. In a very short time his shell is complete, and he sets up as a fisherman on his own account, for he really is a fisherman, and the manner in which the *Cirrhopoda* fish is very remarkable. Some animals, like the *Sea Anemones*, hang out a net and await the approach of prey, and whatever happens to touch them, if not too large, they will fold up without discrimination, and stuff it in their stomach; other creatures hang out fishing lines, like the fresh water Hydra; others, again, chase their prey through the water, and capture it by superior swiftness or cunning; but the *Balanus* employs none of those methods. He is furnished with a veritable casting net, which ever and anon he throws, expanded into the water, and retracts when closed. The action of a man throwing an ordinary casting net is much the same as that of the *Acorn-shell*. In the drawing on the table, the animal is seen extracted from the shell, and the *cirrhi*, or net of jointed horn and long stiff hairs, is seen to advantage. These hairs cross each other at equal distances, and really form a beautiful network, which permits none but the smallest substances to pass between them. When the animal is in this state, also, he is perfectly protected from whatever his shell may be adhering to, and quite out of reach of all the drugs in the pharmacopœia.

It is not the poisonous nature of copper which prevents these creatures from fixing upon it, for indeed they do fix upon it, as fast as upon any other substance, but it is its rapid oxidation or scaling off which prevents their remaining after they do fix. It is therefore my opinion that, if ever a covering is found to protect an iron ship from fouling, it will be a pigment of some sort that will possess the same property as yellow metal or copper—namely, of scaling off and continually cleaning itself.

It was in this direction that I first extended my inquiries, and my proposal was to cover the iron plates with copper to a considerable depth before building the ship, and to give the two metals a metallic connection, so that there should be no galvanic connection evolved between them. These two metals, however, have no affinity. They will not weld together as iron will, and therefore it was with considerable difficulty that I succeeded in uniting them. By a certain chemical process, however, it was done, as you will see from some small samples on the table. Whether vessels may ever be built in this way I do not know, there being still some mechanical difficulties in the way which I have not as yet been able to remove. But on this question I will not dwell, for although prevention is said to be better than cure, the question of prevention is as yet a *questio vexata* on which not two are found to agree, but which, in the absence of facts, may continue to be a fair field for experiment and speculation.

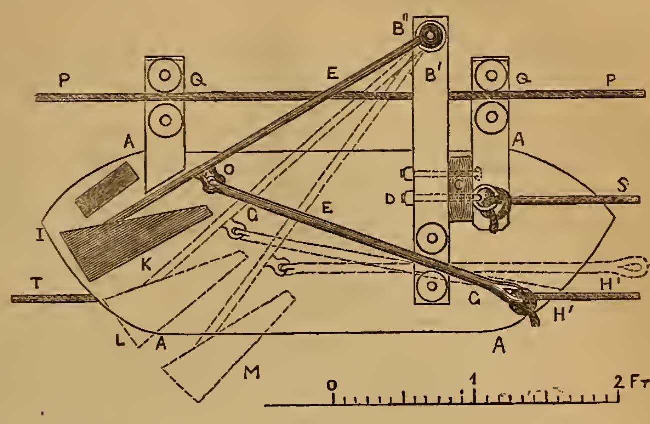
Let us, therefore, now look at another phase of the subject—namely, since we cannot prevent these colonising fishermen from squattin on our property, what is the best way of ejecting them? I answer at once, by mechanical means alone. This, in my opinion, is the most effective plan and the cheapest. Many attempts have been already made in this direction. Some shipmasters have tried the friction of a chain on the bottom, others a series of wooden bars, with pieces of iron upon them. One machine, at present at use in the Navy, is called a "Hog," and consists of a circular brush, shaped like a barrel, and which they cause to revolve beneath the vessel longitudinally from stem to stern. Another machine has been tried in Liverpool, consisting of a rope-ladder, the steps of which are broad pieces of wood, one side being covered with bristles, forming a series of brushes, while on the other there is a piece of iron, forming a series of scrapers. This is placed round the vessel, and is wrought by a sort of see-saw motion, rubbing up and down.

I have reason to know, however, that neither of these plans have given satisfaction, and whoever has examined the degree of tenacity with which these creatures cling to the iron, must know that it is not the soft persuasion of a brush, nor yet even a gentle rub, that will induce them to lose their hold! Nothing, indeed, but a sharp steel edge, equal to that employed by the hand, can ever make any impression upon them.

The extent to which a coating of these animals retard a vessel's progress is something very considerable, ranging from two to as many as six knots an hour. It was a conversation with a ship's captain on this subject which first turned my attention in search of a machine to clean vessels while afloat, before they had started on their homeward voyage. He was a fine specimen of a high-minded, generous sailor, who so completely identified himself with his ship that her honour was to him a personal matter, and her disgrace he held as a personal reproach. He said, in going out he could overhaul all he could see, and passed a large number of vessels, but in coming home the circumstances were sadly reversed. His ship was foul and would not sail, and every other ship went past her. "Hang it," said he, "I was so mad, that when I saw a vessel coming up I used to go below, and stop till they had passed and gone out of sight; for I could not bear to see my ship disgraced!"

The mechanical appliance for cleaning vessels afloat which I have the honour of submitting to you this evening, consists of what may be shortly described as a travelling lever fixed in a moveable frame. The working model before you is precisely the same as the actual instrument, only it is made to a scale of one inch to a foot, or $\frac{1}{12}$th of the actual size. The frame is a wooden sledge, held close to the side of the ship by two guide lines, upon which it travels as upon a railway, down to the keel and back. It is wrought vertically over all the ship, except upon the quarter, where it should be angled towards the stern, to allow it to go into the "run" of the ship.

By referring to the accompanying wood-cut illustration, the internal arrangement of the mechanical power will be better comprehended than upon the model.



The line A A A is an outline of the right side of the sledge, the left side being removed to show the interior. B is an upright fixed to the crossbar, C, by the ring bolt, D. To this fixed base, the other two sides of a triangle, E E, are attached, but jointed and moveable, while the lower side of the triangle, G, passes through double sheeves, beyond the base, ending in an eye for the attachment of the scraper-rope at H. Upon the apex of this triangle, at I, the scraper-blade is fixed, being set at right angles with the shaft, and the long ears at K being at right angles with the edge of the blade.

As is shown by the dotted lines, L, M, when the rope H is hauled upon the scraper, leaves its position at K and descends to L, where, being beneath the level of the frame, it comes hard in contact with the plates of the ship.

The lever being still farther hauled upon at the fulcrum at O, its longest end pushes forward the bar, B, making the machine travel forward on the lines, P, which pass through the double lines at Q Q, while the scrape-blade at L continues its course over the ship's plates, sweeping everything before it.

By constructing the long ears of the blade at right angles with the edge, they perform the threefold office of keeping the blade within the frame while passing over a hollow at the bow, or the quarter where the blade requires to descend, as it is seen at M. They also form an inclined plane for leading the edges over the landings of the plates, so that it is not impeded in its vertical course from the keel upwards to the bulwarks. They also prevent the edge of the scraper from going too deep and injuring the paint on the plates, as the edge can never go deeper than the parallel of these inclined planes.

The ropes, S and T, are used, the former for lowering down the machine and adjusting it; the latter, as will be seen on the model, is for hauling the machine down to the keel against the natural flotation of the frame.

As to the power of scrape which the machine possesses, it can be regulated to almost any amount consistent with the strength of the materials of which it is made. By keeping a gentle strain upon the back rope at T, the machine will be harder to push along at B, and the power of scrape at L or M will be proportionately increased; or by slacking the rope at T, and also throwing the guide-ropes slack, P P, the machine will be relieved from the pressure against the sides of the ship, and will be consequently easier pushed along at Q, and the scrape on the ship at L or M will be lightened in proportion as these ropes are slackened.

The other wooden frames or fenders which stand at the keel, the bilge, and against the topgallant rails of the ship, are merely for the purpose of holding the ropes that guide the machine, and for carrying the running tackle through double sheeves, and so preventing the friction and abrasion of the ropes against the plates.

Such is a brief outline of the mechanism of this instrument. It is exceedingly simple in its construction, and easily managed in its working. It is moved fore and aft the ship by fleet lines attached to the fender at the keel. It is thus perfectly under command, and can be sent down to any part of the ship's bottom, and if it is at any time desirable merely to try the condition of the plates, it is only necessary to attach a bag of thin cloth or small mesh-net to the instrument at the part from I to Q, and it will bring to the surface whatever it takes from the bottom; so that you may always know whether you are taking anything off, or whether there is anything to take off.

From the glance that we took at the natural history of the barnacle we saw that they only inhabit the shallow waters. If, therefore, a vessel be gone over with this scraper immediately before leaving a foreign port, and perhaps get another going over, while waiting for wind in the tropics, she will come home comparatively clean, nearly as clean as when she went out. If so, then the object so much desired will be gained. Iron ships will acquire that ascendancy in point of speed which the material of their construction ought to confer upon them, while the expense of keeping them clean will be less than the putting of copper on a vessel of wood; and thus it is hoped another step will be gained in the great march of industrial progress!

REMARKS ON THE DIFFERENCE BETWEEN LLOYD'S AND THE LIVERPOOL UNDERWRITERS' RULE FOR IRON SHIPS.

By Mr. JOHN FERGUSON.

This subject is of some importance to our members and shipowners who have iron ships classed at Lloyd's and the Liverpool Registry.

Lloyd's rules for the building and classification of iron ships were first introduced in 1855. Previous to that period a great number of iron vessels had been built, the construction and durability of which furnished sufficient data on which to found rules and tables of scantlings for vessels to be classed by them. Since that time the rules have been several times amended, and a large proportion of the iron vessels built in this country have been built in accordance therewith.

The Liverpool Underwriters' Registry, established in 1862, promulgated rules for the building of iron vessels, to which rules vessels intended to be classed exclusively by them were required to conform.

The requirements of both registries, although on the whole not far from each other, differ in some respects, and this difference constitutes a grievance to the shipowner who wishes to have his vessel classed in both books, inasmuch as the scantlings of some parts of the vessel, according to Lloyd's, are much heavier than the Liverpool rules require, while in other parts of the vessel the Liverpool rules require more than Lloyd's, and both societies insist generally on their maximum. It follows, therefore, that when a ship is built to class in both books, the maximum weight of both rules being taken, unnecessarily increases the weight and cost of the ship. The increase of iron in the hull diminishes the dead weight carrying properties of the ship, so that, as a profitable carrying vessel such a ship is inferior to one built to either rule only. The mode of regulating the scantlings, &c., of vessels built according to these respective rules vary. In Lloyd's they are regulated chiefly by the tonnage, except in cases where the proportions of breadth and depth to length exceed the standard of proportions which has been adopted. In vessels exceeding those proportions, the scantlings are increased, particularly longitudinally. In the Liverpool rules the scantlings are regulated chiefly by the dimensions of the vessel, irrespective of the tonnage.

It is not my intention in the present paper to discuss the merits of the difference in those rules, but merely to make a few comparisons between them, in order to obtain the opinion of any of our members who may have given this subject more consideration. The views thus elicited, if deemed proper, may be submitted to the Committees of both Lloyd's and the Liverpool registries, and I have no doubt that those gentlemen will give the opinions of this Association their careful consideration.

The highest grade or class which iron vessels obtain in Lloyd's is Aᴀ 1, which is considered equal to the 12 years A 1 formerly given, while the highest grade or class given to vessels in the Liverpool registry is is 20 years, or, with extra bulkheads, 22 years; and one of the points that falls to be discussed is whether the 20 or 22 years' vessel of the Liverpool book is any better than the Aᴀ 1 vessel of Lloyd's book, or *vice versâ*. For the purpose of forming an opinion on the subject, I have compared the scantlings of vessels of the usual proportions and forms, taking dimensions of vessels which have been classed in both books, and find that in the framing and plating of vessels from 500 to 2,000 tons, Lloyd's rules require on an average from 7 to 10 per cent. more weight of material than the Liverpool rules. While in the inside stringers, kelsons, &c., the Liverpool rules require from 7 to 10 per cent. more weight of material than Lloyd's.

For sailing ships of about 500 tons the difference on the whole is trifling; the Liverpool rules being about $2\frac{1}{2}$ per cent. in excess of Lloyd's.

For sailing ships of 1,000 to 1,500 tons the total quantity of iron required by Lloyd's is about 5 per cent. more than the requirements of the Liverpool rules; while in ships of about 2,000 tons, the quantities are nearly equal for both rules.

In screw steamers of ordinary proportions the excess of weight required by Lloyd's is about 2 per cent.

From these statements it will be seen that the several sizes of vessels of ordinary proportions and form have nearly the same weight of material in them if built in accordance with either of the rules; and we may not be far wrong in assuming that a vessel built to the one rule is as good as one built to the other.

On this point there will, no doubt, be different opinions, but for our present purpose we may assume their equality in that respect.

For comparison, we will take Lloyd's, as the older rules, as our standard, and taking it for granted that the scantlings, &c., of Lloyd's rules are in no wise inferior to those of the Liverpool rules, we ask, Why are we required to add the different items of the latter which are in excess of Lloyd's to what is already in excess of the Liverpool rules? It is questionable whether the ship is improved by these additions; on the contrary, I believe they might be proved injurious in many cases.

As before noticed, one of the principal differences in the scantlings of both rules, that in the Liverpool rules the stringers and outside plating are thinner than Lloyd's scale. Perhaps they may be thick enough for the strength of the ship when she is new; but we must bear in mind that durability has to be considered as well as strength. We all know that corrosion takes place over all the surface exposed, and is proportionately more injurious to thin than to thick plates; and in the case of stringer plates, the Liverpool surveyors aver that the broad thin plates are stronger than Lloyd's, which are narrower and thicker, taking the same section in each. But it is certain that there is much more waste on the broad surface than on the narrow. In a number of our river steamers which had originally stringer-plates of $\frac{3}{16}$ thick I have completely seen them corroded away. In some cases where there had been leaky waterways, there was literally nothing in the shape of stringer-plates left to be taken away after the waterways were removed.

In the floor plates, frames, and reverse bars, especially in the wake of the boilers, the same diminution occurs in the thicknesses; so that cases such as these prove that thickness is of much more importance than breadth, and I hold that a plate 9 by $\frac{1}{4}$ is in the end better than one of 12 by $\frac{3}{16}$. I make these remarks on small sizes, on which difference is more perceptible, to show the importance of looking to the wear, as well as the present sufficiency of material to the strength of the ship.

To take the case of sailing-ships of from 1,000 to 1,200 tons, these sizes being most familiar to our readers who have built vessels to class in both books, the stringer-plates have to be made in accordance with Liverpool rules, broader than for Lloyd's, and although we may submit to the Liverpool surveyors that by Lloyd's we have as much section of iron as they themselves require, we are told that they do not recognise the section as being sufficient without the breadth; and therefore we are required to make stringers to the maximum thickness of Lloyd's, and the maximum breadth of the Liverpool requirements.

Then, again, besides making the centre kelson so much heavier than Lloyd's, the Liverpool rules require an extra or additional kelson or stringer, which I have no doubt may be necessary for vessels built solely to their rules; but when added to a vessel built with the heavy plating of Lloyd's requirements, must be superfluous strength and weight. There are other items which clash in the same manner; and although by correspondence some of the differences may be modified, it is not satisfactary to be dependent on the caprice of committees or surveyors in matters which might be regulated by a little of the give-and-take principle; so that a builder when contracting for a vessel could definitively understand what he was to supply, especially when such excesses add to the weight of the vessel, and thus necessarily increase her first cost. Referring to sailing-ships of about 1,200 tons of the usual proportions and forms, which I have previously stated as being about 5 per cent. heavier by Lloyd's scantlings than by the Liverpool rules, if classed in the latter book, we are further required to increase the weight other 5 per cent. nearly, making the vessel 10 per cent. heavier than the Liverpool rules, that additional weight increasing the first cost above 10s. per ton over Liverpool scale, and 5s. per ton over Lloyd's. If we take the Liverpool book as the standard, then Lloyd's scale is unnecessarily heavy, and the two might be harmonised with great advantage to builders and owners.

Another element of difference between the two rules being that the one regulates the scantlings chiefly by the dimensions, it follows that vessels which have large dimensions for their tonnage, that is fine vessels, are more affected in their scantlings than others which are full and of small dimensions for tonnage. Two vessels may also be built to precisely the same dimensions, while, owing to the diversity of their forms, the tonnage may be vastly different. By Lloyd's rules, the scantlings being regulated by the tonnage, would be in exact proportion to the form or capacity of the ship, while by the other rules they might be out of all proportion to the form and capacity, although correct in their relation to linear dimensions.

As these remarks are only intended to form a groundwork for discussion, the comparison and data are laid down only in a general way, and I hope the discussion of the subject may be the means of bringing about a practical agreement on the scales of scantling, so that the present anomalous increase of weight and expense to the shipowner may be reduced without impairing the efficiency of our ships, as it is a national necessity for us to build ships cheaply and well; but it is scarcely necessary that we should continue to build ships to cost more and carry less, in order to assimilate opposite theories of construction and get two classifications where one might suffice.

On the motion of Mr. J. G. Lawrie, the discussion of the question raised in the paper was adjourned till a special meeting, to be held on the 17th April.

ROYAL SOCIETY.

COMMUNICATION FROM THE PRESIDENT AND COUNCIL OF THE ROYAL SOCIETY TO THE BOARD OF TRADE ON THE SUBJECT OF THE MAGNETISM OF SHIPS.*

" *To the Right Hon. Thomas Milner Gibson, President of the Board of Trade.*

" The Royal Society, May 18, 1865.

" Sir,—The attention of the fellows of the Royal Society has been recently directed to the very great increase which has taken place in the employment of iron in the construction and equipment of ships, and the consequent augmentation of the embarrassment occasioned in their navigation by the action of the ship's magnetism on their compasses.

" The inconveniences which have already made themselves felt in the ships of the mercantile marine, and which threaten to be productive of very serious loss of life and property, unless remedial measures be adopted, similar to those which have proved so advantageous to the ships of Her Majesty's Navy, have induced the president and council of the Royal Society, after much consideration, to venture on the step of calling your attention, as presiding over the Department of Trade, to a subject which they believe to be of pressing importance.

" In this view the accompanying memorandum has been prepared, stating, as briefly as may be, the particulars which they are desirous of bringing under your consideration; in the belief that the time has fully arrived when measures of a more stringent and effectual character are required, in the direction which has been already taken by Her Majesty's Government in such legislative enactments as those contained in the Merchant Shipping Act (1854), adverted to in the accompanying memorandum.

" I have only to add that it would afford the president and council great satisfaction if they could be of any further assistance in a matter which they believe to be of so much importance.

" I have the honour to be,
" Your obedient servant,
" Edward Sabine,
" *President of the Royal Society.*"

" *Memorandum.*

" It is believed that the time has come when it is expedient that the Executive Government should exercise a more direct and systematic supervision over the adjustment of the compasses of ships of the mercantile marine than it has

* Published in the Proceedings, by order of the Council.

hitherto done. The opinion that it might do so with advantage is not new, as may be seen from passages in the 2nd and 3rd reports of the Liverpool Compass Committee (2nd Report, p. 30; 3rd Report, p. 38), but it has of late been gaining strength from the following among other circumstances :—

"(1) The great increase in the number of iron ships, as well as in the amount of iron used in the construction of such ships.

"(2) The losses of iron ships.

"(3) The advances which have been made in, and the present state of, the science of the deviation of the compass.

"We may consider these separately.

"1. It is believed that for some years the number of iron ships constructed has greatly exceeded that of wood-built ships, and this is particularly the case as regards passenger steamers. In such vessels iron is now used not only in the construction of the hull but in decks, deck-houses, masts, rigging, and many other parts of the ship for which wood was till recently used. The consequence has been a great increase in the amount of the deviation of the compass, increased difficulty in finding a proper place for the compass, and increased necessity for, and difficulty in, applying to the deviation either mechanical or tabular corrections.

"2. Many recent losses of iron steamers have taken place, in which it is probable that compass-error has occasioned the loss. In most of these, however, from the want of any record of the magnetic state of the ship, of the amount of original deviation, and of the mode of correction, and from the investigations into the causes of the loss being conducted by persons not instructed in the science, and who are necessarily incompetent either to elicit the facts from which a judgment can be formed, or to form a judgment on those facts which are elicited, no certain conclusion as to the cause of loss can be arrived at. The investigations are, however, sufficient to show the want of a better and more uniform system of compass correction in the mercantile marine, and of more knowledge of the subject among masters and mates.

"3. Since the first introduction of iron ships it has been a recognised fact that they cannot be safely navigated without the compass being, as it is termed, 'adjusted,' *i. e.* without the deviations being corrected either mechanically by magnets or by a table of errors; but at first the correction of each ship was a separate and independent problem. Now the case is different. The theory of the deviation, its causes, and its laws, are now thoroughly understood and reduced to simple formulæ, leaving the numerical magnitude of a certain small number of quantities to be determined by observation for each ship separately; and further, by recording, reducing, and discussing the deviations which have been observed in the ships of the Royal Navy of different classes; numerical results, as to the values of these quantities in ships of each class, have been determined, which promise to be of the greatest use in facilitating the complete determination of the deviation and its correction, and in suggesting modes for constructing iron ships, and in the selection of the position of the standard compass. The science of magnetism, in its relation to navigation, is, in fact, in a position in some degree analogous to that in which the science of astronomy at one time was. The principles of the science have been established, the formulæ have been obtained; but numerical values are wanted, which can only be derived from a large number of observations systematically made and discussed. At present these numerical results have only been obtained from, and are only applicable to, the ships of the Royal Navy. Without some systematic direction, the mercantile marine can neither derive the full benefit of, or contribute its due share to, the advance of the science.

"That the subject is one coming properly within the cognizance of the Board of Trade may be inferred from the Legislature having already in the Merchant Shipping Act, 1854, sect. 301, art. (2), provided that 'every sea-going steamship employed to carry passengers shall have her compasses properly adjusted from time to time, such adjustment to be made to the satisfaction of the shipwright, surveyor, and according to such regulations as may be issued by the Board of Trade.' The shipwright surveyor is then (sect. 309) to make a 'declaration' that the 'compasses are such and in such condition as required by the Act,' and on such 'declaration' the 'certificate' of the Board of Trade is issued.

"It does not appear how these enactments are constructed or carried into effect. It is not, however, understood that the shipwright surveyor is expected or is necessarily competent to do more than see that the ship is furnished with proper compasses, but the goodness of the compass has nothing to do with the deviation; the best compasses are affected by the deviation precisely in the same way and to the same extent as the worst.* It is not understood that he exercises any judgment or control as to the position of the compass, the amount of deviation, or the mode of adjustment, or any of the various points which are involved in the compass being 'properly adjusted.'

"As regards the important subject of 'deviation,' all that has been done by the Board of Trade consists, it is believed, in the publication of the 'Circular on Deviation,' compiled by Admiral Fitzroy, the publication of the reports of the Liverpool Compass Committee, and the publication of 'Practical Information for Masters and Mates,' by Mr. Towson.

"As regards the particular points to which the attention of the Board of Trade may be invited, they may be considered under the following heads :—

"(1) The correction of the compass in particular ships.

"(2) The advancement of the science of deviation of the compass.

"(3) The education of masters and mates.

"1. As before observed, it is now recognised that every iron ship must have it compasses 'adjusted.' Hitherto two totally different modes of adjustment have been practised, each of which has its advantages and disadvantages.

"1. The system recommended by a committee of men of science and naval officers, appointed by the Admiralty in 1837, and which has been uniformly followed in the Royal Navy from that time. In this system each ship has a 'standard compass,' distinct from the steering compass, fixed in a position selected, not for the convenience of the steersman, but for the moderate and uniform amount of the deviation at and around it. The ship is navigated solely by that compass. The deviation of that compass on each course is ascertained by the process of 'swinging' the ship; a table of deviation is formed, and the deviations given by the tables are applied as corrections to the courses steered.

"2. The system proposed by the Astronomer Royal in 1839, and which is understood to be generally followed in the mercantile marine. In this system the deviations of the compass are compensated by magnets (and occasionally soft iron). The ship is navigated by the compass so corrected—generally the steering compass, and generally without any tabular correction.

"It would not be right, considering the weight of authority on each side, to pronounce any decided opinion against either of those modes of correction when properly used. The first system has proved in the Royal Navy to be one which can be used without danger. The same cannot be said of the second method as regards the mercantile marine; but the principle danger of the method arises from what is in truth an abuse of the method. It is that, in reliance on the power of correcting any amount of original deviation, however great, the navigating compass is placed in a position in which the original deviations are excessive and vary rapidly, and in which no navigating compass should be placed.

"In merchant ships the most convenient place for the steering compass is generally near the upper end of the stern-post, the rudder-head, the tiller, and the iron spindle of the steering-wheel—all, from their shape and position, powerfully magnetic. The constructor and owner, for the sake of economy, desire that the steering compass should be the navigating compass. The compass-adjuster fears that any objection on his part would be considered a confession of incompetence, and that some less scrupulous adjuster would not hesitate to undertake the correction. The correction can only be made by powerful magnets. The compass is then held, as it were, in equilibrum by powerful antagonistic force; and when the changes take place, which, it is known, do take place in all new iron ships, or when any changes take place in the magnets, large errors are introduced, which are the more fatal because the shipmaster is taught to believe that his compass is correct.

"This abuse of the method is one the temptation to which is unfortunately so strong, that it is believed it can only be effectually prevented by prohibiting the use of the steering compass as the navigating compass, or rather by requiring that the ship shall have a navigating compass distinct from, and in addition to, the steering compass.

"It is, therefore, recommended that every iron passenger ship should be required to have a standard compass distinct from the steering compass in a selected situation at a certain distance from all masses of iron; that, whether corrected or not, the original deviations of the standard compass should not in ordinary cases exceed a certain limited amount; and that on each occasion of the compass being adjusted, a table of the deviations should be furnished to the master and returned to the Board of Trade; and that if corrected by magnets, a return should be made of the position of the magnets and of every subsequent alteration of their position. Provision may be made for exceptional cases, in which it may be found impracticable to place the standard compass in a position where the original deviation is within the limit, by requiring in such cases a special certificate from the central authority.

"It may be here observed, as regards many practical matters connected with the adjustment of the compass in particular ships, in which at present great diversity of practice prevails, that an organised department under a skilful superintendent in constant communication with the ports, would probably be of the greatest service, not merely in laying down rules, but in giving advice and suggestions to naval constructors, compass-makers, and adjusters, and producing a uniform system of adjustment at the different ports, which would be generally understood by shipmasters. Advice from the same source would be not less useful to the authorities in the different ports in suggesting means of facilitating the adjustment by meridian marks on shore, laying down moorings, &c. It would, probably, be one of the first duties of the superintendent of such a department to acquaint himself thoroughly with the methods practised at the different ports, and to give such suggestions, either in the form of reports to the Board of Trade, or in private communications, or both, as might appear to him advisable. Such a superintendent would also be available as an assessor in investigations into the loss of iron vessels, in cases in which there is any possibility of the loss having been occasioned by compass error.

"2. The advancement of the science of the deviation of the compass.

"Whatever difference of opinion exists as to the advantage or necessity of a standard compass as regards the safety of particular ships, there is none as to its being indispensable for any scientific inquiry into the amount of the deviation and of its constituent parts and its changes. It is from the tables of the deviation of such compasses, and such compasses alone, observed at different times and places, and systematically reduced and discussed, that those numerical results can be obtained which promise to bo so useful in securing in iron ships a place for the standard compass where the deviation is of a safe and manageable amount, and in guarding against the dangers which arise from changes in the magnetism of recently built ships. It is from the recorded deviations of such compasses that on the loss of a ship a judgment may be formed of the effect of the deviation in causing any error in tho course of the ship.

"2. The education of masters and mates.

"At present it may be said that entire ignorance of the subject is the rulo.

"The subject has not hitherto been a recognised branch of the education of the seaman; and the most skilful seamen frequently either ignore it altogether, or look upon it as a mystery not capable of comprehension. Now, however, that the principles of the science havo been established, it is found that the subject is

* This is subject to the qualification that, from the diminution of directive force in ships having large deviations, compasses of superior power and delicacy are required; and if the compasses are corrected by magnets, a particular arrangement of needles is requisite.

not one of any serious difficulty; and although it might not be considered just to require masters and mates already certificated to pass an examination in a new subject, yet an opportunity might be given them of passing a voluntary examination; and as regards future candidates for certificates of competence, notice might be given that after a certain period, say two or three years, a certain amount of knowledge of the subject will be required from candidates (and in the meantime a text book containing the necessary amount of information might be prepared and published), and the examiners of the Local Marine Boards will themselves receive instruction, and, if necessary, undergo an examination on the subject.

"For the purposes indicated, it seems desirable to establish a department of the Board of Trade under a competent superintendent, the whole, or greatest part of whose time should be devoted to this subject. Almost all the advances which have hitherto been made in the science, and which have placed England at the head of the science, are due to there having been for the last twenty-five years one officer charged by the Admiralty with this duty almost exclusively. Such an officer becomes the depositary of all that is known on the subject, and has no difficulty in obtaining the best scientific assistance. It seems desirable that for some years at least the Board of Trade should take advantage of the ability and experience of the present superintendent of the Compass Department of the navy. It is understood that there will be no practical difficulty, and there would be many advantages in the present state of the science in having the superintendence of the compasses of the royal and mercantile marine united in one head, with competent assistants in the two branches of the service. The subject, as has been observed, is not one of difficulty. Any intelligent man could speedily be instructed in all that would be necessary to enable him to discharge the duties of assistant for the mercantile marine; and in the selection of such an assistant, probably it would be more important to look to general ability, intelligence, docility, and the habit of, and aptitude for, dealing with men, and particularly with masters of merchant vessels, than to any previous knowledge of the subject."

VENTILATION OF HOSPITALS.

Under the superintendence of M. de La Valette there has recently been appointed a committe to inquire into the condition of the Hospitals, consisting of General Morin (chairman), Bouillard, Comlies, Devergie, Gilbert, Husson, Laval, De Luireu, Malgaigne (secretary), Melleir, Michel, Levy, Perchappe, Payeu, Tardieu, and Baron De Vatteville. General Morin, as reporter of this committee, has published an account of certain ventilating apparatus in the "Bulletin Official der Ministère de l'Intérieur," published in May, such report having reference to the systems approved by the medical authorities in the district under the supervision of M. De La Vallette. We now set forth briefly the main points of General Morin's reports.

The instructions were designed to indicate the proportions necessary for passages and conduits to be provided for the ventilation of sick rooms in hospitals. As a volume of air to be changed may vary between 2,100 and upwards of 3,600 cubic feet per hour per end, 2,800 cubic feet ought to be taken as an average upon which to base the calculations.

If convenient, the foul air should have an exit through descending tubes having an opening at the head of the bed, one tube being used for every two beds in ordinary, and for every bed in lying-in hospitals.

If the establishment is heated with water, that heat may be used to create the draught necessary to educt the foul air.

Eduction from below obviates weakening the walls by egress conduits, thus avoiding traversing the walls of upper stories.

When there are no cellars to the building, the arches should allow spaces sufficiently wide for ventilation passages to be introduced, the arches of such passages being covered with a suitable composition to exclude the moisture.

For proper ventilation, the temperature of the air in the up-take shaft should exceed that of the outside by from 36° to 45° Fahr. under all circumstances.

It is desirable to provide the top of the eduction chimney with automatic apparatus, so arranged, that the most powerful currents of air may be used to facilitate the draught. Where the position will allow of it, advantage should be taken of chimneys and flues to aid the eduction of the foul air.

Elliptical Blast Furnaces.—At the Dundyvan Ironworks a furnace of this section, of 20ft. by 12ft. diameter, and 60ft. in height, has been erected, which is stated to give extraordinary results.

WORKSHOP MACHINERY.

The practical details of the machinery actually used, in engineering establishments, are worthy of the most careful consideration, and the more so because they are not usually set forth in such a way as to render them available ordinarily.

In most factories machines in great variety are used which are designed to serve especial purposes as well as general; thus, in Messrs. Ledger's factory, in 1855, a large planing machine was fitted with boring treads suitable for boring locomotive cylinders. This machinery, however, was not appreciated when the proprietors retired and sold the works, the boring heads were merely reckoned as old metal though in connection with the planing machine as an adjunct, to which they were designed, they formed a valuable piece of machinery; and in all workshops such contrivances are constantly in requisition, although they are only suited in many cases to the particular works for which they are intended.

Many complicated mechanisms are brought forward which, although attracting the attention of the less practical part of the body of mechanical engineers, nevertheless has seldom come into general use, as machinery which proves most useful is that which is simplest and most durable.

Muir's machinery is doubtless excellent, and, in fact, we are inclined to consider it superior in point of wear to Whitworth's, and in this matter Messrs. Smith, Beacock, and Co.'s lathes deserve considerable credit, as, although they may not possess the fine finish of Whitworth's machinery, they yet can claim the advantage of durability. It is impossible to give anything like a proper idea of what workshop machinery really is; if we take as our examples that which is manufactured by those who supply tool machines, as certain classes of construction are selected and followed which in themselves form the bulk of a plant of mechanical engineer's factory, but which, nevertheless, would be of little utility were they not aided by those contrivances which are constantly required and constructed in accordance with such requirements in every factory where ordinary work is executed.

We intend from time to time to take up this subject of workshop machinery, with a view of illustrating those classes of machinery which, on account of their being specialities, are not usually described in ordinary treatises.

NOTICES TO CORRESPONDENTS.

W. Linholt (Leeds).—The following rule will enable you to determine the engine power for your vessel, its lines being trochoidal:—

Let L = length of ship at waterline in feet.
G = Mean girth under water.
v = Velocity in ft. per sec.
l' = Sum of lengths of bow and stern in feet.
B = Greatest breadth in ft.
I. H. P = Indicated horse-power.

Then

$$\text{I. H. P.} = \frac{L\,G.\,v^3}{95500}\left\{1 + \frac{9{\cdot}87\,B^2}{L^2}\right\}.$$

Mechanic.—To determine the diameter of the slide valve rod, multiply the length of the slide valve in inches by its breadth in inches, and by the effective pressure of steam in lbs. per sq. in. Then divide the square root of the product by 100. The result will be the diameter of the slide valve rod.

Tyro.—Professor Maury has given, in his work on physical geography, a clear account of the Gulf Stream, and to that treatise we refer you for the information you require.

L. S.—To correct the height for curvature of the earth and refraction of the atmosphere together, add to the apparent height in feet the square of the distance in miles, multiply by 4, and divide by 7.

C. E. (Newcastle).—The most practical rule for the thickness of metal in cylinders is as follows:—Multiply the pressure of steam in lbs. per sq. in. by the diameter of the cylinder in inches, divide the product by 440, and to the quotient add the square root of the diameter; the sum divided by 8 will be the required thickness in inches.

W. M. (Hertford).—Messrs. Carne and Vivian can give you the information you require.

REVIEWS AND NOTICES OF NEW BOOKS.

The Engineers' Pocket Remembrancer. An Epitome of Data, Rules, and Formulæ. By FRANCIS CAMPIN, C.E. Second edition. *With an Appendix.* London: Atchley & Co. 1865. Pp. 106.

Among technical pocket books, that now before us has, in its first edition, taken its place with the best. The tables are clear and concise, the rules and formulæ exceedingly simple and complete, and the work has the very desirable qualification of containing all that is usually required to facilitate the ordinary calculations of engineering, without being loaded with useless matter. The second edition is an improvement upon the first, being more compact in form, and the appendix on "Calculation as applied practically to Engineering Purposes," also tend to enhance its value. We can confidently recommend this "Remembrancer" to every branch of the profession.

Papers upon the Supply of Water to Towns. By BALDWIN LATHAM, C.E., A.F.C.E. London: E. and F. N. Spon. 1865. 8vo. pp. 53.

This reprint of the very valuable paper read by Mr. Latham upon water supply before the Society of Engineers, deserves the careful attention of all connected with the hydraulic departments of civil engineering. It contains a great deal of thoroughly practical information in a very condensed form, systematically and conveniently arranged. The examples are illustrated by six well executed plates. The work reflects great credit upon all concerned in its production.

Tables for Facilitating the calculation of Earthwork in the Construction of Railways, &c. By DAVID CUNNINGHAM, C.E. London: E. and F. N. Spon. 1865. Pp. 100.

A complete set of earthwork tables supplying all that is required in the way of data, and being at the same time sufficiently condensed to be handy for reference has long been a desideratum, for until the publication of this work we have seen none possessing those combined qualifications. In the principal tables Mr. Cunningham commences with a base of six feet, advancing by increments of one foot up to 36ft., concluding with 38ft., 40ft., 45ft., and 50ft. In each table the slopes ½ to 1, 1 to 1, 1½ to 1, and 2 to 1 have respectively two columns. Supplementary tables are added to aid in determining quantities not given in the tables of bases.

Public and Middle Class School Education; what it is, and what should it be. By a PRACTICAL MAN. London: Virtue Brothers. 1865. pp. 67.

The author of this work says, in a notice to the reader, "You require a preface, of course, but I cannot write one of the sort you want." So no preface is given; but it is observed that the entire book is "a sort of preface or introduction to another," though to what we are not informed. The author commences with the ordinary truisms about the necessity of being educated according to the times in which we live, and then proceeds to discuss after his own fashion the various questions which have of late arisen in discussions on education. We do not observe anything particularly new or good in this treatise; and in regard to its style, our readers may satisfy themselves from the following extract:—"Thales, Heraclitus, Anaximander, Anaxagras, what was your philosophy? Surely the immortal Γνιοθι σεαυτόν was your motto; but how could you know yourself Thales, who ascribed the existence of all things to the creative power of water." The book may serve to amuse some junior scholars who happen to have read enough of the Latin and Greek Delectus, and "French phrases in common use," to understand the Classic Proverbs and other quotations introduced.

The Pursuit of Knowledge under Difficulties. By GEORGE L. CRAIK, M.A. London: Bell and Daldy. 1865. Pp. 543.

The volume before us has already appeared before under different forms, being originally published in 1830 and re-produced in 1845. Its arrangement, as well as the style in which it is written, is decidedly good; commencing with the classification of those difficulties which on all sides beset the seeker after knowledge, the author proceeds to set forth the natural love of acquiring information, and mentions the philosophy of common things which undoubtedly should form the first study, as experience should be based upon observations of ordinary matters, that referring to unusual affairs being much more limited in its application. "If we could but retain," says our author, "with us always the ingenuousness, the guilelessness, the docility, the simple but yet warm affections of opening life unimpaired by the hardening influences of the world, we should not only be the happier for it, but should without doubt, be gainers too.........We should be wiser if we sought wisdom more like little children." No doubt Mr. Craik is right in this view in the sense in which he intends it to be taken, meaning that we should all sieze and store up every particle of knowledge which falls in our way, or which we can find by searching, not merely retaining that which may be at once formed into a system. Mr. Craik gives us brief accounts of the most celebrated philosophers, artists, and literary men, both of ancient and modern history, neglecting no class of those brilliant intellects which have served to instruct mankind in all ages and to leave recorded in its history their characters as examples most worthy of the emulation of succeeding generations. In conclusion, we may observe that to every one who has the slightest interest in the progress of literature, art, or science, this work cannot fail to be extremely interesting as well as useful.

PRICES CURRENT OF THE LONDON METAL MARKET.

	July 29.			Aug. 5.			Aug. 12.			Aug. 19.			Aug. 26		
COPPER.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
Best, selected, per ton ...	89	0	0	89	0	0	89	0	0	89	0	0	89	0	0
Tough cake, do.	86	0	0	86	0	0	86	0	0	86	0	0	86	0	0
Copper wire, per lb.	0	0	$11\frac{1}{2}$	0	0	$11\frac{1}{2}$	0	0	$11\frac{1}{2}$	0	0	$11\frac{1}{2}$	0	0	$11\frac{1}{2}$
„ tubes, do.	0	1	$0\frac{1}{4}$	0	1	$0\frac{1}{4}$	0	1	$0\frac{1}{4}$	0	1	$0\frac{1}{4}$	0	1	$0\frac{1}{4}$
Sheathing, per ton	91	0	0	91	0	0	91	0	0	91	0	0	91	0	0
Bottoms, do.	96	0	0	96	0	0	96	0	0	96	0	0	96	0	0
IRON.															
Bars, Welsh, in London, per ton	7	15	0	7	15	0	7	15	0	7	15	0	7	15	0
Nail rods, do.	8	10	0	8	10	0	8	10	0	8	10	0	8	10	0
„ Stafford in London, do.	8	15	0	8	15	0	8	15	0	8	15	0	8	15	0
Bars, do.	8	15	0	8	15	0	8	15	0	8	15	0	8	15	0
Hoops, do.	9	17	6	9	17	6	9	17	6	9	17	6	9	17	6
Sheets, single, do.	10	10	0	10	10	0	10	10	0	10	10	0	10	10	0
Pig, No. 1, in Wales, do. ...	4	10	0	4	10	0	4	10	0	4	10	0	4	10	0
„ in Clyde, do. ...	2	15	0	2	15	0	2	15	0	2	15	0	2	15	3
LEAD.															
English pig, ord. soft, per ton	19	5	0	19	5	0	19	5	0	19	5	0	19	15	0
„ sheet, do. ...	20	0	0	20	0	0	20	0	0	20	0	0	20	0	0
„ red lead, do. ...	22	0	0	22	0	0	22	0	0	22	0	0	22	0	0
„ white, do. ...	26	0	0	26	0	0	26	0	0	26	0	0	26	0	0
Spanish, do.	18	10	0	18	15	0	18	15	0	18	10	0	18	10	0
BRASS.															
Sheets, per lb.	0	0	$8\frac{1}{2}$	0	0	$8\frac{1}{2}$	0	0	$8\frac{1}{2}$	0	0	$8\frac{1}{2}$	0	0	$8\frac{1}{2}$
Wire, do.	0	0	$8\frac{3}{4}$	0	0	$8\frac{3}{4}$	0	0	$8\frac{3}{4}$	0	0	$8\frac{3}{4}$	0	0	$8\frac{3}{4}$
Tubes, do.	0	0	$9\frac{1}{2}$	0	0	$9\frac{1}{2}$	0	0	$9\frac{1}{2}$	0	0	$9\frac{1}{2}$	0	0	$9\frac{1}{2}$
FOREIGN STEEL.															
Swedish, in kegs (rolled) ...	13	0	0	13	0	0	13	0	0	13	0	0	13	0	0
„ (hammered)	15	0	0	15	0	0	15	0	0	15	0	0	15	0	0
English, Spring	18	0	0	18	0	0	18	0	0	18	0	0	18	0	0
Quicksilver, per bottle ...	8	0	0	8	0	0	8	0	0	8	0	0	8	0	0
TIN PLATES.															
IC Charcoal, 1st qu., per box	1	10	0	1	10	0	1	10	0	1	10	0	1	10	0
IX „ „ „	1	16	0	1	16	0	1	16	0	1	16	0	1	16	0
IC „ 2nd qua., „	1	7	0	1	7	0	1	7	0	1	7	0	1	7	0
IC Coke, per box	1	3	0	1	3	0	1	3	0	1	3	0	1	3	0
IX „ „	1	9	0	1	9	0	1	9	0	1	9	0	1	9	0

SUBMARINE CABLES.—In Europe, Asia, Africa, and Australia there are 52 submarine cables, which are of the aggregate length of 5,625 miles, and the insulated wires of which measure 9,783 miles. The longest of these is 1,550 fathoms, and the shortest 1½ fathom. There are 95 submarine cables in the United States and British North America, which measure 68 miles, and their insulated wires 133 miles. The overland telegraph line between New York and the west coast of Ireland, through British Columbia, Northern Asia, and Russia, will be 20,479 miles long, 12,740 miles of which are completed. It has at length been resolved that this line shall cross from America to Asia at the southern point of Norton Sound, on the American side to St. Lawrence Island, and from thence to Cape Thadeus, on the Asiatic continent. Two submarine cables will be required for this, one 135 miles long and the other 250 miles long. Cape Thadeus is 1,700 miles from the mouth of the Amoor river.

RECENT LEGAL DECISIONS

AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

UNDER this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least—less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

JUDGMENT DEBTS.—The power provided by section 4 of Mr. Hadfield's Act 27 and 28 Vict., c. 112, which enables a creditor to whom land has been delivered in execution to apply to the Court of Chancery for a sale, does not extend to cases where the judgment has been entered up before the passing of the Act (July 29, 1864), but only to those since that time. This was the holding of Vice-Chancellor Wood, in *re* the Lands of the Isle of Wight Ferry Company.

PRINCIPAL AND AGENT.—In the case of Solomons *v.* Pender, in the Court of Exchequer, the question was whether a person could in the same transaction buy property as a principal, and charge commission as an agent for selling? The Court held that he could not do so; declaring that when an agent is employed to find a purchaser for any property, it is meant he should find a third person. The taking on himself the position of a principal annihilates all his rights as an agent. Therefore, if when so employed, he becomes, either alone or jointly with others, the purchaser of the property, he is not entitled to charge agent's commission on the sale.

COMPOSITION DEEDS.—The Court of Bankruptcy will not give effect to a deed of assignment for the benefit of creditors, where unfair inducements have been offered to some of the creditors to execute the deed. In *re* Ellis, at a meeting of creditors, a composition of 5*s.* in the £1 was offered and refused, and the debtor subsequently executed a deed of assignment, and the estate then showed only 2*s.* 2*d.* in the £1; though previously to the registration of the deed four of the creditors had been paid 5s. in the £1. The Court observing that it was its duty to insist upon the most perfect good faith being kept in such cases, declared the deed void.

Trade Marks.—The House of Lords lately affirmed the decision of Lord Chancellor Westbury (reversing the decree originally made by Vice-Chancellor Wood), in the case of The Leather Cloth Company (Limited) *v.* The American Leather Cloth Company (Limited), holding that the Court of Chancery is not to protect a person in the use of a trade mark which contains false or misleading representations concerning the character of goods to which it is applied. Accordingly in this case, where the purchasers of a manufacturing business, and of the right to use a trade mark, adopted and continued the use of such trade mark, which contained the name of the firm from whom they purchased, and statements and representations which had ceased to be true as regarded the article they manufactured, the House of Lords held that they were not entitled to relief against an infringement of such trade mark.

Partnership Capital.—In the case of Cooke *v.* Benbow it has been decided by the Lords Justices that the withdrawal by a partner of capital in order to pay his private debts is so far for the benefit of the other partners, as preventing the mischief that would arise from an execution against the partnership property, that in the absence of fraud no interest is payable to the other partners on account of the capital so withdrawn. It was observed by Lord Justice Knight Bruce that interest might, under some circumstances, be payable between partners on account of capital brought in or withdrawn, independently of express contract.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

The Institution of Mechanical Engineers.—The Congress held this year in Dublin has terminated its sittings. Several interesting papers have been read. Amongst them were one "On a Portable Steam Rivetter," by Mr. Andrew Wylie, of Liverpool; "On the Manufacture of Peat," by Mr. C. Hodson, of Portarlington; one by Mr. George Low, of Dublin, "On his Rock Boring Machine used at the Roundwood Tunnel of the Dublin Corporation's Waterworks;" and one by Mr. Parke Neville, on the works themselves, and to which we may refer hereafter.

Petroleum in Europe.—It is stated that petroleum has been discovered in Hanover, and capital is being privately subscribed in England to raise the oil from the wells, which are reported to be numerous. The constantly increasing importance of the trade in mineral oils at Marseilles, too, attract attention to the oil deposits of Europe. It is now considered certain that, in a period more or less short, the old continent will not be tributary to America for mineral oils for lighting. Every day new natural reservoirs of petroleum are discovered; and at the same time geologists are beginning to understand oil fields better, and the manner in which they are distributed over the globe. Among the localities which already export petroleum, is Moldo-Wallachia. Havre is the principal French market for petroleum. The *Marseilles Sémaphore*, however, is of opinion that Marseilles is destined to become a large market when the European reservoirs shall be worked on a large scale, and when it can receive the mineral oils of Asia by the Isthmus of Suez. There is an intimate connection between the reservoirs of petroleum in Gallicia and Moldo-Wallachia. These two oil regions, in fact, only form one, which corresponds to the general line of the Carpathian mountains.

The British Association Meeting.—South Staffordshire is making arrangements to receive the Association in a hospitable manner. Invitations have been received from Malvern, Coalbrookdale, and Benton. The local committee are making arrangements for excursions into South Staffordshire. It is proposed to devote Thursday, September 14, almost entirely to the black country. As many members as choose to go will proceed to Dudley early in the morning, for the purpose of visiting the caverns (which the Earl of Dudley will have illuminated for the occasion), and the thick coal open workings, near the Wren's Nest Hill. One section will be taken by Wednesbury, and will visit the leading works in the town and neighbourhood. Another will go to Stourbridge, to inspect the iron, fire-clay, and glass works. A third will be taken in charge of Mr. McLean, and conducted to the Cannock Chase Collieries, and will probably take Walsall on their way. A fourth will go to the Round Oak and Woodside Works, whilst a fifth will remain in the vicinity of Dudley, for the purpose of examining the geological features of the district. No doubt other places of interest, such as Wolverhampton, Oldbury, and Spon-lane Works, &c., will be visited.

History of Coke.—The following advertisement, given in *Notes and Queries*, fixing the period when coke first came into public use in this country, will no doubt be acceptable to any future historian of our coal trade:—"There is a sort of fewel made by charking or calcining Newcastle coals which burns without smoak, without fouling the furniture; and altogether as sweet, and is much more lasting and profitable then wood or charcoal; it kindles suddenly, and is useful either for chambers, roasting of meat, drying of malt or hops, woolcoming, distilling, preserving, or any such like employment. His highness the Lord Protector, with the advice of his Council, have encouraged and authorised the making thereof in order to the preservation of the woods of the nation. If any shall desire to make tryal of it for any of the use aforesaid, which will cost little or nothing the experiment, they may repair to London at Northumberland Wharff, near Chearing Cross; and according to the satisfaction they receive therein, they may be supplied from time to time with what quantity they shall have occasion to use. Those that have made tryal of it, finde it very profitable to all those uses abovementioned. It is also very useful for the tobacco pipe burners."—*Public Intelligencer*, No. 139, from Monday, August 16, to Monday, August 23, 1658, p. 764. This advertisement appears also in the succeeding number for August 30, but apparently not in any of the previous numbers.

Application of Centrifugal Force to the Casting of Metal Tubes, &c.—A young workman, named Auguste Larson, has recently invented a new method of casting tubes, &c. It consists in pouring the fused metal into a cylinder, which is capable of being opened and closed, and then subjecting it to rapid rotation. The liquid mass is thrown by centrifugal force into all the interior contours of the cylinder, and a straight and smooth tube soon results.

Use of Steel in Locomotives.—The Maryport and Carlisle Railway Company have, for some time past, used steel in the formation of the moving parts of their locomotives. With iron tires, 20,000 or 30,000 miles were the utmost that could be run without putting them again in the lathe; and they could not run in all more than from 60,000 to 90,000. Steel tires have run 100,000 miles without being put on the lathe; and there is reason to believe that they might run from 350,000 to 500,000. This advantage is not at all counterbalanced by increased cost, since steel is only about £5 per ton dearer than iron.

A New Explosive Substance.—Glycerine, as we all know, is the sweet principle of oil, and is extensively used for the purposes of the toilet; but it has now received an application of rather an unexpected nature. In 1847 a pupil of M. Pelouze's, M. Sobrero, discovered that glycerine, when treated with nitric acid, was converted into a highly explosive substance, which he called nitro-glycerine. It is oily, heavier than water, soluble in alcohol and ether, and acts so powerfully on the nervous system that a single drop on the top of the tongue will cause a violent headache which will last for several hours. This liquid seems to have been almost forgotten by chemists, and it is only now that M. Nabel, a Swedish engineer, has succeeded in applying it to a very important branch of the art, namely, blasting. From a paper addressed by him to the Academy of Sciences, we learn that the chief advantage which this substance, composed of one part of glycerine and three of nitric acid possesses is that it requires a much smaller hole or chamber than gunpowder does, the strength of the latter being scarcely one-tenth of the former. Hence the miner's work, which, according to the hardness of the rock, represents from five to twenty times the price of the gunpowder used, is so short that the cost of blasting is often reduced by 50 per cent. The process is very easy; if the chamber of the mine presents fissures, it must first be lined with clay to make it watertight; this done, the nitro-glycerine is poured in and water after it, which, being the lighter liquid, remains at the top. A slow match with a well charged percussion cap at one end is then introduced into the nitro-glycerine. The mine may then be sprung by lighting the match, there being no need of tamping. On the 7th of June last three experiments were made with this new compound in the open part of the tin mines of Altenburg, in Saxony. In one of these a chamber 34 millimetres in diameter was made perpendicularly in a dolomitic rock, 60ft. in length, and at a distance of 14ft. from its extremity, which was nearly vertical. At a depth of 8ft. a vault filled with clay was found, in consequence of which the bottom of the hole was tamped, leaving a depth of 7ft. One litre and a half of nitro-glycerine was then poured in; it occupied 5ft.; a match and stopper was then applied, as stated, and the mine sprung. The effect was so enormous as to produce a fissure 50ft. in length, and another of 20ft.; the total effect has not yet been ascertained, because it will require several small blasts to break the blocks which have been partially detached by this.

Traction Carriage.—The specification of Messrs. Bernier and Godard Desmarest's invention describes a steam carriage, in which the motive power, instead of being imparted to wheels, is transmitted by cranks to a set of legs, having an alternating, or rising and falling motion, and bearing at their downstroke against the ground, rail, or surface to be travelled over, so that they propel the carriage in a manner somewhat similar to the action of the legs of a horse. An arrangement of rods, working in slotted brackets, and actuated in levers, is also described for bringing the legs in and out of action.

Banks of Issue.—A return made up to the beginning of the present year shows a list of 137 private banks in England issuing their own notes, and authorised to issue them to the amount in the aggregate of £4,212,846. The largest amount authorised is £112,280, the issue of the East Cornwall bank. Fifty-nine joint-stock banks in England have also authority to issue their notes to the amount together of £3,226,257. Stuckey's Banking Company are authorised to issue to the extent of £356,976, and the National Provincial Bank of England to the extent of £442,371. The 12 Scotch banks of issue are authorised to issue their notes to the aggregate amount of £2,794,271, and the six Irish to the amount of £6,354,494—one of these, the Bank of Ireland, having authority to issue £3,738,428. In the course of the last ten years 13 English private banks of issue have stopped payment, three English joint-stock banks of issue, and one Scotch bank of issue.

Flying Machines.—The American government has seriously taken up the subject of aërial navigation, and is actually having a machine for the purpose, on a large scale, constructed. It consists of a cigar shaped canoe, made of copper, with iron ribs. In the centre of this is placed an engine sufficiently powerful to work four screw fans with 20ft. blades—one of these being placed above, and another below the canoe, and one at each end. The two former are to cause ascent and descent; the two latter for horizontal motion. The whole apparatus, when completed, is to weigh about six tons. It is not difficult to anticipate what the issue of the experiment will be. The American government was induced to make it by the results said to have been arrived at by the late General (and Professor) Mitchell in certain trials he made with screw fans, by which it was considered proved that one 20ft. in diameter would, with a given velocity, raise up very much more than six tons.

Emigration from the Iron and Coal Districts.—During the last few months a large number of colliers and iron workers have emigrated from South Wales, and it is a matter of regret that among the number were hundreds of industrious men who could not be easily replaced in their various avocations. To a great extent emigration is a great and necessary relief to overcrowded mining districts, but when carried to the extent that has been the case in the counties of South Wales since the commencement of this year it is the result of a large amount of inconvenience and positive loss to the employers of labour. The United States is the destination of at least 90 per cent. of those that have left, and the remaining 10 per cent. were bound for Australia, Queensland, Canada, &c. The vast industrial resources of the United States and the glowing accounts received of the state of the labour market there were the principal inducements to their leave their native country, and the warnings of those that have returned disappointed in their expectations and of the newspapers that have exposed the delusive hopes held out by interested agents have had but little effect in checking the stream. If the demand for coal and iron were as brisk as for some months last year, such has been the drain by emigation, that the iron and coal masters would not be able to secure a sufficient number of hands, and even at the present time wages are fully 15 to 20 per cent. higher than they were three years ago.

The Abbe Laborde has been investigating the spectrum produced by the lightning flash, and states, as the result of his experiments, that he has seen on three or four occasions the several bright lines of which the spectrum is composed. The lines seen are all of a dull white or lead colour, but one of them is always more distinct than the others, and is sometimes the only one observed. This line appears to be situated close to Fraunhofer's line E.

THE SWANSEA TOWN COUNCIL AND HARBOUR TRUST have just taken a very wise step on the suggestion of Mr. Joshua Williams, the general manager of this section of the Great Western, and that is to reduce the shipping dues on pig-iron, &c. Unquestionably the trade of the port will be materially benefitted by the reductions made.

THE COPPER SMOKE QUESTION.—Messrs. Vivian and Sons have determined on adopting the patent of a German chemist to utilise the obnoxious copper smoke, and gigantic works and furnaces are now being erected in order to carry out the invention. Mr. H. H. Vivian, M.P., stated publicly that he considered the invention one of the greatest discoveries of modern times, and he hoped, before long, to be able to manufacture 1,000 tons per week of sulphuric acid from copper smoke.

THOMAS DUNN AND CO. (LIMITED).—The Prospectus has been issued of Thomas Dann and Co., Limited, Windsor Bridge Iron Works, Manchester. Capital £120,000, in 6,000 shares of £20 each, with power to increase. Full particulars will be found in our advertising columns.

HYDRAULIC BRUSH.—A very ingenious contrivance has recently been patented in America. It is a circular brush, having at the back a small turbine wheel, which causes it to revolve when a stream of water is admitted into the flexible tube connected with its hollow handle. Not only is this brush, on account of revolving, and its supply of water very effective, but it lasts much longer, as it is worn quite uniformly.

MERSEY STEEL AND IRON COMPANY (LIMITED).—The first meeting of shareholders has been held at Liverpool. Mr. T. B. Horsfell, M.P. (the Chairman), regretted that the dividend would only be 6 per cent., which was owing to the unprecedented dulness of the iron trade during the past six months; in fact, that trade had not been so bad for the last twenty years, but he trusted they had seen the worst. In answer to Mr. Cunningham, Mr. Clay, the managing director, said the new Bessemer works would cost £28,000, being £2,000 below the estimate. Of this amount £20,000 had already been spent, and they were now erecting a new forge at a cost of £6,000, and sinking a well at the cost of £2,000, as they had hitherto had to pay £800 a year for water.

MANUFACTURE OF SALTS OF CHROMIUM.—Mr. J. K. Leather, of St. Helen's, proposes to mould the chrome ore and lime into blocks, and heats these blocks with as little exposure to the flame as possible (the reverse is the usual practice), as he finds it to be practically impossible to get an oxidising flame free from the reducing flame in the reverberatory furnace.

MOTIVE POWER ENGINES FOR CUTTING COAL.—An invention has been provisionally specified by Mr. T. Taylorson, of Woodfold Park, Blackburn, which consists in rendering the apparatus self-acting in reversing the valves at any part of the stroke according to the depth of cut. To effect this he applies an ordinary governor, and so connects it with the pick that in the forward stroke of the pick rotary motion is given thereby to the governor, causing the balls to expand, and immediately on the delivery of the blow the rotation of the governor ceases, the balls collapse, and operate a catch lever, which actuates a suitable arrangement of levers and weights to reverse the valve for another stroke. By this means both time and air are, it is claimed, economised.

AT A RECENT MEETING OF THE HOROLOGICAL INSTITUTE, Lord Caithness in effect declared that the art of clock-making was going out of England. Statistics prove that France and America are doing for us the work which we should do and profit by at home. From Switzerland especially the importation of watches, from France of Ormolu clocks, and from America of brazen clocks, has, of late years, enormously increased, and this cannot be without its effect upon our artisan classes.

THERMO-BATTERY.—At a meeting of the Royal Institution, Mr. Ladd exhibited in the library a powerful thermo-electric battery, made in the manner discovered by Marcus, of Vienna. Although the instrument consisted of but ten pairs, and the means of heating it by a row of gas jets had been hastily devised, yet on making and breaking the circuit a spark was readily obtained. The current from this thermo-battery, sent round an electro-magnet, and lifted a very considerable weight.

STEAM OMNIBUSES.—The first trial of a new machine constructed for the purpose of establishing steam omnibases on the ordinary road has recently been made at Nantes. The engine, of eight-horse power, weighs seven tons with its coal and water, and measures over 18ft. in length, and is nearly 6ft. wide outside the wheels. The journey was performed without interruption, with the exception that in one place too short a turn was taken, and the locomotive had to be unhooked from the omnibus before the error could be rectified. The twenty-nine kilometres between Nantes and Niort were performed in two hours, the locomotive stopping twice to take in water. The steam omnibus is to ply regularly between the two towns.

NAVAL ENGINEERING.

THE "LORD WARDEN".—The large gun-metal cleaver-shaped weapon, which is to form the under-water portion of the stem of the iron-cased frigate *Lord Warden*, at Chatham, has been successfully cast in the foundry at the dockyard, the previous efforts to make the casting having failed. This formidable weapon, which on leaving the foundry weighed between nine and ten tons, and is the largest casting of the kind ever made at Chatham Dockyard, has the appearance of an enormous wedge. Placed as it will be at the most prominent part of the protruding swan-shaped stem of the *Lord Warden*, below the water, it will prove a powerful auxiliary in running down and cleaving open any hostile vessel, should it ever be necessary to use the frigate as a ram. The prow has been placed in its position, and although the operation was attended with some difficulty, and required considerable care, it was effected under the directions of the officials connected with the master shipwrights' staff without accident. The work of fitting and preparing the *Lord Warden* for sea is being pushed forward as rapidly as the resources of the dockyard will permit, nearly 1,000 mechanics and other workmen being employed on her.

AMONG THE NEW MACHINES ORDERED BY THE LORDS OF THE ADMIRALTY to be erected at Chatham Dockyard to meet the constantly increasing requirements of that establishment, is one large steam crane, capable of lifting weights up to 25 tons. It is to be erected on one of the vacant wharves, at a cost of £1,910, together with two 10-ton cranes, at an outlay of £2,160. Messrs. J. Taylor and Co., of the Britannia Works, have received orders to supply the dockyard with two travelling cranes, each capable of lifting 10-ton armour plates, at a cost of £1,180. The same firm will also supply two steam rivetting machines at a sum of £895. Among the other steam machinery ordered for the general service of the establishment is a new 5-ton steam hammer, to be supplied by Messrs. Tannett and Walker at a cost of £1,350. Several other new machines are also ordered to be fitted up in Chatham Dockyard, the whole involving an expenditure on this plant alone of between £9,000 and £10,000.

THE ARMOUR-PLATED SCREW FRIGATE AGINCOURT, built by Messrs. Laird Brothers, of Birkenhead, for the Government, left the Mersey on the 12th ult., under the command of Capt. Paynter, R.N. In passing slowly down the river she received a salute of 21 guns from the battery attached to Messrs. Laird's works. Shortly after she had passed the Bell-buoy she was joined by the National Steam Navigation Company's steamer *Queen*, built by Messrs. Laird on the slip next adjoining the dock in which the *Agincourt* was constructed, and launched a month after the *Agincourt*. The *Queen*, which is 3,500 tons burden, 475-horse power, and 400ft. long over all, accompanied the *Agincourt* for a short distance at full speed, but it appeared that the *Agincourt* had the advantage. The *Queen* has, however, been built for carrying capacity rather than for speed. After leaving the Bell-buoy the *Agincourt*, with the tide in her favour, ran a distance of 55 nautical miles in 4 hours 20 minutes, or at the rate of $12\frac{3}{4}$ knots an hour. Making the usual allowance for the tide, the actual speed would be at the rate of $11\frac{1}{2}$ knots. This corresponded with the register of the patent log. The engines are of 1,350 nominal horse-power, and are on the double piston-rod principle, having return connecting rods. The cylinders are 101in. in diameter, and have a stroke of 4ft. 6in. The steam is supplied by 10 boilers, heated by 40 furnaces, which will consume on the average 100 tons of coal a day. The engines made from 48 to 50 revolutions a minute, with a vacuum of 26in., and a pressure of 19lb. of steam. There was no inconvenience or stoppage of any kind, and no indications of heated bearings. The vibration, too, promises to be very slight in proportion to her power. She answered her helm admirably.

THE "HERCULES."—The following are the principal dimensions of the new iron-cased frigate *Hercules*, of 1,100 horse-power (nominal), which is about to be commenced at Chatham Dockyard, from the designs of Mr. E. J. Reed, the Chief Constructor of the Navy. Length between perpendiculars, 305ft.; extreme breadth, 59ft.; depth of hold, 20ft. 7in.; burden in tons, 4,813 14-94. Her sides are proposed to be constructed of a thickness greater than any vessel now afloat, in order to render her as nearly as possible invulnerable to the heaviest description of ordnance she may be called upon to face. For this purpose the *Hercules* will be plated with a thickness of no less than $11\frac{3}{4}$in. of iron, in addition to 32in. of timber backing at the water-line, and in immediate contiguity to her gun battery. Her armour-plates will be composed of the best description of rolled iron, 9in. thick, in addition to which a double skin of iron-plating, composed of plates $1\frac{1}{2}$in. in thickness, will be worked behind the 10-inch teak backing, to which the armour-plates will be bolted. Behind these again will be 22in. of timber, and finally the ordinary $\frac{3}{4}$in. inner plating, or skin of the frigate. Contrasting these with the corresponding figures in the *Minotaur*, *Warrior*, and others of our ironclads, the *Hercules* will have a thickness of iron-plating more than double that of either of the vessels named. In the case of the *Warrior* the iron armour-plates are only $4\frac{1}{2}$in. in thickness, and in the *Minotaur* $5\frac{1}{2}$in., while along a portion of her broadside the *Bellerophon* carries armour-plates of 6in. in thickness, with an inner plating of $1\frac{1}{2}$in. in thickness behind the 10in. timber backing. Like the *Bellerophon*, the *Hercules* will be built on the cellular principle, with a double bottom, the *Bellerophon* being the first vessel in the British Navy constructed on that plan. In her construction steel will be used for her stronger plates and in other parts where experience has shown that it is advisable to employ that substance. The *Hercules* will be commenced in the second dock, in which the *Lord Warden* wooden armour-plated frigate is now being fitted for sea.

TESTING STEEL PLATES.—In order to test the quality of the steel plates which have been sent into Chatham Dockyard, as supplied by the Cammell Company Sheffield, who have taken the contract from the Admiralty, a certain number were selected, at hazard, from the stock now in store, and, with the consent of the authorities, tested at the Government rifle range at Milton, where the troops from Chatham garrison undergo their course of ball practice, the ranges at which the plates were fired at varying from 50 to 300 yards. Each plate was struck by about 100 balls, and they have now been returned to the dockyard for the purpose of enabling an examination to be made for the effects of the shot upon each plate. Taking one of the $\frac{3}{8}$in. steel plates, of the same kind as those which form the upper deck of the ironclad frigate *Belleropon*, the marks of about 80 shots are visible on its surface, a label showing the range at which each was fired. In the majority of cases so excellent is the steel that the effects of each shot are mere "splashes," while in only some few cases have the minutest indentations been made, the opposite side of the plate being in the same state as before the experiments were commenced. In the case of shots which have struck the extreme edge, the plate in the immediate locality is slightly bent, while a minute examination fails to detect the least appearance of lamination, showing the plate to be in all respects perfect. The same kind of experiments were also made with one of the half-inch ordinary iron "skin" plates of the *Bellerophon*, and in this case also the results were equally satisfactory. As in the trials with the steel plates the ranges at which the half-inch iron plate was tested varied from 50 to 300 yards, but in no case does the slightest appearance of the plate being penetrated present itself, the majority of the shots making indents of only about one-sixteenth of an inch. The results of the trials establish the superiority of the iron of which the *Bellerophon's* plates are made.

THE "HELICON," 837 tons and 250 horse-power nominal, left Portsmouth on the 8th ult., to complete her trials, in charge of the usual officials of the steam factory and reserve of the port, drawing 10ft. 3in. of water aft and 9ft. 10in. forward; half an inch mean immersion in excess of her load draught when complete in all respects for service at sea. The force of wind and the state of the sea were about equal to what existed when the *Salamis* was tried. The runs over the measured mile gave the following results:—With full boiler power—No. 1 run, 14·575 knots; No. 2 run, 14·285 knots; No. 3 run, 14·815 knots; No. 4 run, 14·118 knots; No. 5 run, 15·000 knots; No. 6 run, 13·846 knots. First means:—14·430 knots, 14·550 knots, 14·466 knots, 14·559 knots, 14·423 knots. Second means:—14·490 knots, 14·508 knots, 14·512 knots, and 14·491 knots. Mean of means, or speed of the ship, 14·500 knots; revolutions of engines—*maximum*, 35; *minimum*, 25; load on safety valve, 25lbs.; pressure of steam in boilers, 27lbs.; vacuum in condensers, 25in. With half-boiler power, four runs were made, which gave knots per each run, 11·220, 10·414, 11·118, and 11·111; first means, 12·317 knots, 12·316 knots, and 12·614 knots; second means, 12·316—12·465 knots; mean of means, or speed of the ship, 12·390 knots; revolutions of the engines—*maximum*, 30; *minimum*, 29·5. As the *Salamis* made her trial, as the trial vessel of the *Helicon*, at as nearly as possible the same displacement, &c., we append here the general results of her trial at full boiler power, premising it, however, with the remark that the indicated horse-power of the *Helicon's* engines has not been given from want of time on the trial to work it out on the indicator card diagrams:—Mean speed of *Salamis*, 13·689 knots; revolutions of engines—*maximum*, 32·5; *minimum*, 31·916; indicated horse-power, 1,388·24. Comparing, therefore, the full boiler power trials of the two ships, it will be seen that the *Helicon*, with her prolonged bow, has made nearly a knot greater speed than the *Salamis* accomplished with her old hatchet-shaped bow, notwithstanding that such hatchet-shaped forms had hitherto been considered the "clippers" of Whitehall. Mr. Reed may, therefore, be fairly congratulated on his success with the *Helicon*, and especially so as he explicitly declared previous to her launch off the stocks, that his chief anticipations of the proved success of the *Helicon* over her sister despatch vessels would "be at sea among waves" rather than at the measured mile. With regard to the > shaped metal facing to the *Helicon's* stem, it was found that there was a considerably less sheet of water spinning up her stem when she was at full speed as compared with the last time she was under weigh, and there was also a somewhat less volume of heaped up or broken water in front of the the bows, the difference in the latter respect being, as nearly as could possibly be ascertained under the circumstance, as 2ft. above the surrounding water level on the last occasion to 18in. on the present. The working of the engines and boilers was most satisfactory, and give credit to the makers, Messrs. Ravenhill, Salkeld, and Co.

THE "LIVERPOOL," SCREW FRIGATE, 35, Captain R. Lambert, underwent a trial of her machinery at the measured mile in Stokes Bay, on the 4th ult., under the supervision of the officials of Portsmouth Steam Reserve and Factory. The ship's draught of water on weighing her anchor from Spithead was 21ft. 5in. forward, and

23ft. aft. Her engines are of 600-horse power nominal, and drive a two-bladed Griffiths' screw of 18ft. diameter, 26ft. 6in. pitch, 3ft. 6in. in length, and an immersion of the upper edge of 2ft. 4in. Six runs with full boiler power was made over the mile, the speed of the ship being in each instance 10·975, 9·399, 11·321, 8·801, 11·840, and 9·000 knots. The mean speed of the ship in the six runs was 10·261 knots. Two runs at half-boiler power gave 8·238 and 7·185 knots. The indicated horse power was under 2·000, or considerably less than four times the nominal power. The machinery worked exceedingly well, but the diagrams on the indicator cards showed an insufficient supply of steam.

Naval Appointments.—The following appintments have taken place since our last: —F. E. Julian, Engineer, to the *Resistance*; E. Holmes, Second-class Assist.-Engineer, to the *Tyrian*; E. E. Lucas, Second-class Assist.-Engineer to the *Asia*, for the *Mersey*; J. Ryley, Chief Engineer, to the *Terror*, *vice* Brown; W. Anderson, Chief Engineer to the *Cumberland*, for the *Rodney*, *vice* Ryley; J. Bridgeman, Chief Engineer, to the *Royal George*; J. Carlisle, Chief Engineer to the Cumberland, for service in the *Charybdis*; W. Crosbie, Engineer to the *Blenheim*, for service in her Tenders; E. Taylor, Engineer to the *Blenheim*, for service in the *Julia*; M. Barker, Engineer to the *Aboukir*, *vice* Jack; F. Skelton, Engineer to the *St. George*, *vice* Barker; G. T. Ludlow, First-class Assist.-Engineer, to the *Research*; J. Redgrave, promoted to the rank of First-class Assist.-Engineer; J. Ellis, Engineer, to the *Linnet*; J. V. B. Thompson and G. W. Lewis, First-class Assist.-Engineers, to the *Linnet*; J. Multar, First-class Assist.-Engineer to the *Dauntless*, for service in the Tenders; J. G. Taylor, Engineer, to the *Britomart*; H. A. Henri, B. Carr, and A. Hindmarsh, Engineers, to the *Duncan*, for disposal; J. Bates, J. Davis, and W. G. Paige, for First-class Assist.-Engineers to the *Duncan*, for disposal; J. Herwood, Chief Engineer to the *Asia*, for service in the *Cæsar*, *vice* Marshall; P. Hutchinson, Engineer to the *Frederick William*, for Tenders; C. Platt, Engineer to the *Himalaya*, *vice* Hutchison; and J. Dyson, First-class Assist.-Engineer, to the *Frederick William*, for Tenders.

STEAM SHIPPING.

Atlantic Steamships Lost.—The *Glasgow* makes the twenty-ninth steamship lost while plying between European ports and America and Canada during the past twenty-seven years, or an average of about one a year since the commencement of ocean steam navigation between the two continents: The following is a list of the vessels, placed in the order in which they were lost:—The *President, Columbia, Humboldt, City of Glasgow, City of Philadelphia, Franklin, Arctic, Pacific, Lyonnais, Tempest, Austria, Canadian* (No. 1), *New York, Indiana, Argo, Hungarian, Cannaught, United States, Canadian* (No. 2), *North Briton, Caledonia, Anglo-Saxon, Norwegian, Georgia, Bohemian, City of New York, Jura, Iowa*, and *Glasgow*.

LAUNCHES.

The Launch of an Ironclad for the Peruvian Navy took place on the 8th ult., from the building-yard of Messrs. Samuda, at Poplar. The vessel in question was named by Madame Barreda, wife of the Peruvian Minister, the *Independencia*. The vessel, which is built entirely of iron, has an outer casing of iron plates of 4½ inches in thickness, extending from stem to stern, and reaching to about 4 feet below the water line. This plating, which fore and aft is carried up to the main deck, is contineed amidships to the gunwale, thus forming a completely protected battery in which very heavy guns can be effectually worked. The stem of the vessel is constructed to be used as a ram, for which purpose the bowsprit is hinged so as to be easily brought inboard when the ram is about to be used. The long voyage which the *Independencia* will have to make before reaching the Peruvian coast has led the builders to adopt every possible means to enable her to avail herself of her sails, and with that object in view a screw well has been so arranged that the screw can be easily lifted from the water without any interference with the armour-plating or the free play of the stern guns. The intended armament consists entirely of Armstrong guns on the shunt principle—viz., twelve 70-pounders of 4 tons each on the main deck, and two pivot guns, 150-pounders, weighing 7 tons each, on the upper deck. These latter guns can be used on a line even with the keel. In order to insure the utmost amount of security possible the bottom of the ship is double, the space intervening between the two skins being perfectly watertight. It is intended to utilise this space as a ballast tank to keep the vessel in proper floating trim, besides which there is an obvious advantage in the event of bilging or other accident. When fully weighted with all her coals, guns, and stores on board, the main deck port sills will be seven feet above the water. The extreme length of the vessel is 215ft., and her beam 44ft. 9in., with a depth of 32ft. 6in., measuring, according to builders' computation, 2,004 tons. Being designed with a view to force rather than elegance, she presents a less graceful appearance than other vessels of finer lines, but her builders anticipate that when fitted by Messrs. Penn with engines of a collective power of 550 horses, she will, in sea-going trim, attain a speed of not less than 12.

The Launch of the "Dunnerberg," United States iron-clad took place on the 22nd of June, at New York, from the yard of W. H. Webb, the builder of several celebrated vessels, among them the Russian ship *General Admiral*, the *Re Luigi di Portugallo*, and the *Re d'Italia*. Her draught when ready for sea will be about 21ft., and her displacement of water about 7,000 tons. Her tonnage measurement as registered is 5,090 tons, and her iron armour will weigh about 1,000 tons. She has six main and two donkey boilers, each main boiler being 13ft. deep, 17ft. 6in. high, and 21ft. front; together they will weigh about 450 tons. The boiler surface is 30,000ft., the grate surface 1,200ft., and the condensing surface 12,000ft. The engines are horizontal back-action condensing with two 100-inch cylinders, and 45in. stroke of piston. The propeller is 21ft. in diameter, has a varying pitch of from 27ft. to 30ft., and weighs 34,580lb. The coal bunkers will contain 1,000 tons of coal, sufficient for about 12 days' steaming. The plan of the *Dunderberg* is novel, and the results promised by her constructor will make her one of the greatest sea-going ironclad rams afloat. Her floor is flat, her sides angular, and her lines such that she must be very easy in a sea-way, so that in all probability she will be able to use her guns when other vessels are rocking fearfully. The casemate surrounding the hull is pierced for 21 guns, and its sides slope inward at an angle of 35 degrees, sufficient, it is believed, to shed shot with ease and certainty. The sides of the casemate are over 3ft. thick, covered with plates of hammered iron 9ft. long, 28in. wide, and 5½in. thick, and fastened on with heavy screw bolts. The peculiar construction of the *Dunderberg* makes her, as it were, two vessels, the space between the inner and the outer ship being used as coal bunkers, thus serving as an additional protection to the engines and boilers. Her dimensions are—length, 380ft. 4in.; beam, 72ft. 10in.; depth of hold, 22ft. 7in.; height of casemate inside, 7ft. 9in.; length of ram bow, 50ft. One enormous keel and six keelsons strengthen the ship fore and aft, and aid in sustaining the great weight of the armoured casemate and battery. Bulkheads, dividing her into sections, give additional strength and guarantee safety in the event of stranding or collision. The ram is part of the ship, and is not bolted or fastened on as is usually the case, but is an extension of the bow, which for 50ft. is a firm and solid mass of timber. This is covered over with heavy wrought-iron armour, and forms a terrible beak, which, driven at a high rate of speed, would pierce through the strongest ships. On the side of the vessel below the casemate the armour is 3½in. thick, and placed on vertically in screw bolted slabs, from 12ft. to 15ft. long and 3ft. wide. The propeller and two rudders are protected by a shelf, which runs out aft and is braced to the stern and sides. One of her rudders is common to all ships, the other is placed above and forward of the huge propeller, so that if the main one is damaged it can be at once replaced, The *Dunderberg* is brig-rigged, and has been for nearly three years building, and her armament will consist of four 15-inch Rodman guns and 12 or 14 11-inch Dahlgren guns—a battery of immense power. The most important part of the vessel, however, is her speed, and this cannot be tested until she is ready for sea. Immediately after the launch she drew 15ft. aft, 13ft. amidships, and 9ft. 6in. forward. Her draught when ready for sea is not to exceed 21ft., and her engines are 5,000 actual horse power. The contract on which she was built calls for a speed of 15 knots an hour.

The Screw Steamer "Preston Belle" was launched on the 22nd July, from the yard of the Preston Iron Shipbuilding Company. The following are her dimensions:—Length, 18ft.; beam, 26ft.; depth, 16ft. 6in.; tonnage, 593 tons; horse-power, 80 nominal. Engines by Forrester and Co., of Liverpool. The company are also building a steel yacht for the Pasha of Egypt. Length, 170ft.; beam, 20ft.; depth, 8ft.; horse-power 100 nominal. Also a steamer of 1,000 tons for a large company in London, besides several sailing vessels, making the total amount of tonnage now in course of construction 3,500 tons.

TELEGRAPHIC ENGINEERING.

Telegraphic Gossip.—A Warsaw journal announces that the plan for a telegraph line between Russia and America has been approved and signed by the Czar. The Russian Government undertakes to complete the line as far as Nicolajewsk, the remaining portion—from Nicolajewsk to San Francisco—being at the charge of the American Company. The capital of the latter amounts to 10,000,000 dollars, and bonds representing 8,434,600 dollars have already been issued. It is intended that this route shall be finished in five years.——At the half-yearly meeting of the Electric and International Telegraph Company it was stated that the net profit for the half-year was £54,696, out of which a dividend was recommended of 4½ per cent. for the six months. The dividend was unanimously agreed to, and the balance of £9,140 ordered to be added to the Trust Fund.——During the hearing of an application for discharge, made by Messrs. Charles Joyce and Co., merchants and underwriters, Moorgate-street, London, who had held a high position in the commercial world, and had failed with liabilities of unusual magnitude, it was stated that by an unfortunate mistake in the reading of a telegram, which led to a large purchase of cotton, a loss of £94,000 had been incurred.

The Telegraph to India Company (Limited) have met for the purpose of declaring a dividend for the half-year ending the 30th of June last. Sir Macdonald Stephenson, who presided, made a statement on the whole, as to the operations of the company, and the conditions and prospect of the various lines of telegraphy in which they are interested. Notwithstanding the drawbacks that had occurred, and the large sums of money that had been expended, the chairman thought that a great problem had been solved towards the completion of a system of international telegraphic communication throughout the world. A dividend at the rate of 5 per cent. per annum, free of income tax for the half year, was declared, and the report generally was unanimously adopted.

The Atlantic Cable.—The *Great Eastern* has returned without having laid more than two-thirds of the Atlantic cable. When the partial loss of insulation took place, those on board the *Great Eastern* appear to have attributed the defect to a fault in the cable six miles from the ship, and in attempting to lift it the cable broke. Four attempts were made to hook it up, and three times it was partially lifted, but the rope broke each time. The spot was therefore marked by buoying, and the *Great Eastern* has returned. Further particulars will be found in another page.

RAILWAYS.

Pneumatic Railway.—The transmission of carriages for passengers through metallic tubes is now about to be tested on a large scale, and in circumstances that will bring out more clearly its capabilities. The tube, which will be 12ft. in internal diameter, will begin at a station in Great Scotland Yard, pass through the Thames Embankment to the river, across which it will be carried in a channel sunk for the purpose, and filled in with concrete; it will thence pass, under College-street and Vine-street, to a terminus convenient to that of the South Western Railway at Waterloo-bridge. The river will be prepared for the reception of the tube by sinking three piers, by means of iron caissons. When these have been brought sufficiently near the bed of the river, the upper portions of the caissons will be removed, and the channel for the tube will be dredged down to the upper course masonry. The tube will be lowered in four sections. The trains, which will be commodious and well lighted, will be despatched at intervals of three minutes, being drawn in one direction by exhaustion, and impelled in the other by pressure. The works will be completed in twelve months from their commencement, at a cost of £130,000. The pressure required when the carriages are within the tube—an arrangement not only proposed, but tried, forty years ago—is but the one-fortieth of that which was necessary with the old pneumatic railway system, with which a continuous valve, subject to serious leakage, was required. It is asserted, however, that compression will not answer as well for the propulsion of the trains as exhaustion, the action of the latter being instantaneous, while that of the former is slow and comparatively insignificant. It appears that if a lighted taper is placed in one end of a sufficiently long pipe, a forge bellows at the other end will not blow it out. The matter will, however, very soon be tested, and, should it be necessary, exhaustion can be used in both directions, but will, in certain cases entail the expense of an additional steam-engine.

Adoption of Electric Communication between Passengers and Guards on the South-Western Raiway.—The managing authorities of the London and South-Western Railway have adopted the system of electric communication between passengers and guards of trains which was brought lately under the notice of the public by Mr. Preece, the telegraphic superintendent of their line. The carriages of the Exeter express are now fitted with the apparatus, and plain directions for its use have been issued. These are as follow:—In the event of something of a serious nature occurring which urgently requires the stoppage of the train, the passenger may "break the glass" and "ring" by moving the bell handle in the direction denoted by the arrow. Thereby a bell will ring in each guards van, and also on the engine. When the guards and enginemen hear the bell ring they will at once look carefully along each side of the train, and in case any violent oscillation be seen, or a carriage be on fire, or other occurrence of a serious character be observed, the train will be stopped as speedily as possible, and when stopped must be protected by signals as prescribed. Should, however, the guard and engine-driver fail to observe anything which really necessitates an immediate stoppage of the train, their duty will be to stop the train at the next station or junction, so as to protect the train when stopped by the fixed signals. When the train is stopped, the passenger who broke the glass and rang the bell will communicate with the guard; but should he fail to do so the guard will detect the compartment from which the passenger gave the alarm, by looking for the broken glass; and, in case the alarm has been mischievously and wantonly given, or from insufficient cause, the names and addresses of all the passengers in that compartment will be taken, in order that the law may be enforced." The instructions conclude with an earnest request that the passengers will protect the communication from improper and mischievous use, as it is very important that it should not be used without real and urgent necessity.

Railway Viaducts and Tunnels in France.—It appears from official statistics relating to French railways, that the viaducts over which they run, taken altogether, are more than seven leagues in length. One of the most remarkable of these viaducts is that of Val-Fleury, near Meudon, built in 1840. It is 140 yards long, 31 yards high, and cost 600,000f. The viaduct of Chaumont, on the Strasburg line, is the first in point of expense, as it cost 5,800,878f. There is a remarkable viaduct at Mirville, on the Western Railway, which cost 2,300,625f.; and the viaduct of Brunay, on the Lyons line, which cost 1,540,000f. The tunnels of all the railways in France are 366 in number, and would, if combined, measure 37 leagues, in length. The longest tunnel is that of Nerthe, near Marseilles, on the Lyons Railway, which cost 10,500,000f.; that of Blaisy, on the same line, cost 8,000,000f.; and that of the Credo, between Lyons and Geneva, 6,500,000f. The entire cost of the bridges, viaducts, and tunnels on the various French railways amounts to 432,681,953f. The government and the railway companies have expended on the railways 5,500,000,000f. The cost of bridges, viaducts, and tunnels amounts to 8 per cent. on the whole.

THE GREAT WESTERN CARRIAGE WORKS.—It is now definitely settled that these works will come to Oxford, the company having communicated to the mayor (Mr. Jas. Hughes) that their resolution for moving them to this city, agreed to in April, will be carried out. The Cripley meadow, which underwent an examination as to its subsoil, &c., having been reported by the company's engineers as an eligible site, they had instructed their solicitor at Oxford to get the necessary conveyance from the town clerk, in order that the same may be signed, sealed, and delivered.

STOPPING RAILWAY TRAINS.—If a train moving at the rate of twenty-five miles an hour were stopped instantaneously the passengers would experience a concussion equal to that of a body falling from a height of nineteen feet; they would be hurled against the sides of the carriage with a force equal to that they would be exposed to in falling from a window on the second floor of a house. If the train were moving at the rate of thirty miles per hours, they might as well fall from a height of three pair of stairs, and an express train would, in point of fact, make them fall from a fourth storey.

METROPOLITAN RAILWAY TRAVELLING.—They experience of the Metropolitan Railway affords some curious and interesting results connected with the locomotion of the inhabitants of London. It appears from the returns that during the half-year just ended a number of persons equal to two-and-a-half times the whole population travelled upon the line, the total number being 7,432,823. The increase in the numbers conveyed over those of the corresponding year was 2,255,488, or equal to the united populations of Manchester, Liverpool, Birmingham, Leeds, Sheffield, Newcastle York, Leicester, Hull, Bristol, Nottingham, Preston, and some half-a-dozen smaller towns of England. Of the seven millions and upwards who were carried, the great bulk consisted, of course, of third-class passengers; but a comparison with the figures of the previous year shows that the proportion of both first and second classes is slightly decreasing, as the third-class passengers increase in a greater ratio than the others. The figures are sufficiently interesting to be given in detail:—

	1865	1864
First class	832,112	635,651
Second class	1,519,887	1,210,259
Third class	5,110,823	3,361,425
Total...	7,432,823	5,207,335

A calculation shows that the first-class travellers in the first half-year of 1864 were 12·20 per cent. of the whole, while this year they were only 11.15; the percentage of the second-class in 1864 was 23·25, for the year just ended it was 20·37; while the third-class travellers, who in 1864 formed 64·55 per cent. of the whole, made up last year the larger proportion of 68·48 per cent. The extent to which travelling upon railways may be encouraged by low fares is illustrated by the travelling from station to station. The fares between intermediate stations were reduced this year from 4*d*., 3*d*., and 2*d*. for single journeys, to 3*d*., 2*d*., and 1*d*.; for the return journey from 6*d*., 4*d*., and 3*d*., to 4*d*., 3*d*., and 2*d*. The consequence is that in the month of June last as many as 39·403 persons booked by the third-class or 1*d*. fares, to ride from one station to another on the line; 4,045 travelled second-class, and 2,398 first-class between intermediate stations. The increase during the month consequent on the reduction of the intermediate fares was a total of 29,842, or representing an annual increase of nearly 1,000 travellers per day. With respect to the carrying capacity of the Metropolitan Railway, it appears that the ordinary trains running for a week could carry 744,600 persons, but—and this is a fact deserving the attention of railway reformers who base their calculations upon an average of full trains—the number actually conveyed was not equal to one-half the carrying capacity of the line, amounting to only 330,904. The whole of this amount of traffic has been conducted underground, without the loss of a single life or the occurrence of a single casualty to passengers. In return for the work done the shareholders have just received a dividend of 3½ per cent., being at the rate of about ½ per cent. for each million passengers carried.—*Railway News.*

COMMUNICATION IN RAILWAY TRAINS.—The managers and superintendents of the leading railways met on Thursday at the London and North-Western Station, Euston Square, to witness the results of some experiments of the practibility of an invention of Mr. Albert Westhead, for obtaining the above-mentioned object. The plan consisted of conducting a small current of steam from the engine throughout the length of the train, under the carriage by means of tubing. When the free egress of the steam is checked the current is reversed, and passes through a whistle mounted on the tube at the engine, which necessarily arrests the attention of the driver. Each carriage carries its own section of tubing, which is fitted with a valve that can be closed by means of a cord placed conveniently in each compartment, but which can only be replaced by the guard or other party in charge of the train, thus denoting the person or persons who may call the signal into action. This is necessary, in order to prevent any passengers from wantonly using the means of communication, it being contemplated to make such persons liable to a penalty for doing so. The guards have each the means of using the signal. The apparatus in this instance was merely fitted temporarily, to prove the practicability of the principle, and the result appeared to be highly satisfactory. The whistle was called into action in the space of a few seconds after closing the valve at the extreme end of the train. The couplings between the carriages can be easily effected. At the same time, should a carriage become detached, a valve is closed and the whistle on the engine sounded. The attention of the public has been so unmistakeably directed to this subject, that two or three hundred patents for various inventions for communication have been taken out.

RAILWAY ACCIDENTS.

ACCIDENT ON THE GREAT NORTHERN RAILWAY.—On the 21st ult. an accident took place on the Great Northern Railway, about a mile on the London side of the passenger station at Peterborough. It appears that a heavily-laden train of fish and goods was going into Peterborough, and at a spot where a bridge crosses the London-road there is an incline over the Nene viaduct. The engine of this train either failed altogether, or was able to travel up this incline at a very slow pace, for before the last van of the train had cleared the bridge in question it was dashed into by a special train, conveying horses and a few passengers, some of whom were severely injured.

ACCIDENT ON THE GREAT EASTERN RAILWAY.—A serious accident took place on the Bury St. Edmund's and Sudbury section of the Great Eastern Railway on the 19th ult. The train ex Sudbury, due at Bury St. Edmund's at 7 p.m., ran off the rails about two miles from that town, and drew the train (which consisted of only two carriages and a break van) down an embankment. One of the carriages and the break van were overturned, but the passengers, of whom there were several, escaped without injury beyond a few bruises. The engine embedded itself in the ground near the line, and was thereby brought to a standstill. The cause of the accident is unknown, but it is supposed to have arisen from the line not having yet become perfectly consolidated. The section was only opened for traffic on the 9th inst.

RAILWAY ACCIDENT AT MANCHESTER.—On the 14th ult., as the London and North-Western train from Wigan, *viâ* Tyldesley, entered the Victoria-station, Manchester, it had what the railway people call "a pitch-in." The time was about 20 minutes past 10 o'clock a.m. The train having received the usual impetus had been disengaged from the engine, and should have gone into an empty siding, but from some cause it missed the proper rails, and ran into the front of a train about to depart for Patricroft. The crash occurred at that end of the station on the iron bridges over the road and the river. The people, both in the trains and on the station, were much alarmed, and some of them seriously injured.

RAILWAY COLLISION ON THE LANCASHIRE AND YORKSHIRE LINE.—A railway collision took place on the 19th ult. near the Euxton Junction, a few miles from Preston. At an early hour in the morning three trains, one of which belonged to the Lancashire and Yorkshire Railway, and the others to the London and North-Western, left the Preston station for the south. They were all laden with goods and merchandise of various kinds. The Lancashire and Yorkshire train started first, and it proceeded all right until it had got to the incline near Euxton Junction. Here the engine, probably through the heavy strain upon it from behind, broke down, and the entire train was, of course, brought to a standstill. The morning was very foggy, and as neither signals could be seen at any distance, nor anyone obtained to run back sufficiently far on the line to give warning of what had happened, one of the London and North-Western trains came up at a rapid rate, and dashed with tremendous force into the rear waggons of the standing train. The engine which had run into the train was badly damaged; the buffer planks, &c., were smashed, and a considerable portion of the front part was staved in. Several of the waggons were almost broken to pieces, and their contents were strewed upon the line in all directions. Fortunately no one received any serious injury.

ACCIDENT TO A NORTH-EASTERN EXPRESS TRAIN.—An accident to an express train occurred at Malton station on the 5th ult. It appears that a train ran off the line on the Malton and Driffield Railway, near the tunnel, and an engine and two vans, with a repairing staff had been up that line, and after effecting the repairs had returned to Malton. It seems that the driver of the repairing engine was backing from the up line to the down line, in order to run on the wrong line a short distance, and get before another train, and so get early into York. This was done in the very teeth of the express to Scarborough, then due, and which, before the engine had left the crossing, dashed into it; the engine of the express striking the other obliquely, and in consequence leaping across the rails of an adjoining siding. The express engine was considerably damaged, but the other was soon replaced on the line. The whole of the carriages, strange to say, remained on the line, the passengers being jerked from one seat to another in an extraordinary manner. There were over 30 passengers, with four first and second class carriages, none of whom were seriously hurt.

RAILWAY ACCIDENT ON THE GREAT NORTHERN.—On the 15th ult., at 4.20 a.m., an excursion train left Burton for London. It contained upwards of one hundred persons on leaving Burton, and on calling at several stations on the route it was joined by other passengers, who arrived safely at King's-cross at about 9.35 a.m. The return train left King's-cross punctually at 8.20 p.m. After a pleasant journey of two hours, at Wellingborough, in Northamptonshire, the train dashed into a guard's break and a truck laden with shoes from Market Harborough, which stood on the main line. The break and truck were completely destroyed. The passengers, some of whom were asleep, were suddenly jerked from their seats, and in the train rebounding were knocked backwards and forwards from one side of the carriages to the other, inflicting serious injury on many.

DOCKS, HARBOURS, BRIDGES.

SUSPENSION BRIDGE ACROSS THE OHIO RIVER.—The piers of this bridge are nearly completed, and the wires will be suspended in a short time. The span, 1,057ft., of the bridge, is called the longest in the United States.

PORTPATRICK HARBOUR.—The works at Portpatrick Harbour to adapt it to the purposes of a mail packet station are at length nearly completed. The work now in progress is the deepening of the channel from the outer to the inner harbour. There are two, or rather three, docks,—the entrance dock, or outer harbour, which is open to the sea, and two inner basins, one of which is intended for the mail packets, and the other for local traffic. A very heavy sea rolls into the outer harbour at times. The engineers who have planned and executed the recent improvements have had this fact in view; but in the opinion of many nautical men, they have not provided for it to the extent they should have done. What they have done is to construct an inner harbour some 200ft. square only, into which the steamers must pass from the outer harbour, and where they can lie secure from the weather.

IMMENSE TURNING BRIDGE.—The width of the waterway between the piers of the iron turning bridge over the Penfield, at the entrance of the Port of Brest, is 347ft. 10in., and the height of the girders from high water, at spring tides, 63ft. 9¾in. This bridge turns in two halves, each of which has a total length of 282ft. 4in. The depth of that part of each girder which is over the hollow tower of masonry on which it turns, is 20ft.; but the depth of each, where they meet in the centre, only 5ft. The under-side, which is that inclined to the horizon, is a straight line, and thus imparts a form neither consistent with a graceful appearance, nor, as it would seem, with the requirements of strength, &c. The counterpoises rest on abutments.

THE LONDON BRIDGES.—On Friday, May 19th, 99,236 foot passengers crossed London Bridge in the twenty-four hours, and 65,756 persons in vehicles or on horseback. It was a fine day. On Tuesday, 23rd May (morning fine, but raining heavily between four and five p.m.), there were 91,080 foot passengers, and 72,559 in vehicles. Half the vehicles belonged to Borough traffic, rather more than a quarter to railway traffic, nearly a quarter to Tooley-street traffic. In the half-year after the opening of Southwark Bridge toll free, to 7th of May, 1865, 2,359,312 foot passengers crossed the bridge. In the half-year from 8th November, 1863, to May 7th, 1864, when there was a penny toll, the number of foot passengers was 257,616. On Friday, 9th June, 48,572 foot passengers crossed Blackfriars Bridge in the twenty-four hours, and 30,141 persons in vehicles; between eight and nine in the evening the number of foot passengers reached 5,098. In the year ending 23rd february, 5,111,368 foot passengers paid a halfpenny toll and crossed Waterloo Bridge. In the eight months from 1st September to 30th April, 1,294,246 passengers paid a halfpenny toll and crossed Hungerford Bridge; the average was 5,348 a day. On the 11th June, 47,062 foot passengers crossed Westminster Bridge in the twenty-four hours, two-thirds using the north footway; 13,119 vehicles also crossed. The traffic over Lambeth Bridge, a toll-bridge, is at the rate of about 1,300,000 persons annually.

MINES, METALLURGY, &c.

GASES IN MINES.—Much, says the *London Review*, has been effected by the researches of Graham and others, there is still a great deal to be known concerning the laws regulating the passage of gases through porous substances and membranes. Mr. G. F. Andsell, of the Royal Mint, who has been experimenting upon the gases of mines, with a view to discover a satisfactory method of detecting those explosive compounds, has just observed a phenomenon which must be of interest to all physicists. He has discovered that some gases will travel with rapidity through buiscuit-ware and not through india-rubber, and conversely that others will pass readily through india-rubber, but not through buiscuit-ware. Mr. Andsell has found that if a glass cylinder be intercepted at its middle by a plate of biscuit-ware securely cemented in, and that then one end of the cylinder be covered with a thin sheet of india-rubber, and diffusion allowed to proceed through the latter, the gas (especially coal gas) which has passed through the india-rubber, remains between that substance and the buiscuit-ware, exerting considerable force, although the other end of the cylinder be perfectly open to the atmosphere. The explanation of this phenomenon, Mr. Andsell believes, is to be sought in the existence of two forms of the same gas which possess entirely opposite permeating powers.

The Gold Mines of North Carolina.—A correspondent of the *New York World*, writing from Charlotte, N.C., says:—"In these times of mining excitement it should be more widely known that North Carolina is a competitor with California, Idaho, and Nebraska. Gold is found in paying quantities in the State and in the northern parts of Carolina and Georgia. For 100 miles west and south-west of Charlotte all the streams contain more or less gold dust. Nuggets of a few ounces have been frequently found, and there is one well-authenticated case of a solid nugget weighing 28 lbs., which was purchased from its ignorant owner for 3 dols., and afterwards sold at the Mint. Report says that a still larger lump was found and cut up by the guard at one of the mines. Both at Greensboro', Salisbury, and here, the most reliable residents concur in pointing to certain farms where the owners procure large sums of gold. One German is said to have taken more than a million dollars from his farm, and refuses to sell his land for any price. Negroes are and have been accustomed to go out to the creeks and wash on Saturdays, frequently bringing in 2 dols. or 3 dols. worth, and not unfrequently negroes come to town with little nuggets of the pure ore to trade. Capitalists seeking mining investments would do well to prospect in this vicinity.

The Caulnon Low Limestone Quarries.—An extraordinary blast of limestone at the North Staffordshire Railway Company's great quarries at Cauldron Low, a few miles from Leek, is thus described in the *Staffordshire Advertiser*:—The blast took place in the centre of the quarries. At a few feet above the floor a lateral gallery, 4ft. by 2ft. 6in., and 41ft. long, was driven; this was continued vertically to the depth of 17ft., and again laterally to the length of 7ft. 6in. At the end of this last last-named branch a chamber was formed, in which the "shot," consisting of 30 cwt. of powder, was deposited. The construction of these galleries occupied two months. A Pickford fuse, burning 3ft. per minute, was used to fire the charge, and this was ignited immediately on the arrival of our party. In about a quarter of an hour the explosion took place with magnificent effect, and it was found that the charge had dislodged about 14,000 tons.

Mineral Statistics of the United Kingdom for 1864.—The returns obtained from our mines and collieries by Mr. Robert Hunt, keeper of mining records in the Museum of Practical Geology, and published annually by her Majesty's Stationery Office, have just been completed. The following are among the principal statistics of the returns:—Coal: There were at work during 1864 3,268 collieries in Great Britain and Ireland. In 1853 there appear to have been only 2,397. The quantity of coal raised, sold, and used during last year from all these works was 92,787,873 tons. The largest quantities were produced from the following coalfields:—Durham and Northumberland, 23,248,367 tons; Scotland, 13,400,000 tons; Lancashire, 11,530,000 tons; Staffordshire and Worcestershire, 11,459,850 tons; South Wales and Monmouthshire, 10,976,500 tons; Yorkshire, 8,809,600 tons. There was an increase in our exportations of coal to foreign ports in 1864 of 525,208 tons, the quantity exported in 1863 being 8,275,212 tons against 8,800,420 tons in 1864. Iron: The extension of our iron manufacture, and the increasing development of iron ore-producing districts is strikingly shown. Last year we obtained 10,064,890 tons of iron ore from our own rocks. Even this large quantity was insufficient for our wants, and we imported 75,194 tons more. This was employed to feed 612 blast furnaces, which produced of pig iron:—in England, 2,620,472 tons; in Wales, 988,729 tons; in Scotland, 1,158,750 tons; the total make of the kingdom being 4,767,951 tons. Of pig iron we exported 465,951 tons; all the rest was converted into merchant iron. This was effected at 127 ironworks, where 6,262 puddling furnaces were in activity, and 718 rolling mills performing their herculean labours of producing bars and rails. Gold: During 1864 this precious metal was obtained from five mines in Merionethshire; 2,336 tons of auriferous qurrtz were crushed and treated by the amalgamating processes. From this was obtained 2,887 ounces of gold, the value of which was £9,991. By an improvement in the process of amalgamation, the discovery of Mr. William Crookes, F.R.S., it is expected that the productiou of British gold will be considerably increased during the current year. Tin: The tin obtained from the mines of Cornwall and Devonshire in 1864 was certainly in excess of that ever before procured, although the tin mines and stream works of this, our only stanniferous district, have been diligently worked for more than 2,000 years. 15,211 tons of tin ore were raised, which produced of metallic tin 10,108 tons. The price of tin during 1864 was lower than it has been during any year since 1853, and more than £14 a ton below the price of 1859. The value of the ore sold, £925,969, which was more than £38,000 less than the money value of the block tin sold in 1863. Copper: From 192 mines in south-western England, and about 30 distributed over other parts of the United Kingdom, 214,604 tons of copper ore, producing 13,302 tons 13 cwt. of metallic copper, were obtained. In addition to this 67,283 tons of ore were imported, 26,018 of copper regulus, 10,015 tons of bricks and pigs, and 14,924 tons of copper bars, &c., from our own colonies and other countries. Lead and silver: There was an increase in our production of lead in 1864; 94,433 tons of lead ore, principally galena, were dressed, sold, and smelted. This produced 91,283 tons of lead, and gave us 641,088 oz. of silver. Of zinc ores, nearly all being the sulphide of zinc (commonly called black jack), 15,047 tons were mined, producing 4,040 tons of metal. Of iron pyrites—ores used for the sulphur they contain in our sulphuric acid and soda works,—we procured 94,458 tons. In addition we find returns of a small quantity each, manganese and wolfram, together with arsenic, ochres, barytes, porcelain and pottery clays, and salt. The total value, at the place of production, of the minerals obtained in 1864 (exclusive of building stones, bricks, and the like), was £31,604,047. The value of the metal smelted from the metalliferous ores was £15,281,869; so that if we add to this the value of our coals at the pit's mouth, £23,197,968, and £1,500,000, the estimated value of the other earthy minerals, of which returns are given in the "Mineral Statistics," we have as the aggregate value of mineral treasures £39,979,837.

Gold.—The following interesting intelligence we extract from the *North British Review*:—In the wildest regions frequented by the nomad hordes of Central Asia, the traveller discovers the vestiges of former cultivation and wealth. But he can now perceive in such regions, that while he stands on the grave of an old civilisation, he stands also on the borders of a new one. It seems certain, at least, as regards Asia, which contains the bulk of the human race, that not only the stationary but the retrograde communities will become progressive—will be reached by roads, railways, river navigation, and Western commerce, and obtain the aid of Western capital and skill. And it seems equally certain that the pecuniary value of their produce will immensely increase; that they will need vast quantities of coin for its circulation; and that the question is one of importance, whether coin enough for the purpose will be easily obtained. The steady decline in the produce of the gold fields of Victoria, from 2,761,528ozs. in 1857, to 1,557,397ozs. in 1864, might seem at first to justify a doubt on the subject; and the existence of a great gold region near the sources of the Nile, on which some writers have reckoned, is in Sir Roderick Murchison's opinion, contravened by the evidence of Capt. Speke respecting the geological structure of the country. But the decline in the production of gold in Victoria has arisen rather from the migration of miners to New South Wales and New Zealand than from a diminishing fertility of the mines. In fact, the gold fields of Victoria yielded more in proportion to the number of labourers in 1864 than in either of the previous years: 97,942 miners obtaining 1,702,460ozs. in 1862; 92,292 obtaining 1,578,079ozs. in 1863; and 83,394 obtaining 1,557,397ozs. in 1864. And in 1857, when the gold yield of Victoria reached its maximum, that of New South Wales only amounted to the value of £674,470; whereas it has been more than three times as much on the average for the last three years. From the Western States of North America, again, the supply of the precious metals seem likely to increase. In a recent report the British Consul at San Francisco states it as his belief that even in California the production of the precious metals will increase for many years to come; and that when to this is added the produce of the rich mines of Nevada, Idaho, Arizona, and Oregon, there can be no doubt that the total increase will be very great. This anticipation seems confirmed by the fact that the exports of treasure from San Francisco in the fiscal year ending June, 1864, amounted to 51,264,023 dollars; the larger proportion being in the latter half of the period, and the entire sum being considerably greater than in any year since 1856. From Mexico and South America great additional supplies may also be expected. Of Peru, the British Consul says:—"Peru is one vast mine, which the hand of man has only hitherto scratched." To the produce of the mines must further be added the vast sums that the progress of commerce will restore to circulation from the hoards of Asia and Europe, which even in Lapland, are great. Large sums of Norwegian money are said by Mr. Laing, in his "Journal of a Residence in Norway," to have disappeared in Lapland; the weathiest Laplanders having always been accustomed to live, like the poorest, on the produce of their reindeer, and to bury the money coming to them from Norway in places where their heirs often fail to discover it. The movement we have discussed is one which tends to bring all buried and neglected riches to light; and we anticipate from it both an ample provision of money, and an increasing demand for it.

Production of Steel by Means of Gases.—M. Aristide Bérard brought before the Academy of Sciences, at its sitting of June 26, his method of forming steel by means of gases. It consists in alternately oxidising and reducing cast-iron in a furnace suited to the purpose. The oxidation is produced on one portion of the cast-iron, by the introduction of atmospheric air, and the reduction on another by a mixture of hydrogen and bonic oxide, previously freed from sulphur. After twelve or fifteen minutes the processes are reversed, the portion subjected to oxidation being submitted to reduction, and *vice versâ*. Any oxygen evolved is absorbed by burning coke placed in a suitable position. When this alternate action is found by trial to have been continued long enough, the operation is stopped, decarbonation being the terminating process. During oxidation the bases of the metals proper and of the earths are oxidated; the sulphur, phosphorus, &c., form acids, and escape. During reduction, the iron is brought to the metallic state, and the earths separate as scoria, any remaining sulphur, phosphorus, &c., being eliminated as acids, and some carbon is restored to the iron. A high temperature is produced during oxidation, a low during reduction. Ten or twelve tons are manipulated at each operation in the establishment which has been formed by the inventor; and the steel produced is said to have all the properties of the ordinary kind.

Smelting Copper Ores.—The invention of Messrs. Peter Spence and H. Davis consists in using, as a flux, the spent shale of the alum manufacture, being the residuum of the shale of the coal measures after it has been acted upon by sulphuric acid for the production of alum. The quantity of such spent shale necessrry for each charge of ore will vary with the character of the ore, and, in practice, is easily ascertained by the workman, who will discover that, when a sufficient quantity has been added, the flux or slag will part easily from the regulus or metal, and enable him to skim off and draw out the slag, without the regulus or metal clinging to it. In practice it is found that, by using spent shale for a flux, a slag more than ordinarily free from copper, or, as it is termed, a clean slag, is obtained, which is a matter of great importance in copper smelting, as when the slag is not clean there is a great loss of copper in consequence. The patentees claim the use of spent shale as a flux in copper smelting.

Manufacturing Blocks of Malleable Iron.—The invention of Mr. W. P. Struve consists in manufacturing slabs or blocks from a bloom obtained by first refining iron in a refinery, and then running it into a hearth, and there exposing it to blast. He constructs the finery and hearth of a greater size than heretofore, in order to obtain a bloom of sufficient size to produce a rail plate or other article. He refines the iron in the finery to the extent he thinks necessary, and then runs it into the hearth, and there applies blast, and by constant breaking up of the iron exposes all parts to the blast to bring it to nature in the form of a large lump. In place of breaking up and piling this lump, as has heretofore been done, he places it under a hammer, and by successive re-heatings and re-hammerings operates upon it to advance its quality as wrought-iron, at the same time preserving its homogenity, and by this means produces a bloom of homogeneous unlaminated wrought-iron, suitable for rolling into a railway rail, plate, or other article.

Coal in Brazil and the Falkland Islands.—Professor Agassiz, with his staff, has been engaged in a careful survey of the district watered by the Amazon, and his opinion has also been obtained concerning the coal fields of Candiota. For some time past attention has been directed to the famous coal beds of Candiota, in the province of Rio Grande do Sul. The expectations of many are turned in that direction, as the most valued instance of the hidden wealth of Brazil. Mr. Plant has so far awakened or revived an interest in these things, that from time to time the topic has been made a public one, has been looked at as a field for commercial activity, and has been debated each time with growing interest in the Legislature. Mr. Plant, as a geologist, submitted to the examination of the professor such fossils and geological illustrations of the province of Rio Grande do Sul as he supposed would be of interest, and would help to complete the collections which are being made for the United States Government. The importance of these fossils, and the sure deductions which science draws from them, appear to have startled and delighted him, and in acknowledging the presentation of the specimen he remarks, after alluding to his slight delay in returning his thanks—"However, this gives me an opportunity of expressing a more mature opinion concerning their geological age, which I am glad to have have an opportunity of recording, especially since the examination I have made of them has satisfied me of the correctness of some views concerning the fossils of the oldest geological formation, in which I had little confidence. That these organic remains all belong to the carboniferous period is unquestionable, and it is the close affinity with the characteristic fossils of Europe which particularly interests, and, in a measure, surprises me. Had the whole collection been made in Pennsylvania, I would not more decidedly have recognised its carboniferous characteristics, down to the rocks underlying and overlying the fossiliferous beds; and the photographs you have shown me of the localities leave no doubt of the great extent and value of the coal-beds proper of the River Candiota, whilst the coal itself may fairly be compared to the best in the masket, judging from the specimens you have shown me, and those I owe to your kindness. As to the coal of the Falkland Islands, I can only compare it to the anthracite of Mansfield, in Massachusetts, and the adjoining deposits in Rhode Island; though it does not arpear quite so pure as the best anthracite of the United States; but this is an impression derived from surface specimens gathered at random."

GAS SUPPLY.

AT CROWLAND, great complaints are made by the consumers of gas, the price being 7*s.* 6*d.* per 1,000ft., while in other towns of a similar population the price is only 5*s.*, and a discount allowed for prompt payment. The high price deters many from using the gas, and many that did discontinued its use.

BAKEWELL GAS COMPANY.—The report of the directors of this company states that the heavy expenses incurred in 1863, by the erection of new purifying and condensing apparatus, were now entirely paid off. The directors recommended a dividend at the rate of 8 per cent., free of income tax. A reduction has been made in the price of gas, which is now 5*s.* 6*d.*, per 1,000 cubic feet. The report was adopted.

IN CORK, the price of gas has just been reduced 3*d.* per 1,000 cubic feet, by the consumers' company, owing to outward pressure, which makes it now 3*s.* 9*d.* per 1,000. The company was started in 1858; and although they have been supplying gas for 4*s.* per 1,000, and individuals have been made rich out of the management, it has paid the shareholders 8 per cent. per annum ever since, which absorbs £4,650 each year; and yet after all the dividends were paid at the last half yearly meeting, there was still on hand an unappropriated balance of £3,930, an increase of £639 on the reserve.

COLERAINE.—The rapid growth of the town of Coleraine, and the consequent increase in the number of gas consumers, have necessitated a corresponding enlargement in the street gas mains. Pipes of double the capacity of the old ones are being laid, from the the works to the waterside, and from the works to the outer limits of the town, on the south side, to provide light for the workhouse. This is one of the many signs of progress in Coleraine at present.

THE BANBURY GAS COMPANY have declared a dividend of 7½ per cent., free of income tax, for the past year.

THE GAS PRODUCTS UTILISING COMPANY have declared a dividend of 5 per cent. for the last half-year, free of income-tax, making, with the 5 per cent. for the previous half-year, in all 10 per cent. per annum, besides transferring £1,000 to the reserve fund.

THE WISBECH GAS COMPANY have declared a dividend of 9 per cent. for the last year, clear of income-tax, and the Boston Gas Company one of 8½ per cent.

THE NORTHAMPTON GAS-LIGHT COMPANY have reduced the price of their gas to 4*s.* per 1,000 cubic feet.

AT THE ANNUAL MEETING OF THE NEWCASTLE-UNDER-LYNE GAS COMPANY, the chairman said that, although the company had reduced the price of gas 20 per cent., and was now laying-out nearly £3,000 in a new gas-holder and extensions in connection therewith, which would not be immediately remunerative, they hoped at no very distant period to be able still further to reduce the price, and that without doing injustice to the shareholders. A dividend at the rate of 10 per cent. per annum was declared.

THE TAUNTON GAS-LIGHT AND COKE COMPANY have declared a dividend of 8 per cent. for the last year, free from income-tax. The annual report says "The price of gas has been lowered from 5*s.* 6*d.* to 4*s.* 6*d.* per 1,000. Whilst the supply had increased, the amount paid into their exchequer by private consumers had also increased by the sum of £1,325; but instead of the gas being of the illuminating power of ten candles, it was equal to fifteen candles. When they first took to the gas-works the leakage was nearly 25 per cent., but in consequence of the alterations and improvements made it was under 6 per cent.

APPLIED CHEMISTRY.

GALE'S NON-EXPLOSIVE GUNPOWDER.—Mr. Gale is repeating his experiments in various places with success, and the subject is attracting much attention. The secret is now made known by the publication of the patent, and we learn that the combustibility is produced by mixing one part of gunpowder with three or four parts of finely powdered glass. By the addition of this powder every grain of gunpowder is isolated, and thus only those grains are ignited which come in contact with the source of heat. Mr. Gale is not the first who has experimented in this direction. A French and a Russian chemist have both made experiments on the subject. M. Piobert, in 1835, tried a variety of substances, and among them sand. He tried, also, the separate constituents of gunpowder, and of the three gave preference to nitre, which he found to deprive gunpowder of its dangerously explosive character. M. Fadéieff, the Russian, preferred a mixture of wood charcoal and graphite, which he found to be unaffected by moisture. Mr. Hearder has lately found almost any dry compact powder will answer the purpose, and states that pipe-clay, gypsum, or chalk do very well. Our readers know that Mr. Gale only proposes that stored gunpowder, and powder for transport, should be treated with his process. When this powder is required for use the fine glass is separated by means of a sieve, and the question which is engaging attention is whether or not the powder is damaged by being submitted to this treatment. One writer suggests that glass powder is liable to become alkine, and therefore hygroscopic. Mr. Hearder objects that it may not be possible to separate the glass completely, and therefore the explosive force of the powder must be more or less diminished. The *Reader* mentions some experiments which "seem to show that the addition of the protective powder to ordinary powder has the effect of rendering the explosion more gradual"—an effect which would be valuable if the protective powder were combustible. We have not as yet seen any notice of the effect of the glass on the glazing of the powder, any interference with which would seriously affect the quality of the powder, particularly of the finer kinds.

EXPERIMENTS ON THE PRECIPITATION OF PHOSPHORIC ACID AS PHOSPHOMOLYBDATE OF AMMONIA, BY DR. R. FRESENIUS.—The author has studied the influence of various reagents on the estimation of phosphoric acid by precipitation as phosphomolybdate of of ammonia, and has come to the following conclusions:—His experiments were made with the same solution of phosphate of soda, 10 c.c. of which precipitated and weighed as pyrophosphate of magnesia gave as a mean 0·0209 of phosphoric acid. The determinations with the molybdenic solution were controlled by a re-determination of the phosphoric acid in the precipitate as pyrophosphate of magnesia. Ten c.c. of the phosphate of soda solution precipitated by the molybdenic solution gave 0·0208 phosphoric acid or 99 per cent. of the amount really present. Nitric acid, even when in very large excess, the author found not to interfere with the result. Hydrochloric acid, when in large excess, partially or even completely hinders the precipitation. When the amount of the acid is as low as 3·3 per cent. of the liquid, the result comes near the truth, but is always too low. The simultaneous presence of much nitric and hydrochloric acid completely prevents the precipitation. Thus the 10 c.c. of phosphate of soda solution, as above, gave, in the presence of sulphuric acid, 0·0205 of phosphoric acid, and in a second experiments 0·0205. With perchloride of iron the same amount of phosphate of soda solution gave 0·0207 phosphoric acid. The pyrophosphate of magnesia solution obtained from this precipitate showed a trace of iron with sulpho-cyanide of potassium. In the presence of a considerable proportion of sal-ammoniac the amount of precipitate was always a little too low; as was the case when the solution was made diluted. The author made another series of experiments. A solution in which the amounts of iron and aluminium greatly exceeded the proportion of phosphoric acid, as when the acid is estimated in a hydrochloric extract of a soil. He prepared a solution that contained in a litre 20 grammes of iron, as chloride, 2 grammes of aluminium, as chloride, and 0·01 gramme of phosphoric acid. By the direct precipitation of 100 c.c. of this solution with the molybdenic solution 0·0091 of phosphoric acid was obtained. 100 c.c. of the same solution evaporated to dryness on a water bath, and the residue dissolved in the smallest amount of nitric acid, also gave 0·00991 of phosphoric acid. 100 c.c. evaporated, and the residue dissolved in the least possible amount of hydrochloric acid, gave only 0·00972 phosphoric acid. The above results will serve to guide analysts in the use of the process mentioned for determining phosphoric acid. We ought perhaps to state that the author prepares his molybdic solution by dissolving one part of molybdic acid in four parts of ammonia, sp. gr. 0·96, and adding to the solution fifteen parts of pure nitric acid, sp. gr. 1·2. In making the determinations, the phosphoric and molybdic solutions are mixed hot, and are kept at 65° C. for six hours. The precipitate is then collected on a filter and washed with equal parts of the molybdic solution and water.

ON A VOLUMETRIC METHOD OF VALUING SOAPS, BY M. PONS.—The author remarks that the following method, which, as we have said, is Clark's test reversed, gives with sufficient exactness for commercial purposes the real value of a soap as compared with a given standard. The standard soap he chooses is mottled Marseilles, known here as Castile soap. This soap contains only 30 per cent. of water, and is free from all mineral adulterations. It has the following composition:—

Soda	6
Fatty acids	64
Water	30
	100

A gramme of such a soap, according to calculation, will be exactly neutralised by 0·1074 gram. of chloride of calcium. Therefore, a solution composed of 1·074 of chloride of calcium, and 1000 cubic centimetres of distilled water, will be neutralised by an equal volume of a second solution made of 10 grammes of the standard soap, 100 cubic centimetres of alcohol, and sufficient distilled water to make up 1000 cubic centimetres. The addition of the smallest excess of soap solution will of course give the persistent froth, as in Clark's test. M. Pons applies his process as follows:—10 cubic centimetres of the standard solution of chloride of calcium, and about 20 cubic centimetres of distilled water, are placed in a stoppered bottle, capable of holding 60 or 80 cubic centimetres. Ten grammes of the soap to be analysed are dissolved in 100 cubic centimetres of alcohol. Earthy and insoluble matters will be separated in this part of the operation, and after washing with alcohol can be weighed and analysed if required. The soap solution is now diluted with sufficient distilled water to make 1000 cubic centimetres, and the mixture is added to the lime solution from a burette graduated in cubic centimetres, and tenths of a cubic centimetre. When the persistent froth is arrived at, the amount of soap solution used is read off, and the richness of the soap experimented upon, as compared with that of the standard soap, is found by dividing 10 cubic centimetres by the number of the cubic centimetres employed. If the number used is 10 cubic centimetres, the sample is as rich as the standard; if 20 cubic centimetres are employed, the richness is only 10-20ths, or 50 per cent. of the standard, and so on.

REACTIONS OF GELATINE, BY M. CAREY LEA, PHILADELPHIA.—I have been occupied at times for some years past with the the study of this very interesting substance, and propose here to describe a new reaction which I have observed, and which constitutes, I believe, the first coloured reaction described as produced between pure gelatine and a perfectly colourless reagent. It is true that the precipitate produced in gelatine solutions by gallotannic acid is much deeper in colour than the precipitant. But the straw yellow colour of gallotannic acid naturally leads to the expectation of coloured combinations, whereas in the case I am about to mention, the precipitant is colourless, and the production of a marked colour seems to point to a more complete action than that of simple combination. When a piece of gelatine is dropped into an acid solution of pernitrate of mercury, it gradually assumes a strong red colouration, and after a time dissolves in it completely, at ordinary temperatures, to a fine red solution. This solution deepens a little if boiled for some minutes. By chlorate of potash the hot solution is quickly decolourised, and passes to a pale dirty yellow. This red colouration seems to require a certain amount of time for its production, which cannot be replaced by heat. If a piece of gelatine be immersed in the solution of protonitrate and boiled for some minutes it is dissolved, but the solution thus obtained is not red, but yellowish. It is to be regretted that the reaction here described is not more delicate. It is only striking when tolerably strong solutions of gelatine are employed. When the solution is very weak, as, for example, if the gelatine constitutes only one half of one per cent. of the mixed liquids, the limit of the delicacy of the test is reached. Such a solution by standing twenty-four hours exhibits a light but distinct pink colour. Although this delicacy is not what may be desired, still colloid organic substances are so comparatively difficult of qualitative detection as a general thing, that the method is not without value. The experiment was next extended to meta-gelatine. A neutral meta-gelatine was prepared in the following manner:—Gelatine was set to swell in cold saturated solution of oxalic acid, and then a moderate heat was applied for a sufficiently long time for the mass to remain quite fluid when cold. It was then agitated with precipitate carbonate of lime until the whole of the oxalic acid was got rid of. Meta-gelatine prepared in this way was kept for months in a corked phial, in a warm room, without showing any disposition to putrefy. It was almost as fluid as water, perfectly neutral, and almost insipid to the taste. With this meta-gelatine, the red colouration was produced even more decidedly with ordinary gelatine. The addition of the acid solution of pernitrate of mercury produced at first a whitish flocculent precipitate, which, by standing, acquired a strong red colour, as did the supernatant liquid.

ZIRCONIUM.—Since the discovery of aluminium, which was brought about by the aid of the powerful reducer, sodium, chemists have been untiring in their endeavours to obtain the other metals suspected to exist in the bases, which had until then resisted every effort to decompose them. It was thus magnesium was found soon after aluminium; and now M. Troost, in a paper addressed to the Academy of Sciences, has described his researches on zirconium, or the base of zirconia, which is extracted from the precious stone called hyacinth zircon, or "jargon," remarkable for its delicate tints, varying between white and red. M. Troost wished to determine whether zirconium, already found in an amorphous state by Berzelius, was a metal similar to magnesium or aluminium, or a metalloid not unlike carbon, boron, or silicium. His first experiments were directed towards obtaining zirconium in a crystallised state, and in this he succeeded by heating one part of double fluoride of zirconium and potassium with one part and a half of aluminium in a crucible made of the charcoal which accumulates in the gas retorts, and at a temperature equal to that required for melting iron. When the crucible has cooled, the surface of the button of aluminium which has been formed is covered with thin crystallised laminæ, pressed together like the leaves of a book. The aluminium may be removed by dissolving it in hydrochloric acid diluted with twice its volume of water; by this means the laminæ of zirconium may be removed, but there still remains some, consisting of an alloy of aluminium and zirconium. The pure metal, in the crystallised state, as described, is a very hard substance, of great brilliancy, and resembling antimony in colour, lustre, and brittleness. The laminæ are easy to cleave in two directions inclined to each other at about 93°, their planes being inclined to the third or ground plane at an angle of about 103°. The density of crystallised zirconium is 4·15. Chlorine combines with it at a dull red heat; the sulphuric and nitric acids do not attack it at the ordinary temperature. Its real dissolvent is hydrofluoric acid. Amorphous zirconium, as obtained by Berzelius, is a powder scarcely distinguishable from powdered charcoal; it is a bad conductor of electricity.

LIST OF APPLICATIONS FOR LETTERS PATENT.

We have adopted a new arrangement of the Provisional Protections applied for by Inventors at the Great Seal Patent Office. If any difficulty should arise with reference to the names, addresses, or titles given in the list, the requisite information will be furnished, free of expense, from the office, by addressing a letter, prepaid, to the Editor of "The Artizan."

Dated July 25th, 1865.

1923 M. B. Schumann—Receptacle to contain aerated liquids
1924 J. Rigg—Railway carriages
1925 L. Petre & E. S. Tucker—Cruet frames, flower, egg, and other stands
1926 T. J. Mayall—Parts of military and other outfits
1927 M. J. Roberts—Producing friction or adhesion between pulleys
1928 W. Zbyszewski—Applying mineral oils for generating steam
1929 J. Juckes and J. Swinburne—Locomotive steam furnaces
1930 H. Wright—Improved shank for buttons, studs, and solitaires
1931 J. H. Johnson—Lacing boots and other articles united by laces
1932 J. H. Johnson—Washing or cleansing wool and woollen fabrics
1933 A. P. Price—Manufacture of carbonate of ammonia

Dated July 26th, 1865.

1934 M. Kenney—Opening bridges
1935 T. Spencer—Preparation of soils to promote general vegetation
1936 W. Richards and J. Richards—Manufacture of sal-ammoniac
1937 J. Belicard—Pile fabrics
1938 G. T. Bousfield—Liquids for generating steam and other purposes
1939 E. Spicer—Compositions similar to gunpowder for blasting
1940 S. Lusty—Fluid meters
1941 A. V. Newton—Sewing machinery
1942 W. E. Newton—Planing metals
1943 F. Pulman and R. Ginman—Composition for coating ships' bottoms
1944 W. Barton—Construction of cooking stoves and ranges
1945 J. Jacques, S. Weuk, and A. A. Mathieu—Preventing railway accidents
1946 T. Pepper—Manufacture of anti-inflammable starch.

Dated July 27th, 1865.

1947 P. A. F. Bobœuf—Preparation and application of certain colouring matter
1948 R. Mortimer—Marking or impressing railway tickets
1949 W. E. Newton—Bolt screwing machines
1950 T. Brown—Tea-pots, urns, and other vessels for domestic purposes
1951 A. Cheffins—Sewing machines
1952 H. Sherwood—Treating animal and vegetable fibrous materials

Dated July 28th, 1865.

1953 L. P. Laroche—Fire-engines and hydraulic machines
1954 W. King—Retarding the progress of railway trains
1955 I. Gregory—Communicating between passengers and guard
1956 W. E. Newton—Steam valves
1957 W. E. Newton—Applying air-proof solutions to the interior of casks and barrels
1958 W. E. Newton—Water meter
1959 R. B. Mitchell—Brake for railway and other wheeled carriages
1960 W. Cockburn—Weaving ornamental fabrics

Dated July 29th, 1865.

1961 R. Clayton, J. Raper, and J. Goulding—Looms for weaving
1962 F. A. Abel—Compounds for waterproofing and insulating purposes
1963 B. Latham and R. Campbell—Drying grass and other substances
1964 E. Sabel—Iron
1965 A. Larmuth—Apparatus for cutting the edges of paper hangings
1966 R. Worsnop—Cap frames
1967 V. Baker—Utilising water power
1968 F. Knp—Gas burners
1969 J. Swinburne and J. Laming—Retarding railway carriages
1970 W. W. Biggs—Iron

Dated July 31st, 1865.

1971 T. D. Stetson—Hats
1972 B. Robinson and J. Varley—Prevention of smoke and economy of fuel
1973 J. J. Stoll—Self-generating continuous motive power
1974 A. Y. Rehm—Crinolines
1975 J. Ramsbottom—Hoops
1976 E. Sabel—Iron rails and girders
1977 J. Lawson and E. G. Fitton—Preparing machinery for flax
1978 A. Applegath—Printing in colours
1979 A. V. Newton—Obtaining induced currents of electricity from magnets
1980 A. V. Newton—Refining petroleum and other hydro-carbon oils
1981 A. V. Newton—Ejectors for discharging bilge water
1982 W. Clark—Apparatus to be used in swimming

Dated August 1st, 1865.

1983 T. W. Tobin and Colonel Stodare—Apparatus for illusory exhibitions
1984 F. R. Wells—Producing photographic images on metal plates
1985 T. B. Paton—Manufacture of linen or other yarns or threads
1986 W. Is Penotiere—Coating the bottoms of iron and wooden ships
1987 A. Doull—Construction of atmospheric railways and carriages
1988 W. Singleton—Cutting scales, and forming metal webs for knives
1989 A. Noble—Fuses for shells
1990 L. E. C. Martin—Locomotive and other tubular boilers
1991 F. Ransome—Roofing tiles
1992 M. P. W. Boulton—Obtaining motive power by heat

Dated August 2nd, 1865.

1993 A. Ford—Forming india-rubber, gutta percha, or such like balls
1994 H. Levy—Testing alloys of gold
1995 T. Andrew and J. W. Taylor—Fastenings for doors
1996 J. McEwen and W. Neilson—Drawing and forcing water
1997 J. G. Teal—Communication between passengers and guards
1998 J. Crean and C. J. Barr—Giving alarm in cases of fire
1999 F. C. Dear—Communicating between passengers and guards
2000 J. Pickin and R. Bailey—Signalling and giving alarm on railways
2001 H. Frankenburg—Construction of travelling and other bags
2002 W. W. Burdon—Reducing vegetable fibre to pulp
2003 R. Bailey—Locks
2004 C. Hodgson—Treating peat in bogs and obtaining it therefrom
2005 W. H. Petitjean and E. McNally—Railway carriages
2006 H. Allman—Burglar proof safes
2007 J. H. Tyler—Rolling leather

Dated August 3rd, 1865.

2008 J. W. Perkins—Refining of hydro carbon or paraffin oils
2009 E. S. Horridge—Railway signals
2010 F. Cato—Knees for ships' fastenings
2011 W. H. Brookes—Securing the tongues or reeds of fog horns
2012 E. Sabel—Machinery to be used in the manufacture of plate or sheet iron
2013 W. Morgan—Coke ovens
2014 H. D. P. Cunningham—Working guns
2015 E. L. Ransome—Paints
2016 W. H. Preece—Railway electrical signal apparatus
2017 L. Anderson—Horse-shoes and other similar articles

Dated August 4th, 1865.

2018 E. Sabel—Iron
2019 P. Robertson—Brewing and distilling, also in drying yeast
2020 A. Sleigh—Motive power
2021 W. Clark—Apparatus applicable as a motive power engine
2022 J. Gaukroger and J. Dodgeon—Drying fibrous substances
2023 J. A. Leon, G. Tossimond, and J. Kissack—Filtering sugar
2024 E. Wild and W. Wessel—Wick holders
2025 F. G. Mulholland—Submarine cables
2026 T. S. Raney—Securing roof lamp glasses of railway and other carriages
2027 H. A. Bonneville—Axle boxes
2028 H. A. Bonneville—Revolver pistols
2029 H. A. Bonneville—Checking the payment of fares in public vehicles
2030 T. W. Webley—Breech-loading fire-arms
2031 A. V. Newton—Gun wipers
2032 A. V. Newton—Manufacturing cigars
2033 G. B. Woodruff—Binders for sewing machines

Dated August 5th, 1865.

2034 H. C. Baudet—New musical instrument.
2035 S. Buxton—Numerical registering machine
2036 H. Geering—Sacking
2037 T. Smith and J. Brook—Self-acting coupling for carriages
2038 J. H. Johnson—Ornamenting glass
2039 J. Petrie—Washing wool
2040 A. Millochau—Stills for the distillation of oily substances
2041 C. H. Simpson—Sustaining and lowering ships' boats

Dated August 7th, 1865.

2042 A. F. Osler—Lamps for burning paraffin and other volatile oils
2043 A. A. Fouhert—Regulating the flow of steam, water, and other fluids
2044 W. Pollock—Washing yarns
2045 J. Mead—Retarding or stopping railway carriages
2046 W. and G. Crosher—Scarfs
2047 L. J. Crossley—Electric telegraphic apparatus
2048 W. Clark—Loading, unloading, and stowage of ships' cargoes
2049 A. V. Newton—Facilitating the transportation and delivery of letters, newspapers, and other freight
2050 W. C. Dodge—Fire-arms
2051 M. P. W. Boulton—Generating steam

Dated August 8th, 1865.

2052 H. Fletcher and G. Gore—Communication between passengers and guard
2053 J. Buchanan and R. Boyd—Dyeing yarns
2054 W. R. Corson—Construction of shop fronts and other buildings
2055 T. G. Messenger—Cutting of screw threads on pipes
2056 W. Rock—Printing machines
2057 J. Gale—Rendering gunpowder unexplosive
2058 S. Middleton—Brushing hair by machinery
2059 J. H. Radcliffe—Lubricating spindles

Dated August 9th, 1865.

2060 G. Harvey and A. Harvey—Screwing bolts and nuts
2061 T. R. Shaw—Looms for weaving
2062 H. Cartwright—Steam engines
2063 S. Law—Breech-loading fire-arms
2064 C. West—Apparatus for giving immediate warning of undue heat
2065 A. Budenberg—Adjusting levels
2066 W. Aston—Buttons
2067 B. Russ and E. Grundell—Sewing machines
2068 J. W. Sumner and C. A. Scott—Bricks
2069 J. W. Longstaff—Relieving slide valves of back pressure
2070 L. Schad—Production of violet colours from magenta

Dated August 10th, 1865.

2071 M. H. Blanchard—Manufacture of terra cotta or vitreous stone
2072 T. F. Henley—Heating
2073 J. Ingham, H. Ingham, and J. Broadley—Looms for weaving
2074 C. O. Crosby—Needles
2075 C. J. R. Johns—Mounting telescopes and microscopes
2076 A. Mendel—Paper
2077 T. Allcock—Machinery used in the manufacture of stair rods
2078 J. Fareu—Machinery for cleaning China grass and flax
2079 W. E. Newton—Machinery for making eyelets

Dated August 11th, 1865.

2080 W. T. Cole, H. S. Swift, and A. Scares—Propulsion of machinery
2081 P. C. Kjellberg—Fixing safes
2082 R. D. Morgan—Coupling of railway carriages and trucks
2083 R. A. Brooman—Treating and printing threads employed in weaving
2084 R. W. Armstrong—Machinery for moulding hollow articles in earth
2085 J. H. Johnson—Candles
2086 T. E. Stephens—Passing from one compartment to another in a railway train
2087 H. Jee—Salt
2088 H. R. Guy—Submarine telegraph cables

Dated August 12th, 1865.

2089 J. Tatham and J. Smith—Preparing cotton
2090 J. Knowles—Lubricating
2091 W. Bullough—Looms for weaving
2092 W. E. Newton—Burglar-proof safes
2093 W. Betts—Capsules
2094 H. Woodward—Gas burners
2095 H. Woodward—Carburetting coal gas
2096 R. A. W. Westley—Discharging certain fluids for sanitary purposes

Dated August 14th, 1865.

2097 F. Brampton—Files or holders for holding letters
2098 W. Bauger—Ascertaining the quality and condition of grain
2099 W. F. Henson—Railway chairs
2100 J. T. Leckey—Improvements in and connected with the manufacture of copper
2101 J. G. and S. Dale—Preventing the forgery of bankers' cheques
2102 J. Gamgee—Cowhouses
2103 R. C. Lilly—Fastenings for sleeve links

Dated August 15th, 1865.

2104 J. W. McDermott—Bolt heading machines
2105 J. F. Boetius—Furnaces
2106 J. H. Johnson—Production of spongy metals
2107 A. Mills—Pumps
2108 J. Brown—Fire-arms
2109 W. O. Wilson—Extinguishing fires and sounding fire alarms
2110 M. Henry—Photography
2111 J. Billings—Ventilators

Dated August 16th, 1865.

2112 W. Clark—Taking measurements
2113 J. Smith and W. Schofield—Dyeing yarns
2114 J. Ingham—Treating China grass
2115 W. Gadd and J. Moore—Looms for weaving
2116 J. H. Johnson—Paper bags
2117 F. M. Chalmers—Textile fabrics
2118 W. West—Lubricating compounds
2119 J. B. Brown—Mowing machines
2120 S. Parry—Coating ships' bottoms

Dated August 17th, 1865.

2121 S. Phillips—Safes
2122 A. Akeroyd and J. Lister—Shuttles
2123 O. Laureoce—Medicine for the cure of diseases of the stomach
2124 F. J. Jones—Fastenings
2125 E. Rimmel—Capsules
2126 R. A. Brooman—Washing fabrics
2127 A. V. Newton—Drying timber and other products
2128 N. C. Szerelmey—Paper boards

Dated August 18th, 1866.

2129 G. H. Smith—Drying and preparing hemp and other fabrics
2130 J. Stevenson—Steam engines
2131 R. Clarke—Crinolines
2132 M. Cartwright and A. Dale—Elastic material for boots
2133 P. Lawrence—Boots
2134 J. L. Clark—Recovering submerged telegraph cables
2135 A. and W. Young—Type distributing and composing machines
2136 W. E. Gedge—Reducing the thickness of parts of hides
2137 R. A. Brooman—Steel
2138 G. Howard—Ornamenting walls
2139 J. L. Nash—Apparatus for illustrating astronomical phenomena
2140 A. Watt—Soap
2141 J. Hope—Packing cases
2142 I. Bernhard—Artificial saltpetre

Dated August 19th, 1865.

2143 W. Wood and J. W. Wood—Pomfret cakes
2144 J. S. Watson, A. Horwood, and C. Brumfit—Giving alarm in case of fire
2145 G. Whitford—A toy or game called Flying-fish
2146 C. Edkins, J. Newman, and T. Greaves—Manufacture of buttons
2147 R. A. Brooman—Twisting threads
2148 J. E. Marsh—Punkahs
2149 W. E. Newton—Bricks
2150 J. B. Austin—Stopping bottles
2151 W. Soper—Breech-loading fire-arms

Dated August 21st, 1865.

2152 J. Bowden—Forges
2153 G. G. Dennis—Taper matches
2154 W. Shakspear—Retarding or stopping railway trains
2155 F. Jenkin—Telegraph cables

Dated August 22nd, 1865.

2156 D. G. and S. Staight—Pianoforte keys
2157 J. A. Turner—Covering for rollers
2158 J. Lockwood—Furnaces
2159 F. C. B. Robinson—Couplings for railway carriages
2160 M. J. Lopez-y-Munoz—Cigarettes
2161 C. Marsden—Telegraph cables
2162 D. O. Jones—Cleaning ships' bottoms
2163 J. G. Avery—Composition to be used as a substitute for paint
2164 G. Little—Combing fibrous materials
2165 H. Willis and G. Rice—Sewing machines

Dated August 23rd, 1865.

2166 J. H. Scott—Annealing iron
2167 J. Newton—Stench trap
2168 L. J. Levisohn—Syphons
2169 D. Macpherson—Sewing machines
2170 D. McKellar—Lithographic and copper-plate printing
2171 E. H. C. Monckton—Manufacture of rye straw into fibre
2172 J. G. Tongue—Shearing horses
2173 J. Moody—Floating lights

Dated August 24th, 1865.

2174 D. Davies—Steam hammers
2175 W. C. Cambridge—Steel and other metals suitable for bearings
2176 F. Thomas—Heating kitchen ovens
2177 F. Ayckbourn—Stockings
2178 W. E. Newton—Well sinking tubes
2179 G. Bagnagatti—Gas burners

Dated August 25th, 1865.

2180 J. I. Barber—Self-adapting skate
2181 L. Clayton—Carpets
2182 H. H. Henson—Railway chairs, fastenings, and sleepers
2183 W. Rogers—Permanent way of railways
2184 E. A. Curley—Production of light
2185 G. W. Howard—Tanks
2186 G. Owen—Presses for copying letters and other written documents
2187 C. A. Watkins—Supplying carbonic acid gas to vessels from which wine and other fermented liquors are drawn
2188 E. H. Woodward—Cutting marble
2189 W. E. Newton—Generators
2190 A. V. Newton—Skates
2191 J. Mosle—Treatment of tar

Dated August 26th, 1865.

2192 F. Hazeldine—Construction of vehicles for transporting furniture
2193 J. F. Hearsey—Spirit meter
2194 J. A. Wanklyn—Violet dye stuffs
2195 J. Fordred—Treating certain products obtained in refining petroleum
2196 F. A. E. G. de Massas—Machinery for treating cotton seeds
2197 J. Symmons—Horse shoes
2198 E. D. Hodgson—Locks
2199 R. G. Rattray—Supplying regulated or measured quantities of water
2200 G. T. Bousfield—Folding chairs

Dated August 28th, 1865.

2201 A. Paraf—Dyeing fabrics
2202 W. Graham, J. Broughton, and T. Corkhill—Rotary engines
2203 H. A. Bonneville—Distilling
2204 H. A. Bonneville—Velvet
2205 H. A. Bonneville—Construction of presses
2206 H. A. Bonneville—Dyeing and fixing colours in fabrics
2207 H. A. Bonneville—Raising and holding the skirts of ladies' dresses
2208 H. A. Bonneville—Construction of flying toys
2209 S. T. Jones—Submarine telegraph cables
2210 P. Polain—A sliding revolver with isolated chambers
2211 A. V. Newton—Supplying boilers with water
2212 E. Davies—Combination drill brace
2213 W. P. Piggott—Telegraph cables

WEBB'S CURVILINEAR SLOTTING MACHINE.

Fig. 3.

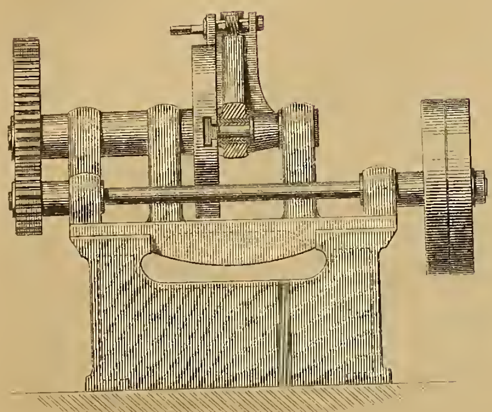


Fig. 1.

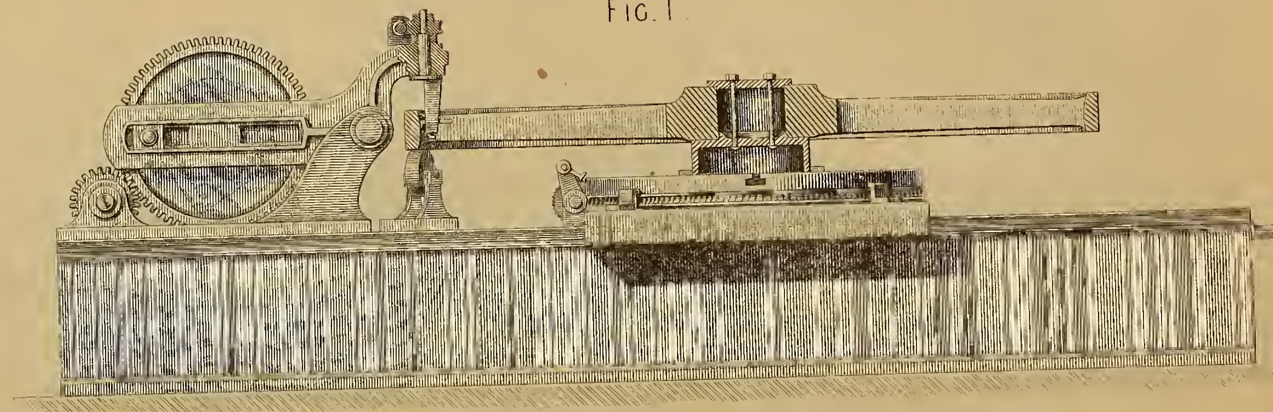


Fig. 2.

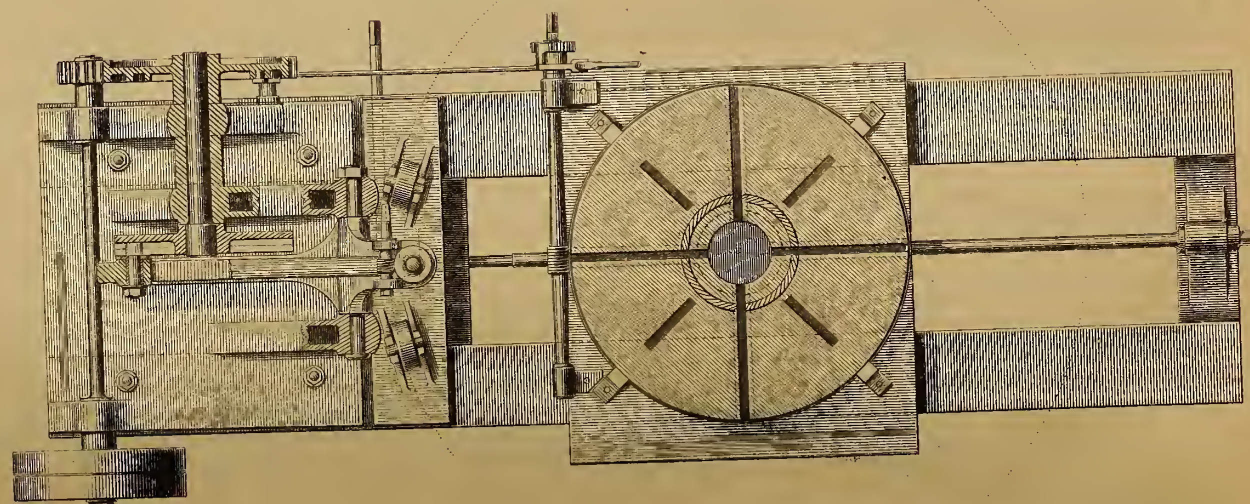
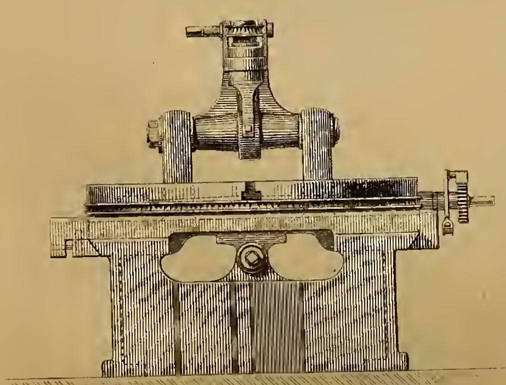


Fig. 4.



THE ARTIZAN.

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OCTOBER 1st, 1865.

A VISIT TO THE CREWE LOCOMOTIVE WORKS.

By J. J. Birckel.

(*Illustrated by Plate* 286.)

On the 25th of July last the members and friends of the Liverpool Polytechnic Society went to Crewe for the purpose of inspecting the extensive works of the London and North Western Railway Company, and were most courteously received there by Mr. Ramsbottom, the chief engineer, and by Mr. Webb, his principal assistant. These two gentlemen conducted the party through the several machine shops, boiler yard, smithy, erecting and paint shops, pointing out to them the various processes by which the several parts of the locomotive engine are made ready and finally brought together into one harmonious and intelligent whole. Among the many appliances in use, or tools employed to prepare those parts, it is not too much to say that the most useful and the most elegant or ingenious, are the offspring of Mr. Ramsbottom's own productive genius and of his immediate assistants, amongst whom we have already mentioned Mr. Webb. Some of those tools are of such recent introduction that they are not yet to be found in any other locomotive factory, though there cannot be the least doubt that their special merits will cause them to be generally adopted by those locomotive builders who are desirous to keep pace with the engineering spirit of the day. Among them are specially to be mentioned a curvilinear slotting machine for shaping the inside of the rim of locomotive wheels, so as to render them of equal thickness all round the circumference—a desideratum of the highest importance, which had not before been realised; and a species of lathe for roughing out the sweeps of crank axles in which the axle revolves at a very slow speed upon the axis of the crank-pin, while the sweep is being scooped out by a series of revolving cutters, which are so arranged, that when the axle has made a complete revolution the sweep is entirely cut out, and the crank pin proper cut to shape ready for the finishing tool.

The party afterwards were conducted into the rolling mills, where the London and North Western Company manufacture their steel rails from Bessemer's steel made by themselves in another branch of these works. The principal attraction in this department, however, was one of Siemens's gas furnaces, in which the steel ingots or blooms are heated by the flame of a mixture of common gas and of atmospheric air. The characteristic feature of this furnace is that no more heat is allowed to escape through the chimney than is required to create the necessary draught, but the heat which is not immediately consumed in the body of the furnace is absorbed by a network of fire-bricks, through which the flame is made to pass until they have reached a certain degree of temperature, when the flame is made to pass through another similar network of fire-bricks, and the air which has to be mixed with the gas before combustion can take place is then admitted through the first tier of bricks, or condenser, and is thus heated before it meets with the coal gas. The operation of reversing the currents of flame and of cold air is repeated at stated intervals of time; and it is thus that all the caloric contained in the coal is, practically speaking, made use of. Mr. Ramsbottom states that, taking into consideration the circumstance that the gas consumed may be manufactured from an inferior quality of coal, the cost in fuel of such a furnace is only one-third that of an ordinary hot air furnace.

From the rolling mills the party were conducted into the steam sheds, which are not circular as in most locomotive depots, but the engine stand in parallel rows of two or three, the smoke being taken up by a continuous trough over each row provided with a number of uptakes or short chimney stacks, the whole being made of timber.

The same system of steam sheds is now being, or has been, put up at Edge Hill station, near Liverpool.

The party now adjourned to the Railway Hotel adjoining, where Mr. Ramsbottom had had the courtesy to provide an excellent lunch for them, which, acceptable as it was after three hours' continuous attention to mechanical objects, was so much the more agreeable to them, as this attention on the part of Mr. Ramsbottom was quite unexpected. After an hour's rest, the party took train, a special one having been provided, and went to inspect the steel works, which are situate a couple of miles from the main works, and to view the converting operation by Bessemer's process. Here the first object of interest which attracted their attention was Mr. Ramsbottom's horizontal steam hammer, which may be said to consist of two rams of equal weight, moving to and fro horizontally upon small wheels running on rails, motion being communicated by a steam cylinder placed in the foundation below, provided with suitable mechanism for altering the stroke. The general features of the process of converting iron into steel, by blowing carefully divided currents of air through it, are now so generally known that it is not necessary to enter into a description of them, but we shall state unhesitatingly that the interest attaching to it can only be realised by witnessing the operation. On this occasion that interest was enhanced by the presence of the apparatus for analysing the chemical nature of the flame, as it escapes through the mouth of the retort, by means of the spectrum. For this purpose Mr. Ramsbottom has had for some time a professional chemist at work there, in order, through his observations, to make himself thoroughly conversant with the succession of chemical changes that take place, with a view undoubtedly to the more successful conduct of that branch of the establishment, which at present is being greatly enlarged.

We hope to be able to lay successively before our readers detailed illustrations of the several special tools referred to in the above narrative, and on the present occasion we have illustrated upon Plate 286 the circular slotting machine mentioned, and which we believe to be one of the most elegant tools devised for the purposes of the locomotive builder.

The machine, it will be observed, consists chiefly of a bed plate, which carries a compound sliding and revolving table similar to those of the ordinary slotting machine, with the omission of the cross slide which here is not required; and secondly, of a cranked lever vibrating upon a fixed axis, one end of which is provided with a long slot, while the other end carries the cutting tool; an alternate up and down motion is communicated to this lever by means of a disc which carries a crank pin, and which latter engages into a slide block fitted accurately into the slot of the cranked lever. It is evident that, as the disc revolves, it will communicate a vibratory motion to this lever, and, moreover, it will be readily perceived that the return stroke of the tool will be performed in a shorter period of time than the working stroke. The disc is provided with a T slot, in which the crank pin may be made to slide towards or away from the centre of the disc for the purpose of regulating the stroke of the cutting tool.

The disc shaft itself receives its motion through a spur wheel from a pinion fixed upon the first motion shaft which is driven by a belt from the main shaft line; it is provided with fast and loose pulleys, so that the machine may be easily thrown out of gear.

The cutting edge of the working tool is made to be lineable with the horizontal centre line of the fixed pivot of the cranked lever and consequently the respective elements of the arc described on either side of this horizontal line form equal angles of inclination with it. Provided, therefore, the plane of the middle of the rim be so placed as to contain that horizontal line, the rim when slotted will be symmetrical on either side of its middle. In order to the easy accomplishment of this object, the centre of the fixed pivot is raised sufficiently above the table to leave room for a rest or chock between it and the wheel boss, a special one being readily prepared to suit each new series of wheels, and the chock being circular it is made to drop into a groove concentric with the axis of the revolving table, so that the two operations of centering and of levelling the wheel are accomplished simultaneously. The rim of the wheel is supported upon two friction rollers resting in brackets fixed upon the bed plate just underneath that portion where the cut is taking place, and for rims of different breadths, rollers of different diameters may be prepared beforehand; but as it is an easy matter for a locomotive engineer to fix upon an uniform width of rim, this is not likely to be needed at Crewe.

The circular feed motion proceeds from a cam cast on to the spur wheel of the disc shaft, which cam works a worm shaft, by means of levers, rod, pall, and ratchet wheel, and the worm gearing into the teeth cast on the circumference of the revolving table, an intermittent revolving motion is thus communicated to the table and wheel. When the cutting tool has reached close upon one of the arms or spokes of the wheel the feed motion is thrown out of gear, and the tool rest is worked round by hand upon its own axis, in order to shape the hollow of the arm where it merges into the rim.

We have been informed by the shop foreman that the actual saving in cost of the work of this machine, as compared with that of the ordinary operation of chipping, is 25 per cent: of greater importance, however, is the obvious result of having the rim of the wheel truly balanced throughout its circumference. We should state that this machine was designed by Mr. Webb.

(*To be continued.*)

DYNAMIC TESTS.

In all descriptions of motive power engines the dynamic value of the apparatus as measured by mechanical testing instruments is found to differ widely from the result of calculations based upon the intended conditions under which the prime mover is supposed to work, and the importance of possessing a really reliable means of measuring and indicating the true power available from any machine can scarcely be overestimated; but in addition to this, in order to compare the different classes of engines, we must know how much of the total power developed is lost in friction in the engines themselves.

The instruments most commonly used for testing the power of prime movers are—the indicator and the brake; the former registers the pressure in the cylinder throughout the stroke, from which the dynamic effect developed from the fluid which is the vehicle, is calculated, by multiplying the mean pressure by the velocity of the piston upon which it acts. Thus is obtained the measurement of the work done within the motor, which, however, will be considerably in excess of that given off by it.

When the friction brake is used, it is applied to the main shaft of the engine, and measures, or is supposed to measure, the effective work given off. In experimenting upon machinery to determine its efficiency, we frequently find the results obtained by no means agree with the subsequent results of regular working. The cause is sufficiently obvious. If an engine is to be tested, the attendants are almost certain to be more careful than usual, and it also happens most frequently that the working of the engine itself is conducted under the superintendence of some scientific man infinitely better qualified to obtain a good duty from the machinery at his disposal, than the attendants in whose charge it will subsequently be placed.

Pumping engines afford great facilities for determining the actual amount of work got out of them as they are employed in lifting weight, which may easily be ascertained, but in the earlier instances there was considerable inaccuracy, because in those days the pump valves were extremely defective, allowing sometimes as much as twelve per cent. of the water raised to return through them, which loss was not taken into account, the calculations being made upon the assumption that at every stroke of the engine the full quantity of water capable of being contained in the pump barrel was raised. In the modern pumping engines improved valves are used, so that the loss of water through them when closing is scarcely appreciable. We can therefore, with this description of engine, readily ascertain the effective work done, and by means of the indicator determine the value of the work developed in the cylinder; the difference between these results will represent the amount of work absorbed by the mechanism of the engine itself, and by deducting therefrom the sum of the work done in the air pump, cold water pump, feed pump, &c., the power lost in overcoming the actual friction of the working parts may be determined. Of course among the items of loss to be deducted is that due to defective vacuum, and on the other hand allowance must be made for that quantity of steam which remains in the cylinder at the end of the return stroke. It is to be regretted on scientific grounds that the common practice in stating the economy of engines is to say that there is so much work done by a given quantity of fuel, as from the varying quality of coals of the same name, and even from the same heap, such statements, unless they refer to trials extending over long periods, are little better than useless, and it appears to us that it would be more satisfactory to state the quantity of water evaporated.

In dealing with rotative engines, greater difficulties present themselves to the endeavour to determine questions of efficiency. In this case we must be guided by the indicator and the brake—and these do not give us quite practical results; for instance, although the indicator may be perfectly reliable, yet an engine working against the steady friction of the brake is not circumstanced the same as when driving machinery, which will of necessity be offering a varying resistance. A system of determining the friction of the engine itself has been commonly used, which consists in testing it when running without any load; but it is evident that the results obtained can only apply to that one particlar condition, for when a load is upon the engine, the pressure on the various working parts being increased, the friction of those parts mutually will be proportionately greater.

Locomotives require indicators of peculiar construction to register the steam pressure in the cylinder while running, as the excessive vibration attendant upon their working prevents the proper action of the ordinary indicator, and we very much doubt whether indicator experiments on locomotives are really reliable, as considering the rapidity with which they move, it is probable that the full steam pressure in the cylinder has scarcely time to be transmitted to the indicator. The effective work given off by a locomotive may be determined by a dynamometer, through which the pull is transmitted to the train of carriages to be drawn.

In discussing the efficiency of steam machinery it should be considered under three heads—efficiency of the furnace, efficiency of the boiler, and efficiency of the engine, and unless these be determined separately, no correct conclusion can be arrived at as to what portions of the entire apparatus may require or afford opportunities for improvement. Commencing with the furnace: its efficiency will depend upon its being so proportioned as to allow the consumption of the fuel without waste, and with the generation of the most intense heat that can safely be borne by the plates; for if the heat can be absorbed with sufficient rapidity, the more intense local heat will produce greater economy than the diffused heat of less intensity; for in the latter case the difference of temperature between the water in the boiler and the heated gases in the flues being smaller, the rapidity of absorption of heat will be reduced in corresponding ratio; also the furnace should be so proportioned, that an excessive amount of air shall not pass through it.

It is by no means easy to determine the efficiency of a furnace except by the chemical examination of the products issuing therefrom.

As regards the rapidity of combustion, it cannot be said that slow or quick combustion is exclusively best, as much depends upon the form of the furnace in which the fuel is consumed. It does not follow that quick combustion necessitates a rapid draught, as furnaces may be worked under pressure with really a slow draught, but quick combustion, the compression of the air supplying oxygen to the fuel, causing a greater quantity of that gas to be in contact with the combustible elements than would be the case under ordinary circumstances.

We must next refer to the boiler efficiency, which depends upon the construction of the flues and their suitability to the fuel intended to be burned in the furnace. It is not difficult to determine the efficiency of the generator, which is measured by the amount of heat absorbed from the flame and gaseous products of combustion, which will be measured by the quantity of water evaporated. In considering the efficiency of a steam generator, it must be remembered that the heat in the furnace should not be allowed to reach such a temperature that the plates, receiving heat quicker than can be imparted to the surrounding water, may be burnt. What the limit is will depend in each case upon the thickness of the plates, the quality of the material of which they are composed, and the freedom with which the water flows to and from them.

The economy of the engine itself is determined from the amount of work done for a given quantity of steam consumed, that is to say, for a given quantity of water evaporated in the boilers. If there be no leakage in the boiler or pipes, the water pumped into it may be measured by a meter, and the quantity thus found, taken minus the quantity left in the boiler at the end of any experiment, as that which passes through the engine in the form of steam.

CIGAR-SHAPED STEAMERS.

Probably the most remarkable innovation ever made upon the established system of naval architecture consists in the projection and construction of the so-called cigar-shaped steam vessels, according to the designs of Mr. Winans. We have from time to time been careful to inform our readers of the progress of the vessel now nearly completed on this principle, and we now purpose devoting a few remarks to the principles involved in it, and upon which its ultimate success depends.

The general appearance of the hull of the vessel is that of a "parabolic spindle," being of circular section throughout, and terminating fore and aft in a sharp point. The extreme length is 256ft., and the greatest diameter 16ft., this width being only one-sixteenth of the length. It is expected that the engines will work up to a power of nearly 2,500 horses, or at the rate of eight indicated horse-power per ton burthen of the vessel. The upper and only external deck is 130ft. long by 10½ft. broad, and but little more of the vessel will be visible above water.

According to a rough calculation of the relation between the immersed surface of the vessel and the power of the engines, a speed exceeding twenty knots should be obtained; but there are conditions peculiar to the cigar form which will materially affect the matter of speed. The cigar form, although being calculated to reduce or obviate a pitching motion, yet will probably afford facilities for rolling with a very moderate impulse, and a pendulous motion being as it were imparted to the ballast, it will not quickly become again steady. Of course, so long as she is kept "end on" to the waves, there will be no tendency to roll; but if she deviates from that position to any considerable extent, such a tendency will become evident.

If we regard this steamer as intended to pass through the waves rather than over them, which will probably be the case, we find that the friction of her passage through the water will be very materially increased, as a much larger surface will be immersed; and in addition to this, a wave will probably roll upon the upper fore part of the vessel, being due to her motion and the inertia of the water, the tendency of which will be to cause a deeper immersion fore than aft, and the amount of force thus acting to produce such a position will depend upon the speed at which she is running, and, to counteract it, proportionate ballast aft will be required; this wave would also be increased by the action of the front screw, when immersed, to more than half its depth in the water, as its action would cause a swell behind it. The form of the vessel renders it no easy task to determine what may be the most suitable system of propulsion to adopt in connection with it, but we cannot think that the large screws at each end will yield satisfactory results. Each screw will have a diameter of 22ft., being 4ft. more than the greatest diameter of the hull; and supposing the points of the vessel to be immersed about a foot under water, there will thus be 10ft. of each screw exposed above the surface, and this, together with the fact of its projecting all round the vessel so far as it will, appears to us to render it very liable to accident.

The screw shaft passes from end to end of the vessel, being driven by three cylinder engines, worked at high pressure. Altogether, the mechanical arrangements do not appear very promising, but it must be remembered that the circumstances are peculiar.

It is not improbable, according to our view of the case, that paddle wheels might be found more satisfactory than the screws we have mentioned, for, by a proper formation of the paddle boxes, the resistance offered by them to waves passing over the upper portion of the steamer might be reduced to a comparatively trifling amount.

To apply a screw in the ordinary manner, that is to say, submerged, is almost impracticable, from the absence of the hollow form of the lines of ordinary vessels towards the stern, and, moreover, there seems to be scarcely room beneath the water line to submerge a screw of sufficient diameter to obtain the requisite speed.

As regards the floating capacity of the cigar ship, there are some points to be noticed which appear probable to act inimically. An ordinary vessel passing through the waves, as, for instance, the *Great Eastern*, separates them laterally, but that of which we are speaking also separates them vertically; the former, if the waves become very deep, has a tendency to rise which is not impeded by the ship's form, but the cigar vessel in rising upon a deep wave, which it has entered, must present resistance almost as great as it would in passing sideways through the water, and this on account of her upper surface, upon which the water would be pressing, being the same as her side, and from her particularly slender form she would not commence rising in a wave until far immersed in it, more especially when running at high speed.

It is not improbable that a submerged hydraulic propeller might be applied to the cigar ship with tolerable success, but of course this is merely a matter of speculation.

To sum up the advantages and disadvantages of this new enterprise, we must state that the former consist in strength, lightness, and a form which would enable the vessel to attain an extraordinary speed, the disadvantages consisting in the tendency to become immersed, and the difficulty of arranging the propelling gear. But, doubtless, if the advantages claimed are really found to exist, the disadvantages will soon be obviated by the skill of the inventor, aided by his increased experience in her management.

New Fog-Signal.—In the course of a lecture delivered at the Royal Institution, Mr Alexander S. Herschel described an interesting new form of fog-signal which has been devised by Mr. Henry T. Humphreys. The apparatus is proposed by its originator to be placed on dangerous rocks and shoals out at sea, or upon headlands in great channels of communication subject to fogs. It consists of a large wrought iron tank, and a tall tower, furnished with such contrivances that the action of the tide will ever cause it to utter a loud shriek such as is produced by a steam-whistle. These recurring screams made by the waves themselves would acquaint mariners of their proximity to danger both in the fogs and in the dark. Mr. Humphreys' invention appears to be both simple and useful, and we trust our Admiralty authorities may see fit to give it a fair and honest examination and trial.

HISTORICAL AND DESCRIPTIVE SKETCH OF THE MERSEY DOCKS AND HARBOUR.

BY J. J. BIRCKEL.

(*Illustrated by Plate* 287.)

The works of the Birkenhead Docks, as authorised by Parliament in 1844, were duly proceeded with, under the superintendence of Mr. Rendel as chief engineer, and although the rate of progress was not very remarkable, yet, in the summer of 1846, two small docks were either completed or nearly so, some warehouses had been erected upon their quays, and the proposed embankment across the Wallasey pool had also been proceeded with in the shape of a river wall, though we have been unable to ascertain what extent of work had been executed upon this part of the scheme. By that time £291,000 had been spent, and the Dock Company having no more funds at their disposal, the work had come to a standstill. It is probably, therefore, with the hope of making a favourable impression upon such of the commercial community as might be interested in their further progress, that the two docks mentioned, namely, the Egerton and the Morpeth, were opened with some pomp in April, 1847, by the Earl of Carlisle, then Lord Morpeth; and we reflect with some pleasure that this event, with all its attendant circumstances, was duly chronicled in the pages of THE ARTIZAN of that day, although we presume that neither the then managers of this journal, nor yet the noble lord who acted as godfather to those works, knew what was the remote object of that pageant, or were acquainted with the penurious condition of the Dock Company's exchequer.

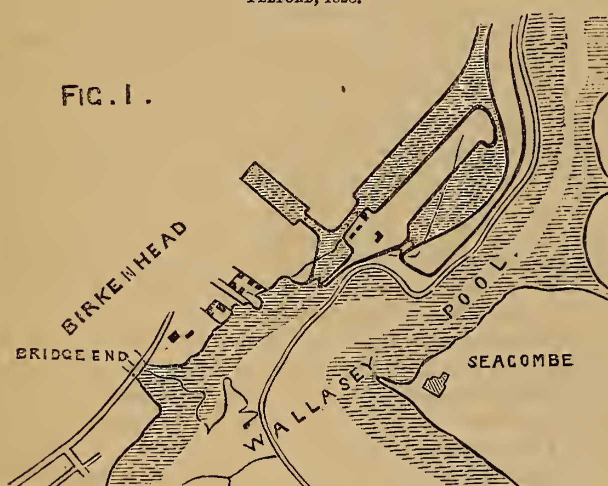
The result, however, seems not to have been what was anticipated, for the works still continued to languish, and divided councils in the managing body (the invariable result of failure in commercial undertakings whose responsibility does not rest upon a single head) now made matters worse by the clamour for a change in the engineering genius which had so far presided over this undertaking, and, accordingly, Mr. Rendel's engagement having expired in 1850, it was not renewed, but Mr. Abernethy was appointed chief engineer in his stead.

The natural consequence of a change of engineer, as was to be expected, and as had been predicted by Mr. Rendel, was a change—or rather a desire on the part of the new chief to effect a change—in the general design of the work; and thus we find the Birkenhead Dock Trust before Parliament again in 1852, seeking powers to deviate from the plans formerly sanctioned, and, as a matter of course, to raise more money.

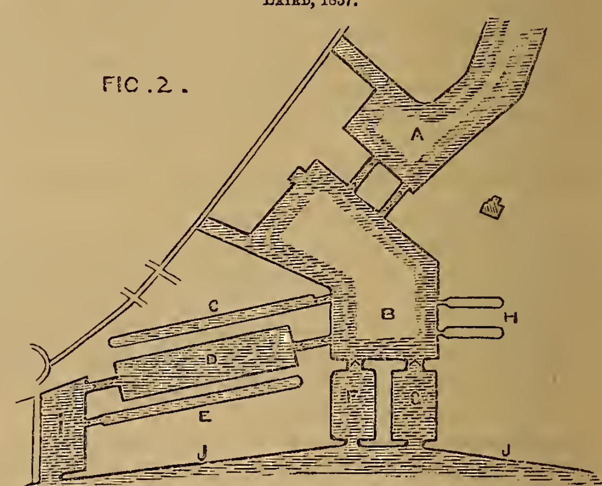
Mr. Abernethy's ground of objection to the original design was the low water basin which, he maintained, could not be kept open by Mr Rendel's proposed subaqueous sluicing, and he therefore proposed to transform that basin into a half-tide dock, to be provided with two entrances, fitted with single gates on the river side, and to communicate with the great float by means of two locks.

This design, with all the previous ones, as well as Mr. Hartley's, according to which the works have been carried out, is illustrated in the accompanying woodcuts, fig. 1 being Telford's; fig. 2, Laird's; fig. 3, Rendel's; fig. 4, Abernethy's; fig. 5, Captain Maughan's; and fig. 6 (page 222), Hartley's.

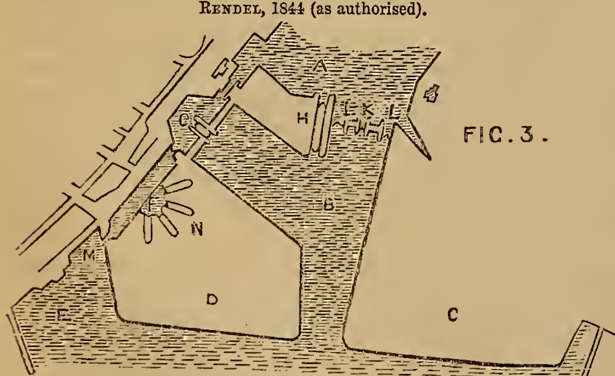
TELFORD, 1828.



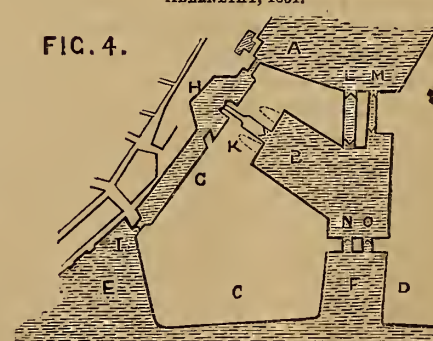
LAIRD, 1837.



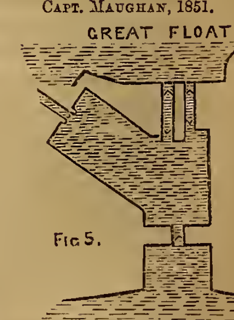
RENDEL, 1844 (as authorised).



ABERNETHY, 1851.



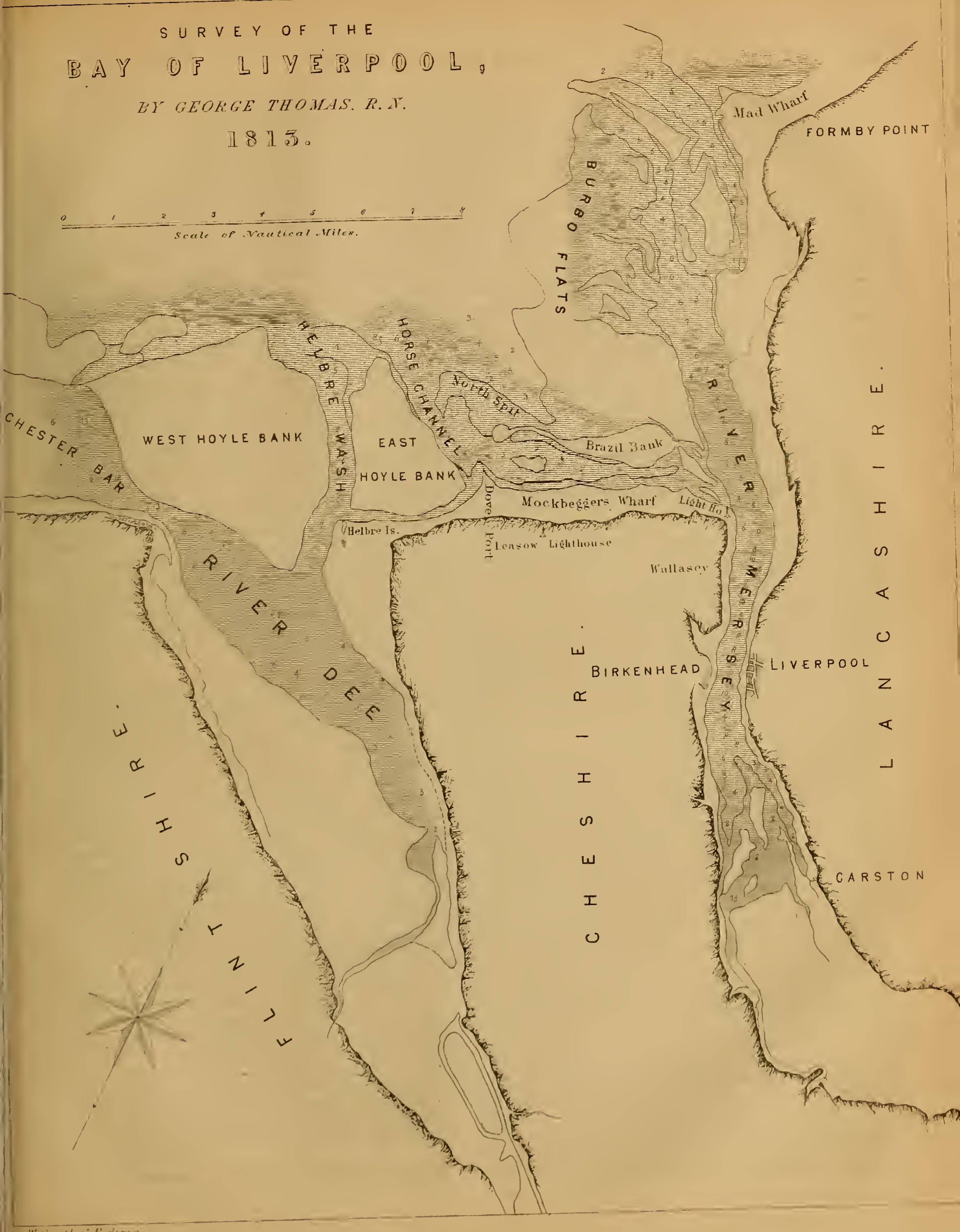
CAPT. MAUGHAN, 1851.



The alteration thus proposed was not sanctioned by Parliament, but the evidence tendered on both sides before the Committee of Inquiry is so full of technical interest, that we have deemed it proper to reproduce those portions of Mr. Abernethy's and of Captain Denham's evidence, which specially refer to the point immediately at issue.

Thus, Mr. Abernethy says, in justification of his alteration:—

"The low-water basin in Mr. Rendel's plan may be regarded as a creek or inlet of the Mersey. At mean spring tides it will have a depth, provided it can be maintained, which I think very doubtful, of 12ft. of water, and at neap tides of 19ft. or 20ft. at low water. As regards the accommo-



W. Smith C.E. direx.

dation afforded to the smaller class of vessels in loading and discharging of cargoes, as mean spring tides rise 27ft., and mean neap tides rise 15ft., there will obviously be a great alteration in the level of the vessels as regards the quays, which involves a constant alteration of the moorings and stages, and at low-water spring tides, as regards the smaller class of vessels, they will be subject also to the current produced by the sluicing power, which has been stated to be as much as two and a half to three miles an hour. I do not admit that such a current throughout the whole of the basin can be produced, but there will no doubt be a very considerable disturbance in the basin during the process of sluicing; and I should apprehend, that as to deeply-laden river craft, it would consequently be a place they would but little frequent, seeing that there is the constant alteration in stages and moorings; and that, moreover, they would be exposed to the operation of the sluicing current at low water. With regard to the larger class of vessels, it can only be regarded as an entrance basin, leading into the float. It is obvious, that having but 12ft. of water in it at low water of spring tide, it cannot be a place of refuge or a harbour for the larger class of shipping that will not take the ground. The general objects that I kept constantly in view were as follow:—I regard the accommodation for the larger class of vessels, and the providing of deep water entrances, as the main features; the keeping the dock at a permanent level, as near as possible, instead of a fluctuating one; the exclusion of the tidal waters and preventing the silting up of the dock. The half-tide basin is to be used as a passage to that dock. and as a place of accommodation for the transit trade, heaving in it always a minimum depth of 20ft. instead of 12ft.; the vessels which draw above 20ft. are not numerous, compared with the whole number. The entrance basin I propose to maintain at the same depth as was proposed in the original plan; and I conceive, taking into account the small number of vessels that would arrive at about the period of low water, that an entrance basin of seven acres is amply sufficient. The advantages of the half-tide basin are the amount of lockage between the float and the river Mersey, and that a large amount of traffic can be locked through with a half-tide basin.

"The half-tide basin being an intermediate level between the dock and the river, the lockage may be carried on from the half-tide basin to the float uninterruptedly during the whole twenty-four hours if necessary; vessels under 20ft. of water being kept afloat in the half-tide basin. It will also be in the power of the harbour-master to establish a common level between the half tide basins and the float, and to pass the vessels accumulated in the half-tide basin rapidly into the dock. The amount of lift is lessened, and a much greater amount of lockage can be carried on in a given period of time than in a low-water basin, inasmuch as at a certain period before and after high water, vessels of a large draught of water cannot be locked up, and in spring tides, vessels drawing more than 12ft. of water would have to go out to their anchorage, or take the ground in the basin. In the proposed plan all vessels under 20ft. would be kept afloat, and may be passed into the half-tide basin, or at once pass out to sea. In the other plan, before and after high water, vessels must be locked out, except during spring tides, for a short period, when the tidal gates will be opened. In case a fleet of fifty vessels should arrive, great and small, they may be passed into the half-tide basin. At high water, or a short time after, it will be in the power of the harbour-master to close the gates, and there will then be a common level, or a level due to the tide of the day. With a lift upwards of two, three, or four feet, the vessels can be passed rapidly into the float; but with the great low water basin, it is obvious at spring tides, if a large number of vessels arrive, forty or fifty arriving shortly before high water must pass through the tidal gates. The gates are supposed to be closed immediately at that period; after that all vessels must be passed through the lock, and as the tide falls, as they cannot all be passed into the float in safety, there being but 12ft. of water in the low-water basin, they will either take the ground or go out to anchorage."

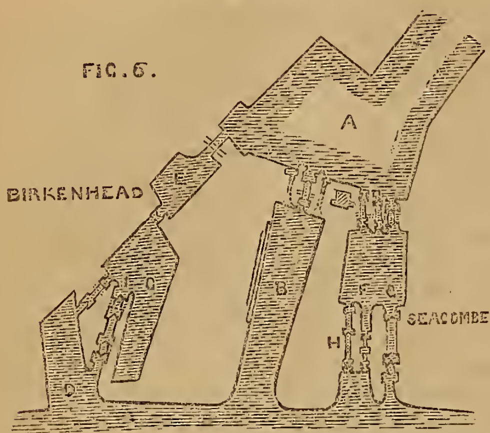
There is in these objections, as set forth by Mr. Abernethy, much plausibility of reasoning, but most of them are readily disposed of by Captain Denham, who, on questions of management of vessels, ought to be considered the best authority of the two. On the practicability of keeping the low-water basin open by means of sluicing, however, he offers no opinion, but is very positive on all other points, as appears from the following:—

"The system at Liverpool being to have the docks open about two hours at high waters, the vessels anchor as near as they can to the dock into which they are about to enter. I have known ships lying for three or four days in the Mersey, with their sails unbent and their crew partly discharged, with a single anchor, under the charge of a pilot, I presume waiting for water to go into the Liverpool Docks, at all times of the year, depending entirely upon the neap tides of that river. At those times there would be water in the low-water basin for the ship to remain always float. The same want of rise of tide to take her into the Liverpool Docks would be attended by a so much less fall of tide that she would find 19ft. in the 12ft. low water basin retained at low water; and therefore if she did not draw more than 19ft. she would be afloat there, and she could unload in this basin such a portion of her cargo as would enable her to cross the Mersey in tow, and to enter the dock, which her cargo prevented in point of draught of water from doing before: 19ft. is a large draught for a sailing ship. The exceptional cases are the large American timber ships; but taking the ships engaged in foreign trade generally, 19ft. is a very large draught. I never heard of a ship in the merchant service of more than 20½ft. or 21ft. draught. By means of the low water basin, all the inconvenience of being neaped in and out of the Liverpool Docks would be entirely obviated, and also the necessity of lying in the river in these dangerous places, where they drag their anchors; both these are matters of the first importance to the maritime and commercial interests. Nothing short of impracticability would justify the abandonment of the low water basin. It is a boon held out to the public: it was one of those points of pre-eminence in the undertaking, and I cannot conceive that the Government of the day would have allowed that shore to be enclosed, or the water impounded, or anything done to prevent the coaster and the river craft from going there at such times as suited their convenience (it being the only sheltered spot that they could lie in out of the way of the vessels) but for such a public boon; anything that goes to shut up that would be a breach of faith with the public, and destroy all confidence in the undertaking. One of the most important outcries at the time, which rather paralysed the matter till it was met properly was, 'What is to become of the river and coasting craft if Wallasey pool is shut up?' And that led to the serious consideration that there should be an open basin for their reception; and I recollect it was also stipulated that there should be even a place left open for those who desired to lie aground instead of floating in the basin. Without a spacious and tranquil sheet of water to receive vessels bound for the internal docks and float, such docks and float would be most difficult of approach; it would be impracticable to get at them straight right in from the river at once. I have heard of the proposal to substitute a half-tide dock on the site of the low water basin. Gates that would impound the water for a half-tide basin, must be within a certain distance of the current of the tidal straits, in a recess that would not be more than two or three times the length of a ship. It appears impracticable to my experience that a ship should round-to into this, with the weigh on that she would have with the wind from the westward, and be checked in time to prevent collision with the very dock gates which would form this half-tide basin."

The result of this inquiry was, as we have already stated, to leave matters as they stood before; and from that date the works were entirely suspended, until in 1855 it was agreed, and sanctioned by Parliament, that the property of the Birkenhead Docks be transferred to the Corporation of Liverpool, as trustees of the docks on this shore of the Mersey.

As soon as this transfer had taken place, Mr. Hartley received instructions to prepare plans for such works on the Birkenhead estate as may be necessary to make it most useful for the accommodation of trade and shipping in connection with the Liverpool Docks. In his original design he entirely omitted the low water basin, introducing only a small basin of some six acres in front of his entrances, but was afterwards compelled by Parliament to add to his scheme a basin of some thirteen acres, to be maintained

Hartley, 1856 (as executed).



at a depth similar to that proposed by Mr. Rendel. His reasons for deviating from, and his opinion on, Mr. Rendel's proposed works, are set forth as follows in his evidence before Parliament:—

"I did not feel justified to recommend our committee to carry that plan out. I had never known of such an area excavated for the purpose of a basin, and being kept free from silting up by the modes proposed to be adopted by Mr. Rendel. I do not believe anything to that extent has been done—certainly not within my experience.

"The water in the Mersey holds in solution a great quantity of sand and silt, which it deposits in various places; it is a source of annoyance and great anxiety to us. That, therefore, in considering the question, is one subject, to which prominent attention should be given; necessarily there must be a large amount of deposit in any inlet from the Mersey, tending gradually, unless efficient means were adopted for its removal, to block up and render useless that large basin. I know the mode proposed to be adopted by Mr. Rendel for obviating that impediment. His proposition was to lay sluices at the end of each fork, at a very little distance above the floor of the basin, and to get a scour by lifting all his cloughs, which is the technical term for the doors of the sluices, or the valves to the sluices: as I understand Mr. Rendel's plan, I have no doubt he would have sluices in his gates, though that I am not aware of; but between the lock and the single entrance there was to be a series of sluices; they were to discharge very near to the bottom of the basin; the water above them would be according to whatever the height of the water was in the float; the centre of the sluices would be about 18ft. below the Old Dock sill, and if you added whatever water there was in the float, it would give you the level of the water. I think Mr. Rendel proposed to lay the sluices about 2ft. above the floor of the basin, the basin itself being 12ft. below low water.

"For the purpose of the sluicing Mr. Rendel proposed to avail himself of the water in the great float, the large area of water which is behind the sluices. By the Act relating to the Birkenhead Docks, as I am informed, the level below which the water may not be reduced is 13ft. above the Old Dock sill, so that unless the water in the float were higher than that, it would be impossible to take away water from the float for the purpose of sluicing power, if that 13ft. level was stringently adhered to. It is important for all docks to be kept as near one level as you can. I do not think it is so essential as some people do. The water in the float would, I imagine, be used at dead low water; that would be the most efficient time for using it. There are portions of the year in which the neap tides do not rise so high as 13ft. above the level of the Old Dock sill; in this year there are about 107 days in which the tides do not rise up to 13ft.; that would be pretty much the mean of every year. During those days the single pair of gates intervening between the float and the outer basin could not be opened if the 13ft. level was stringently adhered to; and during those days there would be no water admitted into the float that would be available for sluicing power; if the water was run down to 13ft. in the first instance, all the tides below that could not be let in, so that no water would go into the float until higher tides come. I have not been able to learn any case in which practically such a scheme as that is carried into effect. I think, if any scheme could be devised to carry out this object, if any one wished to carry it out, that Mr. Rendel's plan is calculated to carry it out; but from what experience I have had in Liverpool, I do not think the effect would be what he expects. In my judgment, that large area of nearly thirty acres could not be maintained at an efficient depth by means of the sluicing power proposed by Mr. Rendel. I do not believe there is any analogous case. I do not know if any are similar to that, or anything like that, with 12ft. of dead water at the time you are sluicing, being kept open by means of sluicing. It must be an experiment, of course, if nothing of the kind has been done before, and I do not find that anything has; if the experiment should fail, the result would be that you would have to put other works, somewhat similar to what I propose. There would be a considerable sum of money sacrificed. Of course some of the works would be useful again. Believing, as I did, that Mr. Rendel's design, beautiful as it was, would not answer the purposes he contemplated, I did not feel I was justified in recommending the Dock committee to carry out the plan as proposed. Mr. Rendel's outer basin would not, in my judgment, be available for a harbour of refuge. Whenever in the river Mersey a harbour of refuge is required, that is during a heavy gale of wind, and all our heavy gales of wind are from the north-west, no vessel could get into it except by steam—it would be right against the wind. The whole of the Wallasey pool lies open to the north-west; the wind comes down it with terrific force; it forms a funnel. I do not think a harbour of refuge is required in the Mersey—it is a harbour of refuge itself; but I see a great difficulty in the large class of vessels getting in except by steam, and the small craft to which it would be a harbour of refuge are such, that they neither could nor would afford to pay for steam towing.

I had an opportunity of considering another scheme, suggested by another engineer, Mr. Abernethy, which had been ventilated, though not quite so much as Mr. Rendel's was: it was very much considered before Parliament in 1852. I had access to all the plans and sections deposited on that occasion, so as to have an accurate knowledge of what was contemplated by Mr. Abernethy: his plan differs from Mr. Rendel's to this extent, that instead of having a low water basin of twenty-eight acres, as Mr. Rendel proposed, Mr. Abernethy put two pair of gates in front of the basin, and converted a portion of it into a half-tide basin; instead of having the basin open altogether to the Mersey, Mr. Abernethy proposed to put single gates between the Mersey and the outer basin, and to put locks between that basin and the float. There was a low water basin of some five or six acres, which was to enable vessels to approach the entrances, and then to pass through single gates when the tide was favourable to admit them into the half-tide basin, in which they would be shut up. I believe Mr. Abernethy proposed to open those gates when the tide had risen to half-tide, and to keep them open till the tide had receded to that level; during that time vessels could get in or out, and being once in they might be locked up into the great float.

I propose to adopt a certain system of lockage in connection with the river and the float. The difference between Mr. Abernethy's plan and mine is this—that supposing our sills to be laid at the same relative depth as soon as a vessel can approach, and there is water for her over my sills, I can take her into dock; whereas he must have waited till the tide floated to half-tide to take her in. That would be a great convenience, as accommodating the smaller class of vessels first, that could approach at an earlier time of the tide.

The instructions supplied to me were to fulfil the Act of Parliament in rendering the Birkenhead Docks available for the commercial purposes of the port of Liverpool in connection with the Liverpool Docks with as little delay as possible. In considering those instructions, the first and the most important object to be attained appeared to be to get the means of the most speedy communication between the great float and the river. The walls are built and the ground is made on the whole of the south side of Wallasey pool, and in order to render it more available for commercial purposes it appeared to me desirable to have in the first instance, with as little delay as possible, another access into the river Mersey. The pool is only partially excavated; it will require a still greater excavation in order to render it available for the anticipated trade.

Speaking with respect to docks generally, the more uniform you can keep your level the better, but it need not be kept at any permanent level. I propose to take advantage of the means that Mr. Rendel had down to 13ft., according to circumstances. Looking at the amount of trade that may be anticipated to frequent the great float, the greater the amount of accessibility the more numerous and the more available the openings the better; also the greater the depth of access the better, if we can maintain it. All these considerations would lead me to the adoption of such a plan as would give the greatest available depth, and the greatest number of accesses that could be maintained efficiently. To carry out those objects I proposed the plan now before the committee. The first feature on my plan is an open basin of about four acres, through which vessels will approach the gates. That basin is proposed to be made 17ft. below the Old Dock sill. When the vessels reach that basin in getting to the locks, they will be out of the action of the tidal stream. From that outer basin I propose three locks, opening into the inner dock or basin: the size of that inner dock or basin is nearly nine acres. I propose to excavate that inner dock to 18ft. below Old Dock sill. The width of the three locks proposed is 100ft., 30ft., and 50ft. The sill of the 100ft. lock is to be 12ft. below the Old Dock sill. The depth of the 50ft. lock is the same, and the depth of the 30ft. lock is 8ft. below the datum. I propose to devote the 50ft. lock to the great majority of trade frequenting the Mersey: sailing vessels and screw steamers are the great majority. I propose to devote the 100ft. lock to the largest class of steamers—the paddle-wheel steamers. The 30ft. lock is for the small river craft and the smaller size coasters. I propose to divide the locks by an intermediate pair of gates, so that they need not waste water when they are only working one ship at a time, being only big enough to occupy half the lock.

I gave my concurrence reluctantly to an extra 2ft. of depth to the 100ft. lock, but I think I can maintain that depth on the Birkenhead side for two reasons: in the first place we shall have more scouring water to help us to keep it clean; and in the next place, being under the lee of the land, there is not that motion in the water, nor that quality of deposit that we have at Liverpool. The keeping the bottom of the entrance deep enough to gain access to the basins of various dimensions is the great difficulty with which I shall have to contend, and it is the knowledge and the fear that I shall have to contend with it that has made me reduce the outer basin to the smallest possible dimensions that I can make it. I am not at all sanguine that I shall be able to keep my entrance clear by sluicing.

On the subject of sluicing against a dead body of water, Capt. Maughan, sometime the manager of some of the London Docks, related the following experimental facts before the same committee:—

"As to scouring against any considerable head of still water in a state of comparative rest, against which the scouring power is to be directed, my practical experience leads me to this: I have tried it in various ways; I have tried it at Cardiff, in a dry basin, and at Shadwell with a paved entrance, that with a depth of 12ft. at low water there is no such a thing as a scour; it is not known. You disturb the mud, but you cannot have a run of water. At the Shadwell entrance, with eight sluices through the lock gates, four of 3ft. by 2ft., and four of 3ft. by 3ft. 2in., making 50 square feet, scouring was found impossible with depths above 8ft. over the sill of the lock gates. With an area in superficial feet of 50 over the whole sluices, and with a very good head of water behind them, say 23ft. or 24ft. of head, with a depth on the sill of the lock gate of 6ft. and under, the effect is to drive all the water through the lock, and far beyond the lock, with such velocity that all the mud and filth is carried along with it—that is, with 6ft. and below 6ft., the scour is very effective without the dock; we have a stone invert just outside the dock up to the dock channel, as long as there is under 6ft. or 6ft., the scouring is very perfect; then it takes the mud and filth into the Thames. The width of the invert is about 47ft., the transverse area is much greater. The result of my experience is, that having at Shadwell Docks sluices with an aggregate area of 50ft., and a head of 23ft., to effect the scouring through a channel of about 300ft. long, and 46ft. wide, it is very efficient up to 6ft. and under; at 8ft. our practical experience taught us it was perfectly useless to waste the water, and we never did; that was the result of experience. At Shadwell the sluicing was at dead low water, varying with the tides; we sometimes have had 3ft. of water, that depends upon the wind and the tides. From 1841 to 1847 I know all about Cardiff Docks. The basin is dry at low water; the sluicing power is through three culverts of 5ft. diameter, and two sluices in the lock gates, 4ft. by 18in.; the head is 28ft., and is supplied by a reservoir, a constant head of 28ft. above the under side of the sluices. The effect of that great scouring power was to undermine the pier-head walls; and yet, with the exception of the channel, and that very imperfectly kept, with a bar forming in the centre of it, the mud on each side of the basin was not removed by scour but by manual labour."

And on the relative merits of the three rival schemes, namely, Mr. Rendel's, Mr. Abernethy's, and Mr. Hartley's, Mr. G. Rennie spoke as follows:—

"I have been cognizant of most of the dock schemes that have been suggested for Wallasey pool since 1840 down to the present time, and of Mr. Rendel's plans, as they have been at different times before Parliament. I was also acquainted with the modifications proposed in those plans by Mr. Abernethy, and supported those modifications. I believed them to be an improvement upon Mr. Rendel's plans, and I am still of that opinion. The foundations of that preference were that the plans made, according to my views, better use of the land for which they were made. Another reason was, I considered that the tidal basin was too large to maintain by sluicing. Another reason was that I considered Mr. Abernethy's plan would do more work, that is to say, it would let into the float more vessels, and do the same in letting them out; that the outer basin was easier maintained in depth; that the half-tide basin was easier worked for the railway. Those were the principal grounds. I am aware of Mr. Hartley's modifications of Mr. Abernethy's plan; in my opinion they are still further improvements upon the original design. In my opinion the changes proposed by Mr. Hartley carry out in a still greater degree those advantages which I believe Mr. Abernethy's plan to have over Mr. Rendel's. I think the main feature of the improvement proposed by Mr. Hartley is the introduction of locks between the low water basin and the tidal basin. I think that these locks, being three in number, are capable of admitting more vessels than two. I call the outer one the low-water basin, and the intermediate one the half-tide basin. I think that there is also an improvement in having one more lock between the intermediate basin and the great float. Having three locks in place of two entrances is an improvement. I conceive that Mr. Hartley's plan will accomplish more work than by carrying out the original scheme of the great low water basin. My feeling as to the great low water basin of Mr. Rendel's plan is, that with a depth of 12ft. of water at low water, no sluicing you can devise will maintain it at that depth. That opinion is founded upon my practical knowledge and experience. I have never anywhere seen it performed even to half the extent. The cases I refer to are the docks in London. I have seen and been present at an experiment made in the London Docks, where a basin, with a rounded and bricked bottom could not be maintained at a greater depth than 7ft.; it being a smooth bottom, the water let out from the lock had a tendency to drive the water before it, but when it got to a distance of

300ft. from the lock it was scarcely effective. I am acquainted with the harbour of Dover—sluicing is employed there; so far as the sluicing goes the sluices are differently disposed, but the principle is still the same; the sluicing is into sill water; the depth varies, but the depth at low water is from 3ft. to 4ft., I should think. It produces very little effect indeed. I refer to the outer sluices which go through the old pier-head—those are made of cast-iron; on certain parts gravel used to accumulate to a great extent. The object of those sluices was to remove that gravel by setting those sluices in motion. They did have that effect at the time, but to keep it a very good low water harbour they never have been able to do.

"Ramsgate Harbour is a low water harbour, into which at neap tides they open the sluices, and allow the water to run from the inside of that harbour. The water runs, I think, a distance from the mouth of the sluices to the eastern pier of about 200ft., and it clears the bottom from the mouth of the sluices until it gets into the low water mark, at the mouth of Ramsgate harbour; and there, I think, there is a depth of 7ft. of water—further it cannot go. So long as the escaping water runs over a dry surface, it does to a certain extent scour away the ground, but it ceases to do so when it gets to water that is still; it ceases to a certain extent to do so at the depth of 4ft. or 5ft. They employ rakes, also, during the time of drawing the sluices. Ramsgate harbour affords no encouragement for believing that Mr. Rendel's scheme as to sluicing would be successful."

Parliament, it will be owned, had great faith in Mr. Rendel, since it ordered the construction of that low water basin, in the face of Captain Maughan's and Mr. Rennie's very positive testimony as to the non-success of similar schemes. In our next paper we shall endeavour to show how experience has dealt with the various theories set up, both in favour and against it.

On Plate 287 herewith we have produced, as promised, the survey of Liverpool Bay, made in 1813, by George Thomas, Master, R.N.

Referring to the accompanying woodcuts of the various Birkenhead Dock schemes, in fig. 2, A is the float; B, half-tide basin; C, canal; D, dock; E, canal; F, outward basin; G, inward basin; H, graving docks; I, basin; J, shipwrights' yards.

In fig. 3, A is the great float; B, great low water basin, 37 acres; C, north reserve (Crown); D, south reserve (Dock Trustees); E, Woodside Basin; F, Morpeth Dock; G, Egerton Dock; H, 50ft. lock; I, 50ft. gates; K, 70ft. gates; L, 50ft. gates; M, 50ft. gates; N, graving dock.

In fig. 4, A is the great float; B, half tide basin, 19 acres; C, south reserve; D, north reserve; E, Woodside Basin; F, entrance basin, 5 acres; G, Morpeth Dock; H, Egerton Dock; I, 50ft. gates; K, graving dock; L, 90ft. lock; M, 60ft. lock; N, 95ft. gate; O, 60ft. gate.

In fig. 6, A is the great float; B, low water basin; C, Morpeth Dock; D, Morpeth Basin; E. Egerton Dock; F, 30ft. lock; G, 100ft. lock; H, 50ft. lock; I, 80ft. lock.

(To be continued.)

LOCOMOTIVE TRACTION.

The adhesion between the tyres of the wheels and the rails upon which they run forms, as it were, the fulcrum for the power which propels a train. The early engineers feared the insufficiency of such adhesion, and now their fears, although for a time regarded as vain, and, in fact, proved to be so, so far as the traffic was concerned, up to within the last few years, are yet revived now that heavy gradients have to be dealt with.

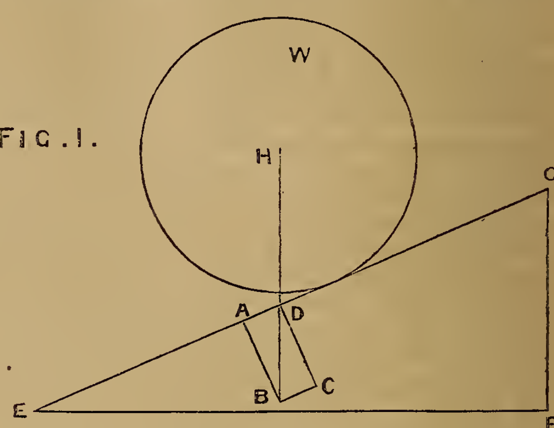
The ordinary laws of mechanics require careful consideration on the part of those who endeavour practically to apply them, not because the theorems and fundamental laws set forth are themselves liable to inaccuracy, but rather on account of the difficulty of determining the data upon which our practical calculations are to be based; thus, in the subject under consideration, two conditions may arise—one in which the laws of friction between solids are to be taken as the criterion of tractive efficiency, and the other in which the laws of friction in liquids are to be attended to.

The law of solid friction is that it varies exactly as the weight upon the surfaces in frictional contact without regard of the extent of such surfaces, whereas, in the friction of liquids, the contrary obtains. In dry weather, our locomotive running upon dry rails, the law for the friction of solids should obtain; but, in wet weather, the driving wheels of the engines will be liable to slip, by reason of the friction between them and the rails approaching the character of fluid friction, the amount of which depends entirely upon the surfaces of contact, regardless of the pressure existing between such surfaces. Of course, the weight upon the driving wheels tends, in a great measure, to expel the moisture from between the wheel and rail, but it is not easy on such surfaces as those to which we refer to extrude all the moisture.

In ascending gradients the greatest liability to slip occurs, and this is not entirely due to the extra load imposed upon the engine, but also to the reduction of the normal pressure between the surfaces of contact.

In fig. 1 let W represent the driving wheel of the locomotive in contact with the inclined surface G E; from the centre H of the wheel W let fall

FIG. 1.



the vertical line H B; from the point B draw B A at right angles to G E, and complete the parallelogram A B C D; then if D B represents the weight upon the driving wheel W, A B will represent the normal pressure upon the surface of the rail G E. Hence, calling T the adhesion due to the weight upon the driving wheel, as compared to its tractive efficiency on a level rail, we find

$$T = \frac{A\,B}{D\,B}$$

But according to the ordinary formulæ for the solution of triangles,

$$A\,B = \frac{D\,B \times \sin.\,B\,D\,A}{\sin.\,B\,A\,D}$$

But

$$\sin.\,B\,A\,D = 1.$$

Hence,

$$A\,B = B\,D \times \sin.\,B\,D\,A,$$

wherefore,

$$T = \frac{B\,D \times \sin.\,B\,D\,A}{D\,B}$$

$$= \sin.\,B\,.\,D\,.\,A = \cos.\,D\,.\,B\,.\,A,$$ because D A B is a right angle.

From the point E draw the horizontal line E F, and upon it from the point G let fall a perpendicular G F, then shall the triangles D B A, G E F be similar; for H B, G F being vertical to the horizon are parallel, and they are intersected by the right line G E. Wherefore

$$F\,G\,E = B\,D\,A,$$

and the angles D A B, G F E being both right angles are equal; hence the remaining angles D B A, F E G are equal. Hence,

$$T = \text{cosine}\ G\,E\,F:$$

but,

$$\tan. G E F = \text{ratio of gradient.}$$

and

$$\frac{\sin. G E F}{\cos. G E F} = \tan. G E F.$$

$$T = \frac{\sin. G E F}{\tan. G E F}$$

$$= \frac{\text{Sin. } G E F}{\text{Ratio of gradient}}$$

In the case of ordinary gradients, the amount of adhesion between the wheel and rail thus lost would be of little importance, but now that that such inclines as 1 in 10 are being proposed, it is desirable to consider every item in the calculation.

In ascending steep gradients, it is certainly a great desideratum to obtain some form of locomotive which shall afford the necessary hold upon the rail without involving costly arrangements, such as those involved in the construction of engines, having wheels working in a horizontal plane, gripping a central rail.

Electro-magnetism is now applied to increase the adhesion between the wheel and rail, and it is stated to yield results showing a gain of 40 per cent., but at present we hardly consider that the invention has been in use sufficiently long to warrant our giving any decided opinion as to its practical utility.

ON THE DETAILS OF WATER WORKS.

(*Continued from page* 200.)

In designing a dam or reservoir the first point to determine is the size and form requisite to withstand the pressure which may be brought to bear against it, of course calculating upon the greatest which can possibly occur.

Let us assume the height of the embankment above the level of the ground to be 10ft., then the hydrostatic pressure against it will be represented by the area of a triangle, of which the height is 10ft. and the length of base equal to the pressure of water, 10ft. below its surface, which is

$$62{\cdot}32 \times 10 = 623{\cdot}2\text{lbs. per sq. ft.}$$

and the area of the triangle, according to the ordinary rule, is

$$623{\cdot}2 \times \frac{10}{2} = 3116\text{lbs.}$$

which represents the total pressure upon each foot length of the embankment. As this force may be regarded as concentrated at the centre of gravity of the triangle which represents its intensity, the overturning moment will be found by multiplying the force by one-third of the height of the bank. Thus, if M = overturning moment.

$$M = 3116 \times \frac{10}{3} = 10386{\cdot}66.$$

This must be resisted by the moment of gravity of the dam about its outer edge. Of course, the bank must be made much stronger in proportion, than would be requisite, merely to balance the overturning moment. Suppose, for instance, we determine to make its resistance twice as great as the pressure on it; let R = the moment of gravity of the bank, then must

$$R = 10386{\cdot}66 \times 2 = 20773{\cdot}33.$$

This moment for one foot length of the embankment will be found by multiplying the weight per cubic foot of the material of which it is constructed by the area of its cross section in square feet, and by the distance in feet from the centre of gravity of its section from its outer toe measured horizontally.

Let h = height of bank in feet, b = breadth at top, B = breadth at bottom, then its sectional area

$$= h. \left\{\frac{B - b}{2}\right\} + h\, b$$

$$= \frac{h}{2}\left\{B + b\right\}$$

Let w = the weight of bank per cubic foot, then the total weight per foot length of the dam

$$= \frac{w\, h}{2}\left\{B + b\right\}.$$

We must next find the horizontal position of the centre of gravity of this mass. Let b' = the horizontal position from the centre of the breadth b of the top of dam to its outer toe. Then the distances of the centres of gravity horizontally from that point will be—

$$\text{for the outer slope} = \tfrac{2}{3}\left\{b' - \frac{b}{2}\right\} = \tfrac{1}{3}\left\{2\,b' - b\right\};$$

$$\text{for the centre part} = b'$$

$$\text{for the inner slope} = \tfrac{1}{3}\left\{B - b' - \frac{b}{2}\right\} + b' - \frac{b}{2}$$

$$= \frac{B}{3} - \frac{b'}{3} - \frac{b}{6} + b' + \frac{b}{2}$$

$$= \tfrac{1}{3}\left\{B + 2\,b' + b\right\}.$$

Let w = 60lbs. per cubic foot, then the moments of resistance to overturning will be if b = 4ft.

$$\text{for outer slope} = \frac{h\, w}{2}.\left\{b' - \frac{b}{2}\right\}.\tfrac{1}{3}\left\{2\,b' - b\right\}$$

$$= \frac{10 \times 60}{2}.\left\{b' - \frac{4}{2}\right\}.\tfrac{1}{3}.\left\{2\,b' - 4\right\}$$

$$= 200\,b'^2 - 800\,b' + 2400$$

$$\text{for the centre of part} = w\,h\,b\,.\,b' = 60 \times 10 \times 4 \times b'$$

$$= 2400\,b'$$

$$\text{for inner slope} = \frac{w\,h}{2}\left\{B - b' - \frac{b}{2}\right\}.\tfrac{1}{3}\left\{B + 2\,b' + b\right\}$$

let B = 10ft., then the last equation becomes—

$$= \frac{10 \times 60}{2}\left\{10 - b' - \frac{4}{2}\right\}.\tfrac{1}{3}.\left\{10 + 2\,b' + 4\right\}$$

$$= 11600 + 200\,b' - 200\,b'^2$$

Summing the three moments of resistance, we obtain for the value of R—

$$R = 1800\,b' + 14000$$

But it has been shown that if the bank is to offer a moment of resistance equal to double that of the pressure,

$$R = 20773{\cdot}33;$$

wherefore,

$$1800\,b' + 14000 = 20773{\cdot}33$$

$$b' = \frac{20773{\cdot}33 - 14000}{1800} = 3{\cdot}76\text{ft. nearly.}$$

From this number the general section of the dam may be determined; for because the base of the outer slope

$$= b' - \frac{b}{2} = b' - 2;$$

therefore it is

$$= 3{\cdot}76 - 2 = 1{\cdot}76;$$

and because

$$B = 10,$$

and the base of the minor slope

$$= B - b' - 2,$$

that base will be

$$= 10 - 3{\cdot}76 - 2 = 4{\cdot}24\text{ft.}$$

In this case the slope of the bank is much smaller than is usual, but the case has been taken for illustration of the amount of stability necessary to resist the overturning force only.

The next point to be considered is the resistance to sliding of the courses or layers of material in the embankment one upon the other, and this will be regulated by the weight of the bank and the friction between its courses or layers.

The co-efficient of friction for masonry upon clay is about 0·5, therefore to *balance* the pressure of the water, the bank should not be less than double in weight the pressure of the water upon it. In the above case the pressure of the water per foot run of the dam is 3,116lbs., and the weight per foot run of the dam is,

$$= \frac{w\,h}{2}\left\{B + b\right\} = \frac{60 \times 10}{2}\left\{10 \times 4\right\} = 42{,}000\text{lbs.}$$

thus giving ample resistance to the sliding tendency.

(*To be continued.*)

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

BIRMINGHAM MEETING, 1865.

The members of the British Association commenced the business of their Congress in Birmingham on the 6th September, by holding a meeting of the general committee in the Lecture Theatre of the Midland Institute. The chair was occupied by Sir Charles Lyell, Bart, M.A., D.C.L., F.R.S., &c., President of the Association, and there were present a large number of members.

After the minutes of the last meeting, which was held in Bath, had been read and confirmed,

Mr. GRIFFITH (assistant general secretary) read the report of the Council, which proposed the names of the Right Hon. the Earl Dudley, the Right Hon. the Lord Lyttelton, Lord Lieutenant of Worcestershire; A. Follett Osler, Esq., F.R.S.; and the Rev. Charles Evans, M.A., Head Master of King Edward's School, as vice-presidents of the present meeting; and the Rev. G. D. Boyle, M.A., as local secretary. The Council had added to the list of corresponding members the names of the following foreign men of science, who had been present at meetings of the association:— M. E. Hébert, Dr. Arnold Moritz, Herr Neumayer, M. Vámbéry, D. Welwitsch. The Council announced with deep regret that the prolonged illness of Mr. Hopking rendered him unable to continue his valuable services in the office of general secretary.

The report was received on the motion of the chairman.

Mr. SPOTTISWOODE, the treasurer, read the financial statement, which showed that during the year the sum of £3,831 19*s*. 1*d*. had been received, and £3,072 16*s*. 7*d*. expended, leaving a balance of £759 2*s*. 6*d*. in the hands of the general treasurer.

The meeting confirmed the appointments recommended in the reports of the Council, and elected the presidents, vice-presidents of sections, and secretaries.

The Recommendation Committee having been appointed,

Dr. HUNT moved, in pursuance to notice given by Mr. Carter Blake at Bath last year, in his unavoidable absence, that a separate section be set apart for anthropology. In moving the resolution Dr. Hunt went into his reasons for so doing at some length. He did not think the objection, that by passing his resolution the number of sections would be increased beyond what could be accommodated, ought to influence the meeting to negative the proposition, because arrangements could easily be made by which this difficulty could be obviated. He trusted that his resolution would be carried.

Sir EDWARD BEECHER seconded the motion, not so much because he understood anthropology, as because he wished all classes of the scientific community to have fair play. (Hear, hear.)

Sir RODERICK MURCHISON, as the representative of the Council, said he was authorised to move a direct negative to the resolution which had been moved by Dr. Hunt. He had as profound a reverence for the science of man as Dr. Hunt or any of his associates; but from the foundation of the British Association it had been found necessary to restrict their sections to seven. He therefore thought, as an old President of the Association, that they would not de well to depart from their fundamental rules, and recommended the members of the Anthropological Society, if they wanted to push forward their science, to hold a separate and distinct conference of their own. Sir Roderick concluded by saying that Professor Owen, who was a great authority on the science, had expressed an opinion that a new section was not necessary.

It was ultimately resolved, on the motion of Professor Phillips, seconded by Mr. Darwin Galton, "That in future, all proposals for establishing new sections, altering the title of existing ones, or making any other change in the constitutional forms and fundamental rules of the Association, be referred to the Recommendation Committee for a report." Professor Phillips explained that his resolution was not directed against any of the motions just negatived by the meeting, but was brought forward on broad grounds, and with a view to prevent hasty, and perhaps faulty legislation.

After a few remarks the late President resigned his position to Professor Phillips (the President elect), who opened the proceedings of the Association for the new session by an address, referring to the progress of science up to the present time.

SECTION A.—MATHEMATICAL AND PHYSICAL SCIENCE.

PRESIDENT.—Mr. W. SPOTTISWOODE, M.A., F.R.S., &c.

The meeting of this Department was held in the Classical School, King Edward's Grammar School.

After an address from the President of this Section,

Mr. Fleming Jenkin read the report of the Electrical Standards Committee. It described the steps which had been taken with a view of obtaining an unvarying standard, and the subsequent distribution of coils, each expressing the British Association standard of electrical resistance. If these coils retained their value some confidence might be felt in the permanence of the unit they had arrived at. There were differences in the unit obtained by silver wire, &c., and the unit obtained by means of mercury, but it might be expected these differences would eventually disappear. The coils had been distributed widely, so that they would be available to actual electricians, and the telegraph companies had the opportunities of using them. The unit had been introduced into India and our Colonial possessions, but it would take long before it was adopted on the Continent. The committee were able, at least, to report one positive result of their labours. Although much remained to be done, and they had undertaken to issue five different units, they had at last issued one.

The President, in thanking Mr. Jenkin for the report from the committee, suggested that as there were two other papers on a similar subject, discussion on it should be postponed till they had been read.

REPORT ON LUMINOUS METEORS.

Mr. James Glaisher read a report on "Luminous Meteors." He said the subject included the familiar appearance of shooting stars and fiery balls, and it was one which, long neglected, yet merited the consideration of those best able to speculate upon it. But few such appearances had been observed during the past year, partly owing to the presence of clouds, and partly to the absence of certain of the meteors usually seen in January, April, and August. A set of maps had been completed for the use of the committee, and they were presented with that report. Various instances were given of the appearance of meteors, and reference was made to the sound caused by them, a phenomenon which, it was hoped, would be explained by continued observation. Mr. Newton conjectured that these meteors were not fragments of old worlds, but that they were composed of matter out of which new worlds were forming. The committee hoped the grants would be continued, so to enable them to add to the catalogue of nearly 2,000 meteors contained in the maps of the Association. Accounts were then rendered of different "fiery balls" which had been observed, and Mr. Glaisher concluded by referring to some of the details given in the appendices.

THE SECOND LAW OF THERMO-DYNAMICS.

Professor Rankine read a paper on "The Second Law of Thermo-Dynamics." This had reference to the quantity of energy which was converted from the form of mechanical power into heat; or from the form of heat into mechanical power. Professor Rankine went into the question of molecular motions, and said, in reference to the hypothesis of molecular motions, that his object was to show how the law was brought out.

TELEGRAPHY.—THE ATLANTIC CABLE.

Mr. Sabine read a paper "On a New Method introduced by Messrs. Siemens, of Measuring Electrical Resistance." Mr. Sabine said the invention was devised for a very important purpose, and he proceeded to explain the manner in which the object sought was effected.

Mr. Siemens also added some words on the same subject.

The President having called for the next paper, which was also connected with the subject of telegraphy,

Mr. Hooper introduced his paper "On India-rubber as an Insulator for Telegraphic Conductors." In a certain stage of India-rubber manufacture, and under certain conditions, it became susceptible to decay; but there were means of securing a perfect insulation by India-rubber, and it had peculiar qualities which made it specially suitable for telegraphic cables. Twenty per cent. more messages could be sent by a cable insulated with India-rubber, than could be sent by one insulated with gutta-percha. The subject, therefore, had an important bearing in a financial point of view, as well as in other respects. Mr. Hooper said he had some lengths in section on the platform, and he proceeded to exhibit the same to the meeting.

Mr. Siemens expressed his concurrence with Mr. Hooper's remarks on the value of India-rubber insulation, as compared with that of gutta-percha. Difficulties had hitherto been found in the application of India-rubber to the purposes of cables, and it would be interesting to the section to know how Mr. Hooper had overcome them. Gutta-percha was inferior to India-rubber to the purposes of cables, and especially at the ordinary pressures, but in laying deep cables they had not had confidence enough to trust to it.

Mr. W. Fairbairn stated it as his opinion that gutta-percha was to be preferred to india-rubber for insulation. He had found, at a very high pressure, the conductivity was improved with gutta-percha insulation to what it was at a less pressure. He did not know the nature of the improvements in india-rubber, but if they could get an insulator that would improve by pressure at great depths it would be of great importance. One fact he found in his experiments was, that gutta-percha was closed much tighter upon the conducting wires at great pressure.

Mr. Fleming Jenkin also made some remarks on the subject. He said gutta-percha did not change when it was laid down at the bottom of the sea, and where gutta-percha was sound it remained sound. Referring to the Atlantic cable, Mr. Jenkins said he was one who believed the cable would be put to rights again. It was not owing to failure in the materials that the cable failed, but to a mechanical accident.

The President said he was not aware that any one connected with the Atlantic telegraphic expedition was in the room, or he should call upon him, to say some words on the subject. Being informed that Mr. Cyrus Field was in the room, he apologised to that gentleman for overlooking him, and called on him to speak on the subject.

Mr. Cyrus Field said he had no idea he should be called on to speak. It was much easier after an accident to find fault with the arrangement which had been made than it would have been to have remedied that fault before unforseen circumstances discovered it. It was very much easier to criticise a book written by some one else than to write that book ourselves. The Atlantic cable had failed. The causes were well-known, but that they would be remedied, and that they were on the eve of a great success, he had no doubt. There were present two gentlemen who had contributed months, and he might say years, of their valuable time to decide what materials were best to use for an Atlantic cable; and, after more than twelve hundred miles of that cable had been paid out, only one single thing caused an accident to it. The men on board the *Great Eastern* attributed it, some to accident, and some to design. One of the mechanics in the tank remarked to him, "It was one of us seventeen that caused the accident." But it seemed to him that, whether caused by accident or design, they had power to arrange things so as to prevent a recurrence of failure. There would be, in the next expedition, improvements made upon the previous arrangements, and it was a great satisfaction to know that everybody on board of the ship felt perfectly confident that the next attempt would be successful, and that they would be able not only to lay down another cable at the bottom of the Atlantic, but to recover the old one. Instead of talking about the subject himself, he would much prefer that the Atlantic cable should speak for itself.

MOVING PHOTOGRAPHIC PICTURES.

Mr. Glaisher read M. Claudet's paper "On Moving Photographic Pictures." The paper detailed the means by which this curious effect was accomplished, and the President expressed his hope that M. Claudet would exhibit his apparatus at the *soirée*.

A NEW FORM OF SPECTRUM MICROSCOPE.

Mr. H. C. Sorby described briefly his "New Form of Spectrum Microscope." He said he intended to explain it in the evening, and should only then draw attention to some of the leading facts. He mentioned its powers and uses in several instances, and amongst others said that in detecting blood marks they could employ it to detect the most minute stains: even of the millionth part of a grain they could have a perfect view.

Mr. Glaisher, as President of the Microscopical Society of London, acknowledged the importance of Mr. Sorby's invention.

THE CONDUCTION OF HEAT.

Professor J. D. Forbes gave some details of experiments he had made at the expense of the Association, with a view of finding a better means of estimating the loss of heat in metallic bars by radiation. The subject had occupied his attention for the last fourteen or fifteen years, and was a very old problem. He had reported in 1852 on the progress he had then made in his experiments, and he now came forward to explain what he had done since in that respect. He had, without reference to either the precise mathematical laws or physical laws on which such estimates had been based by different philosophers, sought to determine the loss of heat from a given bar by direct experiments, and without necessarily inquiring what the precise law is. At the same time they could not be quite regarded as conclusive, and he would be very glad if some member of the Association would extend the experiments.

On the conclusion of Professor Forbes' remarks, Mr. Fleming Jenkin suggested that as iron with which the Professor had made his experiments could seldom be procured pure, copper might be procured with greater advantage.

PHENOMENA OF VOLTAIC BATTERY.

Mr. Gassiott read a paper "On Changes of Form and Colour which the stratified discharge assumes when a varied resistance is introduced in the circuit of an extended Series of the Voltaic Battery." He said that the battery with which he attained his results, consisted, when completed, of 4,000 insulated glass cells, and, in lieu of sulphate of copper, as used by the late Professor Daniel, a table spoonful of sulphate of mercury was introduced into each cell. Zinc plates were then introduced into the cells, which were subsequently filled with rain water. When one wire was inserted in the water, and the other touched the moistened surface of the glass, but was not in actual contact with the water, a luminous discharge was observable, filling the entire tube without any sign or appearance of stratification. On depressing the wire, discs of red light were rapidly produced from the positive pole; and on further depression, the discs receded, and disappeared one by one until nineteen remained, which were much indensed in brilliancy and distinctness. On further depressing, there were other singular effects produced.

The Chairman thought the public, as well as the British Association, should thank Mr. Gassiott for what he had accomplished, as no one before him had been able to produce such results.

DIVING SPECTACLES.

Mr. Francis Galton read a paper "On Spectacles for Divers, and on the Vision of the Amphibiæ." In the outset of his paper he facetiously alluded to the fact that in the programme for the day contained in the journal of the Association, he had been announced to discourse on "visions of amphibæ" instead of "on the vision of the amphibæ." Expressing his utter inability to say whether that class of animals possessed the faculty of dreaming dreams, or seeing visions, or to judge of their nature, if they did so, he went on to remark on the possibility of human beings having provided for them means of seeing objects clearly when under water. He said those who had surmounted the usual repugnance of beginners to keep their eyes open under water found if they did so nothing was to be seen with distinctness—everything they could see at all was seen through a haze, so that if the hands were held out to a distance of eight inches before the face, it would be impossible to discover the space between the fingers even if they were spread out as widely as possible. If he looked through a tube into a vessel of water perfectly still he saw all the objects at its bottom with perfect distinctness, only a little out of their position through refraction. But upon lowering his head he found that the instant his eye touched the water all distinctness vanished—the convex surface of the eyeball had indented the plane surface of the water, and turned the tube into a convex lens. If they desired to counteract this they must use a convex lens of such power that its effect should be exactly opposite to that of a concave water lens. A lens to answer that purpose he had made and now produced. Furnished with spectacles on such a principle they might see as well under water as on dry land, though he had found from experience that a lens of that description had not much power of accommodating itself to distance. He hoped in the future to go more into the question. Men going down in diving bells did not require such aid; through the plate glass inserted in the diving dress, they could see as clearly in the water as any one might see all that was in an aquarium by looking through the glass of which it was composed. He designed his contrivance to be useful to the pearl diver, to the sailor requiring to examine a ship's bottom, to men seeking in the water anything they may have lost there, and to bathers generally, to whom he promised that the possession of these spectacles would add much to their enjoyment. They would find they had acquired a new power. With respect to the amphibæ, he thought their power of accommodating the vision was wholly inexplicable by any theory he had heard promulgated. The hippopotamus, otters, water rats, and diving birds of various descriptions, saw as well on land as in water. The cornea of the seal appeared to be very fat, but it was far otherwise with the rest of the amphibæ.

Mr. Mansfield Ingleby thought that dogs must have the same powers as many of the animals mentioned of adjusting their vision, as it is well known they fished with perfect accuracy. He had been told by Professor Jukes that he had seen a dog fish for half an hour, during which time he had caught a multitude of fish at a very great depth. From his own experience he should think Mr. Galton had under-estimated the power of the human eye to adjust itself to various distances.

Mr. F. F. Clark said he observed that the curvature of the lens was a constant one, but as the curvature of the eye differed at different times, it should not be so.

The Chairman suggested that Mr. Galton might organise an excursion under water during the meeting, to prove the efficacy of his contrivance.

THE POLES IN MAGNETS.

Captain SELWYN read a paper on "Some new arrangements of the Poles in Magnets," in which he said one phenomena connected with magnets was, there might be, and often was a succession of north and south poles in a bar magnet. He described an experiment he had made with regard to the subject. A steel bar having been prepared, and hardened as usual, it was magnetised by any ordinary means—either by touch or an electric current. Then either at the centre or at any other point of the bar, where it was desired that the two poles should eventually be in juxta-position, and even in more than one place, the temper was taken out of the bar by a rod of heated metal, or by a blow-pipe, this operation separating the two magnets, though the needles were still respectively north and south.

THE MOON AND ITS HEAT.

Mr. Harrison read a paper on "The Heat attained by the Moon under Solar Radiation." After referring to various theories on that subject, Mr. Harrison expressed his opinion that a small maximum of heat having been detected in the course of researches into the question made by Professor Smythe at Teneriffe, justified the assumption that the moon's radiant heat was expended in dispelling cirri cloud and vapour before it reached the earth's surface. The heat of the moon at the last quarter, or a day or two after entering that phase, seemed to be greater certainly than when at the full.

The Chairman suggested that Dr. Lee, who was thoroughly acquainted with all that concerned the moon, might give the section some information on the point.

Dr. Lee said enquiries had been made into the question, but they had not yet extended so far as to enable him to state anything for the information of the section on that point.

The section then adjourned to Monday morning, other two papers being on the programme for the day, but the authors of both were absent.

SECTION B.—CHEMICAL SCIENCE.

PRESIDENT.—PROFESSOR W. A. MILLER.

Dr. W. A. Miller, of King's College, presided over this section. He was supported by Dr. Hoffman, late of the Royal College of Chemistry; Dr. Gladstone and Dr. Williamson, University College; Professor Rowney, Galway; Professor Abel, Woolwich; Mr. Isaac Lowthian Bell, ex-Mayor of Newcastle; Dr. Dabenny, Oxford; Mr. Grace Calvert and Mr. Andrews, Belfast; Mr. Stevenson, Mr. M'Cadam, Warner, De Da Rue, Sir Robert Kane, Professor Wanklyn, Mr. H. S. Sorby, and Professor Voelcker.

New Form of Spectrum.

Mr. H. C. Sorby described a new form of spectrum apparatus, as applied to the microscope. The details of the arrangement were not fully described, as the author would have an opportunity of explaining them better at the *soirée*, when the instrument would be exhibited. The prisms used formed what was called a direct vision prism, and consisted of five prisms—three of crown glass, having their bases touching at the edges and in the same plane, and two of flint glass, with their apices fitting between the bases of the crown glass prisms. The arrangement is most suitable for a binocular microscope. The apparatus he had found particularly useful in discriminating the character of blowpipe beads.

In reply to Dr. Gladstone, Mr. Sorby stated that the minute bands were most readily seen by means of this apparatus.

Compounds of Copper and Phosphorus.

Mr. F. A. Abel read a paper on the compounds of copper and phosphorus. This paper was devoted to the description of a series of experiments made to ascertain if phosphorised copper would be more effectual as a material for the manufacture of cannon than the alloy in general use. After refering to the different chemical compounds of copper and phosphorus known, Mr. Abel spoke of his experiments on phosphorised copper, with respect to its tensile strength. He found that an ingot of copper one inch in area broke under a strain of about 25,000lbs., that of a similar ingot of gun metal required 32,000lbs. Whilst copper combined with ·5 per cent. of phosphorus required 38,389lbs., and with 1·4 per cent. phosphorus the strain that the ingot would bear was upwards of 47,000lbs. Although these experiments showed the very superior tenacity of the phesphorised copper, yet there were practical difficulties which prevented the application of this compound to gunnery. In the course of the discussion which followed the reading of this paper, Mr. Abel stated that this phosphorised copper would not be at all suitable for telegraphic purposes, as the presence of phosphorus was most detrimental to the metal as a conductor of electricity.

Silicium in Iron.

Dr. Phipson's paper on this subject was read by the Secretary of the Section, Mr. Winkler Wills. It was well known that silicium existed in cast iron, not only in the free, but also in the combined state. Dr. Phipson had been led to examine the subject of silicium in iron from the fact that he found several samples of iron, which were reported as yielding very different qualities of Bessemer steel, to be of precisely similar chemical composition, and following up the subject, he came to the conclusion that the difference in the quality of the steel arose, not from differences in the total quantity of silicium, but from the manner in which it occurred, as free or combined. This matter was of great importance, as the author was now enabled to determine, by ascertaining the amount of combined silicium, as to the suitableness of an iron for the manufacture of Bessemer steel, that iron which yielded the smallest quantity of combined silicium being most suitable for this purpose. Mr. Abel said that had Dr. Phipson been present, he would have been glad to have heard in what manner that gentleman distinguished between combined and uncombined silicium.

Captain Noble stated that no iron was so deficient in tensile strength as hæmatite iron, but he had determined that this weakness was not due to the silicium the metal contained.

In reply to a question by Mr. De la Rue, Mr. Bell stated that borax—an element very closely allied to silicium—had not been found in any analysis of iron, and that the character of an iron would vary very much, although precisely similar materials were used in its production.

Dr. Miller suggested the spectroscope should be used, in order to determine the presence of barium, the lines given by this element being very characteristic.

Vesuvius.

A paper by Dr. Phipson, on the sublime oligist of Vesuvius, and its artificial production, was then read. At the commencement of this paper, the author referred to the variations in the quantities of oxide of iron found in the products of the eruptions of Vesuvius at different times. The fact of the presence of oxide of iron was accounted for by Misterlich, on the assumption that chloride of iron was sublimed, and afterwards converted into oxide. An experiment the author had made showed clearly that oligist was produced by the action of an alkaline chloride on oxide of iron. The experiment consisted in placing, at the bottom of a crucible, a layer of chloride of ammonium, and upon this was a layer of powdered hæmatite. On subjecting these materials to an intense heat, oligist was found sublimed on a vessel placed within the crucible, the characters of the mineral corresponding with the sublimed oligist of Vesuvius.

Sponges.

A third paper, prepared by Dr. Phipson, "On Sponges, as a source of bromine and nitrogen," was read. The author stated that seaweeds assimilated a considerable amount of iodine, and but little bromine; while sponges yielded a certain quantity of bromine, and but little or no iodine. The amount of bromine yielded by sponge varied from 1 to 2 per cent., and the amount of nitrogen from 15 to 16 per cent.

Determining Carbonic Acid in Air.

Dr. Angus Smith described the new apparatus for determining the quantity of carbonic acid in the air. The apparatus consisted of a bottle, in which one tube passes to the bottom of the bottle, and through which the air to be tested is passed, while the other serves merely as an exit tube, the bottle being filled with a given quantity of baryta water, air is forced through the baryta water until a certain density of precipitation is produced. Now, the quantity of carbonic acid will evidently be measured by the quantity of air forced through, in order to produce a precipitate of the same density. The quantity of air forced through the baryta water is measured by a very simple contrivance. A ball of india-rubber, similar to a child's ball, is connected with the tube dipping into the baryta water. Now, if the ball be squeezed in the hand, the air it contains will be forced through the water. By repeating the process a second ball full of air may be seen through the water. With practice the air sent in in one operation is constant, and by noticing the number of "ball-fulls" of air required to produce the standard precipitate, the quantity of carbonic acid is determined. An arrangement of valves enables the operation of forcing the air through the water to be readily and continuously performed. This method was extremely convenient for determining the state of air in rooms, coal mines, &c., and enabled one readily to judge of the efficiency of ventilation.

Dr. Miller said that the process of Dr. Angus Smith did not at first sight appear to possess that accuracy which was desirable in chemical operations, but he was assured that with practice a great degree of accuracy could be attained.

Dr. Russell inquired how the absolute amount of carbonic acid was determined, to which Dr. Smith replied that it could be done by determining the amount of carbonate of soda required to produce a precipitate of a certain degree of density in a solution of chloride of barium.

Bath Waters.

Dr. Williamson explained the method he had adopted in analysing gases evolved from the waters of the mineral springs at Bath. This investigation was undertaken at the suggestion of Dr. Daubeny, and at the request of members of the Association, with a view of ascertaining if the gases evolved from mineral waters are constant, or subject to variation. Although there are four springs at Bath, the gases of which it was considered desirable to analyse, there were difficulties in making examination of all the springs. A detailed account of the method followed was then given. The water was collected and transmitted to London, where the gases were transferred to an eudiometer and examined. Dr. Daubeny had made an examination of these waters some thirty years ago, and the results of the analysis of Dr. Williamson corresponded closely with those of Dr. Daubeny; the principal difference being in the detection of marsh gas in the latter analysis.

Dr. Miller, in thanking Dr. Williamson, referred to the care with which the analysis was conducted, and called upon Dr. Daubeny.

Dr. Daubeny, in the course of his remarks, referred to the presence of nitrogen, and stated that the element was found in mineral springs by Priestley, and also referred to the bearing of chemical analysis of mineral springs on theories as to the origin of the volcanic action.

Dr. Frankland referred to the liberation of carbonic oxide by pyrogallic acid when used for the absorption of oxygen, and inquired if this evolution of gas had been taken note of in Dr. Williamson's analysis.

Dr. Williamson said that the quantity of carbonic oxide evolved was so small in comparison with the quantity of oxygen present that it was not necessary to take notice of it.

In reply to a question by Dr. Russell, Dr. Grace Calvert stated that he had made numerous experiments on the quantity of carbonic acid evolved by pyrogallic acid, and perhaps the most important result was that the quantity of carbonic oxide increased with the temperature at which the absorption was made.

Acids on Metals and Alloys.

Dr. Crace Calvert read a paper on some experiments he had been making for the last twelve months as to the action of acids of different strengths, upon metals and alloys. He said that much interest must attach to this subject in this town, where metals were so much worked. The first experiments tried had reference to the action of sulphuric acid on zinc. The first point he had paid attention to was the purity of the zinc employed, securing the metal always in the same state, *i.e.*, seeing that the surface shall be perfectly clean. He found that on taking pure monohydrate of sulphuric acid and the pure zinc, he obtained no action. There were 2, 3, and even 4 equivalents of water, still no action was produced. When, however, 6 or 7 equivalents of water were present, the action was slight. On warming the acid a great increase in the action took place. At a temperature of 150° C. he found that 386 drachms per square metre were dissolved, while if the acid contained 3 equivalents of water, 9,083 drachms were dissolved. He also observed, that, under such circumstances, sulphuretted hydrogen was given off, while in other sulphurous acid was formed, this latter substance only being produced when the amount of water exceeded one equivalent. The difference between hydrated acid containing 6 equivalents of water and that containing 7 equivalents was very striking.; for with the former only 561 drachms were dissolved, while with the latter 7,633 drachms were dissolved. With respect to the action of sulphuric acid on tin he had not observed anything that it would be necessary to note, excepting that sulphuretted hydrogen was evolved in the action.

As regards the action of sulphuric acid on copper, he found that the monohydrated acid dissolved 1,420 drachms, while the bihydrate dissolved only 13 drachms.

If an alloy were made of 1 equivalent of zinc and 1 equivalent of copper, the monohydrated acid at a temperature of 150° C. dissolved 1,155 drachms. By varying the proportions of the metals other results were obtained.

In the course of the discussion Dr. Hoffman referred to the secondary products obtained when acting upon tin by nitric acid, and stated that a body having the composition H_3 NO was produced capable of combining with the acid, but which was subsequently reduced, forming a series of secondary products.

Parkesine and its Properties.

A paper on this subject was read by Owen Rowland, Esq., Electrician to the late joint committee of the Board of Trade and the Atlantic Telegraph Company, enquiring into the construction of submarine telegraph cables, &c. Parkesine is so called after its inventor, Mr. Alexander Parkes, of this town, the well-known discoverer of the cold process of vulcanisation of Indian rubber, spoken of in such very high terms by the late Mr. Thomas Hancock. This material (Mr. Rowland stated) is suitable for a great variety of purposes, possessing properties kindred to india-rubber and gutta-percha; it can be produced of any colour or shape, and can be manipulated in almost every conceivable manner. The basis of the material Parkesine is gun cotton, but a variety of other materials are used. These materials were exhibited: they consisted of various solvents, cotton waste, oils, &c. Various articles, manufactured from Parkesine, were shown, and its various applications thus proved. A cotton which is not readily explosive is desirable in the manufacture, iodine and chloride of zinc being used to prevent the rapid combustion of the cotton. Mr. Parkes's solvent is suitable for the solution of india-rubber, gutta-percha, and various gums; and by mixing these substances in various proportions, the different varieties of Parkesine are made. The author then referred to the value of Parkesine as an insulating material for telegraphic purposes, considering it far superior to india-rubber and gutta-percha, or to any combination of materials hitherto used. The strength of the material is considerable, a cable of it being capable of supporting one mile in length of its own substance, whilst sound joints can be made with the greatest facility. The following table, showing the comparative value of Parkesine and other substances, with respect to the sustaining of insulation, was shown:—

	Loss of insulation. deg.		min.	sec.
Parkesine	5	in	1	45
Plain gutta-percha	5	in		37
Gutta-percha and Chatterton's compound ...	5	in	1	8
Plain gutta-percha covered with Parkesine ...	5	in	1	4
India-rubber (masticated)	5	in	1	13
India-rubber (virgin)	5	in		30
Ebonite disc	5	in	2	10
Parkesine disc	5	in	2	35

Dr. Miller thanked Mr. Rowland for his paper on Parkesine, but thought that more experiments must be made before the character of the material as an insulator could be decidedly stated.

UTILISATION OF SLAG.

Dr. F. G. Finch read a paper on the utilisation of blast furnace slag, describing the method adopted abroad to effect this object. Having referred to the various attempts that had been made in this country to economise the slag, he stated that the method pursued abroad was to run the slag into pits about 8ft. or 9ft. in diameter, and then allow the whole to cool slowly; when quite cool the slag was removed and cut by masons into the forms required for paving. The material was used as paving-stone at Metz, and also in some parts of Paris, and appeared to be superior to the grit stones generally used. In consequence of the area required in order to allow of the cooling of the slags it was scarcely likely that this method would be adopted in England, more especially as good paving-stone was generally accessible.

PHOSPHATIC NODULES IN NORTH WALES.

Dr. A. Voelcker read a paper "On Phosphatic Deposits in North Wales." After speaking of the importance of phosphatic deposits to agriculturist, and of the present sources of minerals and substances containing phosphates, a description of these Welsh deposits was given. Although many large beds of phosphates occurred abroad, there were difficulties of conveyance, and it was therefore extremely important that a new source of phosphates in this country should receive attention. The new source of the phosphatic nodules was near Nant Gwynnant, and from analysis which Dr. Voelcker had made, he thought the discovery of importance.

THE ORGANIC ACIDS.

A paper was read by Dr. Frankland on the constitution of the acids of the acetic, lactic, and acrylic series. Dr. Frankland referred to the views of that which had been held on the constitution of these acids, and stated that he considered from recent experiments made by him that the proper formula for these bodies was that which represented them on the ammonia type thus:—

Acetic acid.	Lactic acid.	Acrylic acid.
$C\,2\left\{\begin{array}{l}H'\\H'\\H'\\O''\\OH'\end{array}\right.$	$C\,2\left\{\begin{array}{l}H'\\H'\\OH'\\O''\\OH'\end{array}\right.$	$C\,2\left\{\begin{array}{l}H'\\CH''\\O''\\OH'\end{array}\right.$

Dr. Hoffman, who, in the absence of Dr. Miller, presided, said that he listened with very great interest to the paper of Dr. Frankland, and referred in very high terms to the value of that gentleman's researches.

Professor Wanklyn objected to the formula adopted by Dr. Frankland, as it did not explain certain reactions.

A paper, by Dr. J. E. de Vry, was read, on "The Possibility of Manufacturing Neroli in the British Colonies."

A paper, by Professor Wanklyn, and also one by Dr. Price, were postponed until the next meeting of the section.

The Chairman, in closing the proceedings of the day, said that the section would adjourn until Monday next, at eleven o'clock.

SECTION C.—GEOLOGY.

PRESIDENT, SIR RODERICK I. MURCHISON, K.C.B.

Upon the platform were Sir Charles Lyell, Bart., Professor Jukes, F.R.S., Professor Harkness, F.R.S., Rev. W. Symonds, Dr. P. O. Callaghan, Herr von Decken, C. Moore, F.G.S., W. Saunders, C. Twamley, H. Woodward, &c.

DRIFTS AND RIVER BEDS OF SILURIA.

The first paper was read by Rev. W. S. Symonds, President of the Malvern Field Club, "On some Ancient Drifts and Old River Beds of Siluria." The Forest Cromer period in the deposition drift remains is not represented by any stratified deposits in the West of England. At that time England was a portion of the continent of Europe; and when the elephant, rhinoceros, hippopotamus, &c., were among the existing animal forms. The first evidence of glacial history in Wales consists in the indications of depression during the marine glacial periods, to the extent of above 2,000ft. We have evidence that ice action was in full vigour during the period of submergence. Professor Ramsay has described three periods of glaciation in Wales, during the first of which the land was much higher than it is now, and great glaciers filled every valley; secondly, a period of submergence; and thirdly, the time when the land assumed its present aspects, but the cold was much greater than it ever is now in our latitude. Glaciers also formed in this period, and in sweeping down the valleys ploughed out the boulder drift previously deposited. These alternations of level were brought about gradually, so that long after the higher Welsh mountains were elevated above the water the glacial seas would flow over lower surfaces and above rocks which were not raised into dry land until a later period: and hence we have patches of northern drift, containing boulders and Arctic shells, and which is now found scattered over the counties of Cheshire, Stafford, and Worcester. This drift, hower, does not appear west of the Severn, the Silurian drifts of this period being derived from local rock formation. Later geological researches have proved that the glacial period was protracted long after the mountain districts of Great Britain were elevated to the heights they now occupy above the sea level. A great amount of the transported matter found scattered over Siluria doubtless was carried by means of land ice and snow moving down the valleys and hill slopes, and this land-ice agency doubtless lasted a considerable time after the country was elevated. Deposits formed by this agency appear to exist on the plain east of the Malvern hills, and in hundreds of places in Wales. Siluria also contains remains of ancient river drifts and valley gravels formed by the action of rivers carrying a greater volume of water than any of the present streams do. There are well marked high and low level gravels. Ancient river terraces may be seen in nearly all the principal valleys of Siluria, especially in the great vale of the Severn.

ST. MICHAEL'S MOUNT.

Mr. W. Pengelly, F.G.S., read a paper on "The Insulation of St. Michael's Mount, Cornwall." The author alluded at length to the ancient records of this place, and controverted the theory that its insulation was due to the erosive action of the waves. He is of opinion that the land has been gradually depressed, and he brought forward detailed evidence in support of his views.

COALBROOKDALE.

The Rev. W. Purton read a paper on the "Geology of Coalbrookdale." The point most worthy of notice in this coalfield is the estuarine or fluviatile character of many of its strata, as evidenced by their organic remains, while others seem clearly of marine origin, from which it has been inferred that the coal measures of this field were deposited in an estuary in which flowed a large river, subject to periodical floods. Chief among the organic remains must be noticed the remarkable crustaceans allied to the king crab. Remains of insects are also found. The thickness of the coal measures increases towards the eastern limits of the field, and higher beds come in, while the strata thin out towards the west and south-west, where the land lay close, round which all but the uppermost beds of the carboniferous rocks seem to have accumulated. Part of the Silurian and Old Red Sandstone, south of Coalbrookdale, and west of Bridgnorth and the Forest of Wyre, formed land during the deposition of the lower coal measures, and slowly sunk as the carboniferous rocks were formed. Near Steeraway, on the road from Wellington to Ironbridge, the mountain limestone is exhibited. Further down the dale the millstone grit comes in, and reposes upon the underlying Wenlock shale. This last forms the floor of the valley. The limestone forms a band 160ft. in thickness, resting on a bed of trap, which has been traced for a great distance underneath the coal measures. The limestone disappears altogether towards the eastern side of the field. At Benthall Edge the Wenlock limetone comes in, and extends in the direction of Wenlock. Along the whole escarpment numerous characteristic fossils may be obtained, particularly Silurian corals. Lincoln Hill, on the eastern side of the dale, is an isolated patch of Wenlock shale and limestone. The drift deposits of Coalbrookdale are highly interesting, and have been well worked out by Mr. George Maur. It was from an examination of these beds and the shells found in them that Mr. Maur was enabled to prove what had before been conjectured only, that the Severn Valley was, during a portion of the great glacial epoch, a marine strait. The true coal measures are well explored in several places. At Lightmoor Wood, near the Institution, for instance, the Little Flint coal and Clod coal; while below are six different seams of coal, much contorted, but containing the Pennystone ironstone, and other characteristic beds. The fossil remains of the district are exceedingly interesting.

The President, in thanking Mr. Purton for his paper, observed that the detailed description of this coal field and the locality would be specially valuable to those who proposed to visit the district.

GEOLOGY OF NORTH WALES.

The next paper read was "On an Extensive Distribution of Deposits of White Clay and Sands in North Wales, antecedent to the Boulder Clay Drift," by George Maur, F.G.S. In North Wales there is an entire absence of any recognised deposits of an age between that of the Lias and the Boulder Clay, but there exists a series of strata older than the clay, as determined by the evidence of superpositive and mineral characters. These deposits may be described as isolated patches of quickly alternating strata of white sands and light-coloured pipe clays, occupying pockets in the limestone. The strata are either conformable to the coucave form of the cavaties, or placed almost vertical. There are various localities where these deposits occur, as near Llandudno, Great Orme's Head, at the back of the Conway mountains, in the neighbourhood of Holywell, Mold, &c. These deposits are all unfossiliferous, but closely resemble the Tertiary beds of Dorsetshire. The various isolated patches doubtless once formed a connected deposit, and their preservation is due to the excavation of cavaties in the limestone after the deposition of the strata. The series of geological events implied by the foregoing facts, would be—Firstly, the deposition of the white clay and sand strata any time since the principal erosion of the mountain limestone, which took place probably during the Permian period; secondly, the partial excavation of the pockets by watery dissolution of the limestone and the gradual lowering into them of the pre-existing deposits; thirdly, the erosion of the great mass of the formation not protected in the cavities: fourthly, a continued excavation and deepening of the cavities after the boulder clay period.

Marine Shells at Lilleshall.

Mr. C. J. Woodward, of the Midland Institute, read a paper on "A Deposit, near Lilleshall, Salop, containing recent Marine Shells." The field in which these remains have been discovered is situated at Fox-hill, about a mile and a half from Lilleshall, near to the Donnington Station. The general appearance is a mound, about 30ft. high, composed of gravel and sand. On the north side an opening has been made, and marine shells are found in this sand. The mound rests upon Permian beds. The gravel is composed of fine pebbles of granite, lias, mountain limestone, chalk, &c. The dip of the sands is greater than that of the underlying beds. Many of the pebbles are subangular and perforated. The height of the mountain is 463ft. above mean sea level, no similar deposit appearing to exist nearer than at Bushbury, which seems to be about the same height above the sea as the one at Fox-hill.

Mr. Gwyn Jeffries having examined the fossils, stated that they were of Artic type. The discovery of these beds was important, as extending our knowledge of the remains of the drift of the period.

The Lake Country.

Professor Hawkins and Mr. H. Nicholson made certain additional observations on the geology of the Lake Country. A new graptolite has recently been added to the fauna of the Skiddaw slates; also several new crustaceous shells have now been discovered in these slates. Many important discoveries have been made in the physical geology of the Lake Country, particularly with reference to the lines of fault which intersect the district. He demonstrated that the Wenlock and Llandovery rocks are wanting in Cumberland, though it had previously been supposed that representatives of these formations exist there.

This completed the business of the section. The papers generally were of high scientific interest, and the attendance at the section was very numerous.

The South Staffordshire Coalfield.

The first paper was read by Mr. Samuel Bailey, Walsall, on "The Economic Value of the various Measures of Coal and Ironstone in the South Staffordshire Coalfield." The minerals produced in this district are doubtless amongst the most valuable in the United Kingdom. The ironstone measures, together with the seams of coal, form a mixture from which iron of a superior quality can be made, and have placed this foremost among the iron-making districts of the country. To give some idea of the vast productiveness of a particular locality of this coalfield, it may be mentioned that the coal and ironstone gotten there realised a commercial value of above £20,000 per acre. This was, however, in the days of South Staffordshire's greatest prosperity. In referring to the various measures of coal and ironstone, the coalfield may be divided into five parts, in order to show more clearly the distribution of the respective measures, as they do not uniformly exist over the whole area of the coalfields, and in some instances where they are the same seams, they differ very much in position and in quality. The measures particularised are those which are generally worked for the following purposes:—1. For domestic purposes. 2. For making gas. 3. For manufacturing purposes. Division No. 1: The northern boundary of this southern division is formed by a line drawn from West Bromwich, through Tipton and Deepfields, to the western fault, near Sedgley. The following coal and ironstone measures exist under this division: Brooch coal, thick coal, gubbin ironstone, heathen coal, white ironstone, new mine coal. The total thickness of these beds is 43ft. representing a value of £28,000 per acre. The brooch coal is of very superior quality. It is used exclusively for domestic purposes, and has always realised a high price. It is a favourite coal in Birmingham, and the counties of Worcester, Gloucester, and Hereford; but the supply is now very limited, and the variety known as the Cannock Chase deep coal is supplying its place. The thick coal is composed of ten or more beds, to which different names are applied. The following are the sub-divisions:—Roofs coal, top slipper, white coal, lambs and tow coal, Brazils, foot coal, John coal, stone coal, slipper, and sawyer benches. The first four of the above, together with the slipper and sawyer, are the purest and of excellent quality, and are adapted to the most delicate manufactures of the district. This coal is used raw or uncooked for smelting in the blast furnaces. The Brazils is in much request for use in reverberatory furnaces, for which it is well adapted. The heathen coal is of very fine quality, and is the best for making gas, and is used raw for smelting purposes. It is also the best coking coal of the coalfield. The new mine coal is much inferior in quantity.

Division No. 2.—The southern boundary is formed by the line describing the northern boundary of No. 1 division, and the northern boundary by a line from West Bromwich through Wednesbury, Darlaston, to the North of Bilston, into the western boundary fault, a little to the south of Wolverhampton The measures existing under the division are thick coal, gubbin ironstone, heathen coal, new mine ironstone, poor robins and white ironstone, bottom coal, gubbin or balls ironstone, blue flats ironstone. The brooch coal does not exist in this portion of the district. The new mine and fireclay coal form here a thickness of from three to four yards. The bottom coal is not equal in quality to the new mine coal. The mines in this district have realised a value of from £3,000 to £20,000 per acre, but they are fast being exhausted.

Division No. 3 is bounded towards the north-east by a line drawn from Rushall to Bloxwich, and to Wednesfield Heath. The measures here are heathen coal, brown ironstone, new mine ironstone, yard coal, four feet coal, poor robins ironstone, bottom coal, gubbin ironstone, blue flats ironstone, silver thread ironstone, diamond ironstone. The heathen coal is here much the same as in the central part of the district. The yard coal corresponds with the new mine coal of the former divisions. It is, however, superior in quality, and realises a high price for domestic purposes, making gas, and for smelting. The four-feet coal corresponds with the fire-clay coal. The bottom coal corresponds with this seam in No. 2 division. It is specially adapted for mill and forge purposes, and being the cheapest coal gotten in the district, it is much used in many of the ironworks.

No. 4 Division.—The boundary to the north is marked by a line from Goscote to the neighbourhood of Cannock. The measures are black gubbin ironstone, brown ironstone, cannel coal, beach coal, bottom coal, four-feet coal. This portion of the coal field is of considerable extent and importance, containing many valuable measures of coal and ironstone which have not yet been extensively worked, and which are now being looked forward to for the supply of the ironworks in that part of the field nearly exhausted. The cannel coal is a very superior coal for domestic purposes. The other division consists of the remainder of the coal field extending towards the north. The only important seams here are the yard coal, shallow coal, and deep coal. The area of the last two divisions is equal to about 40 square miles, and at an average estimate contains 300 millions of tons of coal besides ironstone, and, at the annual average produce of 2,500,000 tons, will last one hundred years. The ironstone measures yield about an average of 1,500 tons per acre from each seam.

Duration of the South Staffordshire Coalfield.

The next paper read was by Mr. Henry Johnson, Dudley, "On the Extension and Probable Duration of the South Staffordshire Coalfield." Both the extension and duration of this coalfield are questions open to a very great difference of opinion. If the extent was limited to the at present explored portion of the district, the duration might be tolerably accurately calculated, as all the coals that can be possibly reckoned upon in a descending order in this coalfield have long since been discovered. It is to the confines of the present coalfield, then, that any hopes for fresh supplies can be looked for, and it is a very interesting fact that on all sides of the coalfield explorations are being most successfully carried on, with perhaps the exception of the eastern boundary on Birmingham side. But the great depth at which the thick coal has been last worked in the neighbourhood of West Bromwich (about 400 yards in depth) has probably retarded exploring operations in that direction. The result of operations which are going on in other portions of the coalfield is, however, being looked forward to with great interest, as affording sufficient evidence to warrant an attempt to reach the coals through the Permians at Smethwick and Harborne. During the last ten years, more especially the last five, a great number of new winnings have been made in the north end of Cannock Chase district, as also in the north-east at Aldridge, and at Himley and other places; but probably the most important recent trial sinkings are those on the south end of the coalfield, in the neighbourhood of Hales Owen, Congreaves, Cradley Park, and Wassel Grove. In the event of the one at Hales Owen, belonging to Mr. S. Dawes, and that of Wassel Grove, belonging to Messrs. Geo. Pell and Co., discovering the thick coal—both of which look very promising, and are now sunk to about half way to the coal—more than 4,000 acres of the thick seam may be considered proved, and this assurance will no doubt give a fresh impetus to additional search even further south than those now in operation. Very rapid strides are now being made in developing the thin seams over several thousand acres of previously unexplored ground on Cannock Chase, which is now being intersected by canals and railways in every direction, and having direct communication with the more immediately coal consuming district of the Black Country. These thin seams, however, are speedily exhausted, as compared with the thick coal seam. A scheme for proving the continuity of the coalfield underneath the Permian on the down-throw side of the Great Western boundary fault at Essington, on the property of Mr. H. C. Vernon, is now in course of formation. It is proposed to form a fund for this purpose, by subscription, from all the adjoining landowners likely to be benefited by such a proof, upon the same principle as Mr. Dawes's scheme at Hales Owen. In this case it is proposed to drive from the existing coal workings on the up-throw side the great fault, which lies at a depth of about 200 yards from the surface, across the fault into the Permian district, some 200 or 300 yards horizontally, and then bore up or down in the hope of discovering the position of the coal measures underneath. There is, however, a much more comprehensive scheme for extending the coalfield, and exploring the whole Permian districts lying between the South Staffordshire coalfield and the Warwickshire and Shropshire coalfields, particulars of which may be found in the "Transactions of the Dudley and Midland Geological Society" for June, 1865, p. 37. To attempt to estimate the probable duration of the coalfield, whilst these somewhat important recent additions are being added to it, would be impossible; but it may be observed that such additions are not keeping pace with the enormous consumption and consequent rapid destruction of the parent portion of the coalfield. In a very valuable paper, read by Mr. Mathews, in August, 1860, before the Institute of Mechanical Engineers, at Birmingham, after obtaining the best evidence on the subject, he estimated the then duration of all parts of the coalfield at an average of about forty years from that period. There can be no doubt but that in one-half these number of years a very large portion of the earlier developed part of the coalfield will be totally and for ever exhausted, as, for instance, the mines in the neighbourhood of Bilston, Coseley, Tipton, Wednesbury, Oldbury, West Bromwich, Brockmore, and Brierly Hill, are being fast worked out, and in twenty years hence will be well nigh totally exhausted.

The Chairman thought Mr. Johnson's paper was a very valuable communication. He alluded particularly to the probability of finding the thick coal of South Staffordshire underneath the Permians bounding the district. He had no doubt that the coal will be found all round the coalfield under the red rocks, as was found at Earl Dartmouth's sinkings near West Bromwich, and will be then found of even better quality than it is in the older portion of the field, because in the central part the coal is very much affected by its proximity to the igneous rocks.

MANCHESTER ASSOCIATION FOR THE PREVENTION OF STEAM BOILER EXPLOSIONS.

CHIEF ENGINEER'S MONTHLY REPORT.

The last ordinary monthly meeting of this association was held on August 29th. The chief engineer presented his report, of which the following is an abstract:—

During the last two months 380 engines have been examined, and 688 boilers, and 6 of the latter tested by hydraulic pressure. Of the boiler examinations 490 have been external, 37 internal, and 161 entire. In the boilers examined, 197 defects have been discovered, 7 of those defects being dangerous.

TABULAR STATEMENT OF EXPLOSIONS, FROM JUNE 24TH, 1865, TO AUGUST 25TH, 1865, INCLUSIVE.

Progressive No. for 1865	Date.	General Description of Boiler.	Persons Killed.	Persons Injured.	Total.
29	July 31.	Ordinary Single-flue, or Cornish Internally-fired.	2	1	3
		Total	2	1	3

No. 29 Explosion, which is the only one reported during the past two months, occurred at a marine engine and iron shipbuilder's works, at about twenty minutes before six on the morning of Monday, July 31st. Two persons were killed, and a third injured by the explosion. The boiler was not under the charge of this association.

I had no opportunity of making a personal investigation of this explosion, but have been favoured with a report thereon, accompanied with sketches from an engineer who examined the boiler officially at the request of the coroner, and gave evidence thereon at the inquest. From this it appears that the boiler was of plain Cornish construction, having a single flue, and being internally fired. Its length was 17ft., its diameter in the shell 6ft., and in the furnace tube 2ft. 10½in., while the thickness of the plate was $\frac{7}{16}$in., and the load on the safety valve about 55lb.

The boiler failed from collapse of the furnace crown, which gave way at about 6ft. from the front end or furnace mouth, rending transversely in two places close to the seam of rivets, and also rending longitudinally for half the length of the furnace tube at a seam of rivets running along the crown towards the back end of the boiler. The boiler was not moved from its seating, but from the rush of steam and water that ensued from the collapse, the three men already referred to as injured were scalded, two of whom died several days after.

The collapse was attributed at the inquest to overheating of the furnace crown, in consequence of shortness of water, combined with an injudicious introduction of the feed water. This was admitted near to the hottest part of the fire, which was just where the collapse assumed the greatest amount of depression, and where it appears to have commenced.

Although it is difficult to speak positively, without having made a personal examination, yet there appears ground at least to question the correctness of the above conclusion. The official investigation was not made until a fortnight after the explosion occurred, since the poor men who died from scalding lingered for some days, and there were then no positive indications of the plates having been red hot. The furnace tube was not strengthened either with flanged seams or with T or angle iron hoops, and it is reported that the crown had been damaged through shortness of water some few months previously, when two new plates were put in, and also that the furnace tube was out of shape when the explosion occurred, and had been so for some time; while to this may be added, that it was at that part of the tube which had been repaired at which the collapse assumed the greatest amount of depression, and appears to have commenced. It is thought to be quite possible, therefore, that the distorted shape of the tube, as well as its previous injury and repair, may have been the cause of the explosion rather than shortness of water, although it is not wished to express a positive opinion on the subject, since the boiler has not been personally examined. But without determining whether the explosion resulted from shortness of water, or from weakness of the furnace tube, it may be pointed out that both of these dangers might have been guarded against. Low water safety valves, which relieve the pressure of the steam on the water's falling below its proper level, are a great safeguard against explosions through overheating of furnace crowns. Many of them are attached to boilers under inspection, and work well. Also the furnace flue, although somewhat out of shape, would not have collapsed from simple pressure had it been strengthened with encircling hoops, so that the explosion might have been prevented had the boiler been better made and more liberally fitted. There should also have been a duplicate glass water guage.

No. 8 Explosion.—The boiler, which was not under the charge of this association, was of the plain, single-flued Cornish class. Its length was 32ft., its diameter in the shell 6ft., and in the furnace tube 3ft. 9in., while the thickness of the plates in both was $\frac{7}{16}$in. The furnace flue was not strengthened, either with flanged seams or hoops, &c., neither had the flat end plates of the boiler any gusset or other stays. It was fitted with but a single safety-valve, loaded to 42lbs. on the square inch, and had no steam-pressure guage.

The boiler gave way in the internal flue tube, the crown crushing completely down from one end of the boiler to the other, with the exception of three lengths of plate over the furnace, which remained uninjured. The back end plate was severed entirely from the boiler, and a portion of it, as well as of the flue tube, was blown to a distance of about one hundred yards. The remainder of the shell was unseated, and thrown forward through the firing space to a distance of about 20ft., carrying with it a wall 2ft. thick, and considerably damaging a bed of masonry 5ft. thick.

The explosion was attributed, as it is so usual to do, to shortness of water; a conclusion, however, which it does not appear can be for a moment sustained. The flue tube had not failed at the hottest part over the fire, as it would have done had there been a deficiency of water, but at the back end of the boiler, while the explosion happened when the engine was idle and the damper closed. It has been supposed, again, that the safety valve had stuck, and thus that an undue pressure of steam had accumulated. It is difficult positively to prove that this had not been the case, since there was but a single safety valve, and no steam pressure gauge; but there is no direct evidence of the fact, and the safety valve was found to be perfectly free in its action immediately after the explosion. The key to the explosion will, it is thought, be found in the constructive weakness of the boiler. No flue of so large a diameter as 3ft. 9in., and so great a length as 32ft., should be made without encircling hoops, flanged seams, or other strengthening appliances, while it may be added that the questions that have been raised as to the pressure at the time of the explosion, and which it is difficult afterwards positively to settle, show the importance of fitting every boiler with a duplicate safety valve and a steam pressure gauge.

No. 9 Explosion occurred at an ironworks on March 7th, and by it one person was killed and five others injured. The boilers at these works were not under the inspection of this association.

The boiler was one of a series of eight, which drove two pumping engines at the head of a pit belonging to the works. Seven of these boilers, the exploded one included, were of the plain Cornish class, having a single flue, and being internally fired, while the eighth was of plain Lancashire double-flued construction. The length of the exploded boiler was 28ft., the diameter in the shell about 7ft. 6in., and in the furnace tube—which was not strengthened with hoops or flanged seams, or in any other way—4ft., while the thickness of the plates was $\frac{7}{16}$in., and the blowing-off pressure about 50lbs. on the square inch.

The explosion occurred at the furnace tube, which collapsed from one end to the other, moving the boiler several feet from its seating, and scattering the brickwork to a considerable distance.

The cause of the explosion is very simple, and one to which constant reference has to be made in these reports, as in No. 8, just referred to above. The boiler, as well as the six others of the Cornish class, had been made on the works, and were altogether ill-designed. A plain flue of so large a diameter, as was the one in question, is not safe at a pressure of 50lbs., though it might easily have been made so had it been strengthened with hoops, or with flanged seams, or with other approved appliances; though it would have been wiser in a shell of so large a diameter to have put in two flues instead of one, and thus have exchanged the Cornish for the Lancashire construction.

At the inquest the evidence was of the too frequent unsatisfactory and contradictory character. One witness, a boiler maker, who had been in the habit of repairing the boilers, stated that he could not in any way account for the explosion. He considered that the boiler which had burst was in as good a state of repair as a boiler could be, and strong enough to have resisted double the pressure. Another witness considered the boiler would have borne 100lbs. on the square inch, and attributed the explosion, as is usual under these circumstances, to shortness of water, although it was shown in evidence that there was a depth of 15in. above the furnace crown at the time of the collapse. The managing engineer of the company, who had been engaged on the works for fifteen years, had examined the glass gauges about five minutes before the explosion, and found plenty of water in the boilers. He could not give an opinion as to the cause of the explosion. He considered the tube strong enough for a pressure of 50lbs. on the square inch, and that it had not collapsed from weakness. He had every confidence in the boilers, and added that he would have been prepared to sleep upon them.

Such evidence as this upon a fatal explosion from the collapse of a flue tube 4ft. in diameter, may excuse the almost wearisome repetition with which attention is called in these reports to the true cause of these collapses, and the simple means of preventing them.

No. 26 Explosion, 1864.—By this explosion, which occurred to a boiler not under the inspection of this association, seven persons were killed and seven others injured. On account of its fatal character it excited a great deal of interest in the neighbourhood in which it took place, and was attributed to overheating of the furnace crown through shortness of water. The dimensions of the boiler, and general particulars of the explosion, were briefly given in the report for November last year, but since there had been no opportunity of making a personal investigation, a final opinion upon the cause of the explosion had to be postponed for further particulars. From those already obtained, however, it was ventured to express the expectation that, upon full investigation, it would be found that the explosion was due, not to shortness of water as generally supposed, but to weakness of the boiler. I am now kindly furnished with a copy of the official report by two engineers appointed by the Government to investigate the cause of the explosion and report thereon, and find that in this report the explosion is attributed to weakness of the furnace; while it is added that there were none of the usual indications in the boiler of there having been a short supply of water at the time of the explosion. This explosion, therefore, is another of those due to mal-construction, aud might have been prevented by the adoption of encircling hoops or flanged seams.

RIFLED ARTILLERY.

The report of the Ordnance Select Committee which conducted the trial of the competitive guns rifled on three different systems contains the exact results of the experimental practice with each gun. Those results are noted so minutely in the tables appended to the text of the report, that every shot fired can be referred to. As the trial has ranged over three years, it may be supposed that the tables and diagrams make up the greater portion of the volume.

The experiments to which the first part of the report refers were made with 7in. wrought iron guns, rifled on the French system, and the competing systems of Commander Scott, R.N., Mr. Lancaster, Mr. Jeffery, and Mr. Britten. On these weapons the committee make the following remarks:—

"The difference between the systems of Messrs. Jeffery and Britten consisted substantially in the method of attaching lead to the base of the projectiles, and one gun only was prepared for these two gentlemen. The French gun was added at the request of the committee. The committee, warned by the experience of the former competition, determined on this occasion to limit the trial strictly to the rifling of the guns, and they therefore endeavoured to eliminate all other sources of difference, and themselves fixed a uniform weight and form and windage of shot, and also the charges of powder. Mr. Lancaster's shot are slightly shorter than the others, because the committee had previously determined that the term '7in.' gun should mean a gun down which a 7in. spherical shot could be rolled, and under that definition the internal sectional area of an oval bored gun must necessarily be larger than that of a grooved gun of the same nominal calibre. The committee would gladly have confined the competition to the same amount of twist, but it was clear that the expanding projectiles of Messrs. Jeffery and Britten would be unfairly treated if fired from a gun with as sharp a spiral as would suit the other competitors; and, moreover, the French system is that of an increasing twist, while that of the others is uniform. They therefore allowed each competitor full latitude in this respect."

The following paragraph gives a more detailed description of the guns:—

"The guns are muzzle-loading. They have solid steel tubes 3in. thick, a solid forged breech piece, and external strengthening coils. Their weight averages 149cwt., and the length of bore is 10ft. 6in. Cammell's steel is used in Scott's, Lancaster's, and the Jeffery and Britten guns, and Firth's steel in the other. They are vented 5·75in. from the end of the bore, being the position to give the greatest initial velocity with a charge of 20lb."

The shot used were solid, weighing 100lb. and 110lb. The powder used was A4, and the cartridges were made up to an uniform diameter of 6in. and five-tenths. The charges varied in weight from 12lb. to 25lb.

The following are stated as the "general results" of the trial:—

"Lead-coated expanding projectiles.—A very short experience showed that the systems of Messrs. Jeffery and Britten were unsuited for heavy charges; large pieces of lead were blown off the shot, and the shooting was so wild as to throw these systems entirely out of the competition.

"Endurance.—About 350 rounds have been fired from each gun. This is insufficient to test the endurance of guns such as these, but it is sufficient to indicate that with steel-lined guns there need be no fear of the breaking down of the grooving by the abrasion of the ribs or studs in either of these systems; at all events when in Commander Scott's system soft bearings are used. The committee can see no reason at present for placing one gun before the other in point of endurance.

"Easiness of loading.—The French gun was certainly the easiest to load; but there is nothing to complain of in this respect in Commander Scott's gun. Mr. Lancaster's shot were all got home with more or less difficulty, and in some cases a metal rammer had to be used.

"Liability of the projectiles to injury from rough usage.—None of these descriptions of shot are liable to injury from knocking about, but the Lancaster should take the first place in this respect, Commander Scott's first plan the second place, the French shot on Palliser's system the third, and Commander Scott's second plan the last.

"Recoil.—There seems no practical difference between the guns in this respect. In the early part of the trial the Scott gun had the greatest recoil, but on an exchange of carriages with the French gun, their places in this respect were reversed."

There is no difference worth mentioning in the cost of rifling on these three systems. The report thus concludes:—

"Commander Scott's gun has the advantage of both the others in point of range with round shot, but is very much inferior to both in uniformity of range and accuracy. It is worthy of remark that the charge of 20lbs., which is nearly half the shot's weight, gives an increase of velocity of only 271ft., and only 200 yards, or thereabouts, of additional range, over the charge of 12lbs., which latter charge, with the small windage allowed, gives a considerably higher velocity than that of the service 32-pounder or 68-pounder shot. The committee have now placed the Secretary of State in possession of all the data that are requisite for comparing these five systems of rifling as applicable to heavy battering guns using a charge of one-fifth or one-fourth the weight of the shot. The gun rifled on the French system, with arrangement of the studs suggested by Major Palliser, gives by far the best result, so far, in point of accuracy, the trial not having proceeded beyond solid shot of the forms and weights specified. It was the easiest to load, and although somewhat inferior to Commander Scott's gun in respect to firing round shot, is in every other respect equal or superior to it. The committee also prefer it to Lancaster's, although Mr. Lancaster has subsequently shown how, in his opinion, his shot may be made very easy to load without increase of mean windage, by taking the windage allowed chiefly off the third quadrant of the shot. The committee are confirmed in the preference expressed above by the superiority which the French system of rifling evinced over the former plans of the same gentleman when tried in rifled cast iron 32-pounder guns in 1862. For reasons already given, they reject both the systems of lead-coated projectiles as unsuitable for heavy charges."

THE ARCHITECTURAL MUSEUM, SOUTH KENSINGTON MUSEUM.

Prizes for Art-Workmen.

The following competitions for the Session 1865–66 are open to all *bonâ fide* art-workmen, whether members of the Architectural Museum or not.

The Council of the Architectural Museum offer a first prize of £20, a second prize of £5, and a third prize of £2 (the latter given anonmously through the President), for the most successful carvings in stone of a subject from Flaxman's illustrations of Dante, entitled, "The Triumph of Christ." The carving to be in low relief, and on a panel 1ft. 3in. high, by 1ft. 10in. wide.

It should be understood that the council, in selecting the above illustration, do not insist upon the exact reproduction of every line in the composition, nor will it be absolutely necessary thas the whole of the figures in the background should be represented. Each competitor may treat the subject as he may think best, provided that the outline of the figures, &c., is adhered to, and the spirit of the general composition carried out.

N.B.—The employment of a hard, close-grained stone, if not of marble, is strongly recommended, soft stone being inapplicable for low relief.

A lithograph of the subject may be had by enclosing six penny postage stamps and a stamped envelope, bearing the address of the applicant, to the honorary secretary of the Architectural Museum, Joseph Clarke, Esq., 13, Stratford-place, London, W.

The Council of the Architectural Museum offer a first prize of £15 for the best, and a second prize of £5 for the next best rendering in wood of a poppy-head not less than 10in. high and carved on both sides. The carving to be executed in oak, and finished from the tool, without sand-paper, the use of which will disqualify any specimens for a prize.

A sketch of the subject for competition may be had by enclosing six penny postage stamps and a stamped envelope, bearing the address of the applicant, to the honorary secretary of the Architectural Museum, Joseph Clarke, Esq., 13, Stratford-place, London, W.

The Council of the Architectural Museum offer a first prize of £15 for the best, and a second prize of £5 for the next best reproduction of the head of the statue of Germanicus in *repoussé* or bossed up silver. The head to be taken from the reproduction of the statue sold by Mr. Brucciani (see copy in the Educational Museum at South Kensington), and to be of the same size. The head may be made in two or more parts soldered together. If so, particular notice will be taken of the solder joints. It is distinctly to be understood that the entire head, "in the round," or in full relief, is required; and that the work is to be executed entirely by hand, no portion being cast.

Casts of the head of Germanicus can be had by addressing a letter to the honorary secretary of the Architectural Museum, Joseph Clarke, Esq., 13, Stratford-place, London, W., enclosing 2*s*. in penny postage stamps, or 3*s*. 6*d*. if packing and case is necessary. The casts need not be returned with the works sent in competition.

A prize of £10, given conjointly by the Ecclesiological Society of London, and its president, Mr. Beresford Hope, is offered for the reproduction in translucid enamels, on a flat "plaque" or plate of silver, of the figure of S. Barbara, ascribed to Nino Pisano, and marked 7451 in the statue or sculpture collection at the South Kensington Museum. The height of the figure to be 2¼in., and the style of the enamels to resemble those on the dishes in the art collection, numbered 106 (65) and 107 (65), and the triptych numbered 7148. The ground to be enamelled as well as the figure.

It is to be observed that although the original example is in high relief, the reproduction desired is to be in the usual style of the ancient translucid enamels, so that the silver chasing which receives the enamel will be in extremely low relief, the object of the committee being to induce a facility of translating from one style of work into another. The silver plate itself may be of any shape, but it is not to exceed 2¾in. in its greatest diameter.

Casts of the relievo figure of S. Barbara can be had by addressing a letter to the honorary secretary of the Architectural Museum, Joseph Clarke, Esq., 13, Stratford-place, London, W., enclosing 5*s*. in penny postage stamps, or 7*s*. if packing and case be necessary. The casts need not be returned with the works sent in competition.

A prize of £10, given by Mr. Ruskin, is offered for the reproduction of the same figure in opaque enamels on copper, similar to those of the chasse No. 2231, the altar cross No. 2332, and the two plaques Nos. 2191 and 2192, at South Kensington. The background of the figure is to be gilt, and the metal may be either plain or chased or engraved in a diaper pattern. The height of the figure to be 6in.

For information as to casts of the figure, see above.

The adjudication of both the prizes for enamels will be conducted by the committee of the Ecclesiological Society, conjointly with Mr. Ruskin, Mr. J. C. Robinson, and Mr. W. Burges.

The pattern enamels are exhibited in the first case in the Central Gallery of the South Court of the South Kensington Museum.

The Council of the Architectural Museum offer a first prize of £10 for the best, and a second prize of £5 for the next best panel filled with marble mosaic work, without figures or animal life, suited to architectural decoration. Any foliage introduced must be treated conventionally.

The works must be designed by the competitors, and must not be larger than 1ft. 6in. by 2ft., nor less than 1ft. by 1ft. 6in. in size.

GENERAL CONDITIONS AND DIRECTIONS.

In addition to the above prizes, certificates of merit will be given in deserving cases, and the council of the Architectural Museum may, at their discretion, award the sum of £1 1s., or upwards, or a book, for objects showing merit, although not sufficient to secure a prize, and this they reserve power of doing whether or not they adjudge a prize in the class. It must be distinctly understood that none of the prizes will be awarded unless there appear sufficient merit in any of the specimens to entitle them to such distinction. The judges reserve to themselves the power of combining, reducing, or dividing any of the prizes, according to their discretion.

All objects sent in competition for the prizes must be deposited at the office entrance of the South Kensington Museum, free of cost, by March 1, 1866.

If sent in a parcel it must be addressed to "The Honorary Secretary of the Architectural Museum."

The specimens must bear a distinctive mark or motto only, and somewhere on the front of the specimens, if convenient.

They must each be accompanied by a letter sealed with a blank seal, and having on the outside the title of the particular competition, viz.:—"Wood carving," "Transparent enamel," "Mosaic competition," &c., and also the same mark or motto as that on the specimen. Inside the letter must be given the full name, address, and occupation of the competitor, with those of his employer, if any.

The specimens and letters must not be sent to the private address of the honorary secretary.

The objects will remain the property of the art-workmen or their employers, and will be exhibited in the South Kensington Museum until after the day of the distribution of the prizes, and also in such other places as the Council of the Architectural Museum may see fit.

Although great care will be taken the council will not be responsible for any accident or damage of any kind occurring at any time to the specimens sent in.

They must, after their exhibition, be removed by or at the expense of the respective competitors within one month of notice being given, after which they cannot be taken charge of.

CORRESPONDENCE.

We cannot hold ourselves responsible for the opinions of our Correspondents.

ENGINE POWER FOR STEAMERS.

To the Editor of THE ARTIZAN.

SIR,—As the formula you give in your Notices to Correspondents for September, page 208, is the result of an investigation of mine, I beg leave to state some precautions which must be observed in the use of it, to prevent disappointment:—

1. The length of the trochoidal lines of the aflex-body ought to be not less than that given by Mr. Scott Russell's rule, viz., $37\frac{1}{2}$ft. for 10 knots, and for other speeds as the square of the speed.

2. The ship's bottom ought to be clean.

3. If paddle-wheels are used, they should be feathering; and the screw, or paddle, should be properly proportioned to the vessel.

In the factor between brackets, L^2 has been printed instead of l'^2.

I am, Sir, your most obedient servant,

W. J. MACQUORN RANKINE.

Glasgow, September 2, 1865.

REVIEWS AND NOTICES OF NEW BOOKS.

Engineering Facts and Figures for 1864. Edited by ANDREW BETTS BROWN. London and Edinburgh: A. Fullarton & Co., 1865. 424 p.p. 8vo.

A great desideratum in the library of an engineer is a compendious collection of those discoveries and results of experience which from time to time are made known through the medium of the scientific periodicals, in which of necessity the permanently valuable matter is associated with much which, though at the time of its publication professing qualifications which render it useful, nevertheless is but ephemeral. The selection and compilation of such articles as may be always capable of affording valuable information is a work requiring great care and judgment. The volume now before us possesses all the qualifications requisite to render it perfect. Criticism would be out of place, as the work is a compilation; so we shall conclude this notice by recommending Mr. Brown's work to the profession.

A Treatise on Gas Works. By SAMUEL HUGHES, C.E. Second edition. Revised by W. RICHARDS, C.E. London: Virtue Bros. & Co. 1865. 328 pp. 8vo.

This work is an improved edition of Mr. Hughes' treatise on the same subject in Weale's rudimentary series: as giving a general outline of the ordinary practice of gas engineers it will be found useful.

Road Locomotives: an Epitome of the New Road Locomotive Acts. By THOMAS AVELING. London: E. and F. N. Spon. 1865.

Mr. Aveling's pampblet presents, in a compendious form, the various features of the Road Locomotive Acts, and cannot fail to prove extremely useful to all interested on the subject of steam traction on common roads.

NOTICES TO CORRESPONDENTS.

TYRO (Newcastle).—The best water meters with which we are acquainted are those manufactured by Messrs. Guest and Chrimes. We have several years experience of their action, and find that they register the quantity of water passing through them within about three per cent.

G. DAIMEAU (Harburg).—To reduce a base line measured on any part of the earth to its corresponding line at the level of the sea, multiply the length of the measured line by 21,008,000, and divide the product by that amount plus the height in feet above the level of the sea of the locality in which the base line is measured.

G. M.—To find the super elevation of the outer rail on a curve, multiply the gauge of the rails in feet by the square of the velocity of the train in miles per hour, and divide by the radius of the curve in chains and by 397·5

CREOSOTE.—In answer to your query we find that the price of the tar was $1\frac{1}{2}d.$ per gallon, carriage to distillery about $\frac{1}{2}d.$, carriage to railway, &c., about another 1s. 8d. The naphtha was fetching 1s. 9d. per gallon, creosote $2\frac{1}{2}d.$, and asphalte 35s. per ton. The retorts were of clay, and the coal used of poor quality.

G. H. (Newcastle-on-Tyne).—The rule given in our last issue for strength of cast iron cylinders is not quite applicable for such as are intended to bear very high pressures, for when the metal becomes thick in proportion to the diameter, the interior surface is strained more than the exterior, so that the strength is not most advantageously applied. For thick cylinders the rule is more complex, but we purpose giving an analysis of it in our next number.

PRICES CURRENT OF THE LONDON METAL MARKET.

	Sept. 2.			Sept. 9.			Sept. 16.			Sept. 23.		
	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
COPPER.												
Best, selected, per ton	89	0	0	89	0	0	89	0	0	89	0	0
Tough cake, do.	86	0	0	86	0	0	86	0	0	86	0	0
Copper wire, per lb.	0	0	$11\frac{1}{2}$	0	0	$11\frac{1}{2}$	0	0	$11\frac{1}{2}$	0	0	$11\frac{1}{2}$
,, tubes, do.	0	1	$0\frac{1}{4}$	0	1	$0\frac{1}{4}$	0	1	$0\frac{1}{4}$	0	1	$0\frac{1}{4}$
Sheathing, per ton	91	0	0	91	0	0	91	0	0	91	0	0
Bottoms, do.	96	0	0	96	0	0	96	0	0	96	0	0
IRON.												
Bars, Welsh, in London, per ton	7	15	0	7	15	0	7	12	6	7	12	6
Nail rods, do.	8	10	0	8	10	0	8	10	0	8	10	0
,, Stafford in London, do.	8	15	0	8	15	0	8	10	0	8	10	0
Bars, do.	8	15	0	8	15	0	8	12	6	8	12	6
Hoops, do.	9	17	6	9	17	6	9	15	0	9	15	0
Sheets, single, do.	10	10	0	10	10	0	10	10	0	10	10	0
Pig, No. 1, in Wales, do.	4	10	0	4	10	0	4	10	0	4	10	0
,, in Clyde, do.	2	15	9	2	17	6	2	17	6	2	17	6
LEAD.												
English pig, ord. soft, per ton	19	5	0	19	5	0	19	5	0	19	5	0
,, sheet, do.	20	0	0	20	0	0	20	0	0	20	0	0
,, red lead, do.	22	0	0	22	0	0	22	0	0	22	0	0
,, white, do.	26	0	0	26	0	0	26	0	0	26	0	0
Spanish, do.	18	10	0	18	10	0	18	10	0	18	10	0
BRASS.												
Sheets, per lb.	0	0	$8\frac{1}{4}$	0	0	$8\frac{1}{4}$	0	0	$8\frac{1}{4}$	0	0	$8\frac{1}{4}$
Wire, do.	0	0	$8\frac{3}{4}$	0	0	$8\frac{3}{4}$	0	0	$8\frac{3}{4}$	0	0	$8\frac{3}{4}$
Tubes, do.	0	0	$9\frac{1}{2}$	0	0	$9\frac{1}{2}$	0	0	$9\frac{1}{2}$	0	0	$9\frac{1}{2}$
FOREIGN STEEL.												
Swedish, in kegs (rolled)	13	0	0	13	0	0	13	0	0	13	0	0
,, (hammered)	15	0	0	15	0	0	15	0	0	16	0	0
English, Spring	18	0	0	18	0	0	18	0	0	18	0	0
Quicksilver, per bottle	8	0	0	8	0	0	8	0	0	8	0	0
TIN PLATES.												
IC Charcoal, 1st qu., per box	1	10	0	1	10	0	1	10	0	1	10	0
IX ,, ,, ,,	1	16	0	1	16	0	1	16	0	1	16	0
IC ,, 2nd qua., ,,	1	7	0	1	7	0	1	7	0	1	7	0
IC Coke, per box	1	3	0	1	4	0	1	4	0	1	4	0
IX ,, ,,	1	9	0	1	10	0	1	10	0	1	10	0

RECENT LEGAL DECISIONS

AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

UNDER this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding mouth, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful applicatiou to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least—less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

LIABILITY UPON CHEQUES OBTAINED BY FRAUD.—Where a person, by means of a false pretence, or promise which he does not fulfil, procures another to give him a cheque in favour of a third person, to whom he pays it, and who receives it *bona fide* for value, the person who gives the cheque remains liable upon it—for the drawing of a cheque *prima facie* imports value and liability—and the drawer can only relieve himself from his liability to pay tbe person who has received the cheque by showing that he is not the holder for value, or that he received it with notice of the fraud, or otherwise not *bona fide*. This was the holding of the Court of Exchequer Chambers in the case of Watson *v.* Russell.

DELEGATION OF AUTHORITY.—Public officers cannot delegate their powers, and, therefore, a third person, though acting with their license and permission, and under the superintendence of their surveyor, cannot justify himself for acts creating a public nuisance, although the acts so done are within their statutory powers, and would he legalised if done by themselves. This was holding of the Court of Queen's Bench, in the action Head *v.* Bush, brougbt to recover compensation for an action caused by an alteration in the level of a footway made by the defendant in the course of paving it. The defendant pleaded in justification that the work done by him was so done without any negligence on his part, aud with the license and permission of the District Metropolitan Board of Works, under the superintendence of their surveyor, and in accordance with the provisions of the Act 18 and 19 Vict., cap. 120. The Lord Chief Justice said the discretion given by the Act is one confided to a public body for public purposes, and cannot be delegated.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of henefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

THE PYRAMIDS OF EGYPT.—Mahmud Bey, Astronomer to the Viceroy of Egypt, has published an interesting treatise, with the view of proving their dates from their connection with Sirius, the "Dogstar." The late Viceroy Said Pasha ordered him to work out this problem. He found the exact measurement of the largest to be 231 mètres at the base, and 146.40 from the ground to the apex. Hence follows that the sides are at an angle of 51° 45′. Mahmud Pasha found that the angles of the other three pyramids, near Memphis, were on an average inclination of 52°. The fact that the sides of these monuments are placed exactly true to the four quarters of the globe, seemed to point to some connection with the stars, and Mahmud Bey found Sirius sends his rays nearly vertically upon the south side, when passing the meridian Ghizeh. He then found, on calculating hack the exact positions the star occupied in past centuries, that the rays of Sirius were exactly vertical to the south side of the Great Pyramid, 3300 B.C. Sirius was dedicated to the god Sothis or Toth Anubis, and hence the astronomer deduces, that the Pyramids were built about 3300 B.C.—a date nearly coinciding with Bunsen's calculation, who fixes the reign of Cheops at thirty-four centuries before Christ.

THE GREAT BELL, BIG BEN.—Mr. Thomas Walesby corrects a mistake into which many persons have been led respecting the treatment adopted in the case of Big Ben the second at Westminster palace. He says that though the bell is still imperfect, lacking grandeur and richness of tone—a somewhat gong-like sound being emitted, instead of the proper fundamental note—it has, nevertheless, improved under the treatment of Messrs. Mears. To the question, "What has been done to this cracked bell—has the so-called 'drill and saw' remedy been applied to it?" he answers "Certainly not;" and gives the following statement:—When Big Ben formerly told the hours he was struck regularly by a monster clock-hammer of about 7½ cwt. or 8 cwt., the blow of which produced "a shock enormously greater than that of a clapper, and supposed to he greater than was ever before given to a bell." And thus poor Ben was cracked. Now the principal crack in the bell was found to he diametrically opposite to the hammer. In order, then, that the metal might be partially relieved from strain at the places intersected by the cracks, Messrs. Mears turned the bell about 3ft. and substituted a new clock-hammer, not exceeding 4 cwt., for the old one of 8 cwt. The result, Mr. Walesby goes on to say, unquestionably is, Big Ben speaks out in a more agreeable and continuous tone, though still defective, than he ever did when subjected to the blow of the old mouster hammer.

DOCKYARD ACCOUNTS.—A report has heen prepared by the Accountant-General of the Navy, showing the measures which have been adopted since 1859 for the improvement of dockyard accounts. An account is now annually presented to Parliament stating the expense incurred in the year upon the several ships building, altering, and repairing, and the cost of every ship building. There are also presented the halance-sheets of manufacturing operations in the several workshops and timber conversion accounts. After inquiries instituted by Mr. Stansfeld in the autum of 1863 an annual survey valuation of timber and stores, and a continuous record of the receipts and issues were ordered to be made; and accounts were ordered to he kept on a basis of shipbuilding upon sectional arrangements, to facilitate comparison between the dockyards and the private trade. In the autumn of the following year Mr. Childers continued the inquiries commenced by Mr. Stansfeld, and the result was that a committee was appointed, which has recommended a weekly return of expenditure upon every ship, to enable the Controller of the Navy to exercise a full and prompt supervision over the economy of the various operations in the dockyards and the gradual absorption of the Parliamentary grant; instructions for this purpose are now in operation. The committee were to be engaged this autumn in revising all the books and forms in use in the dockyards. The accounts of the expenditure in the home victnalling yards have also heen subjected to investigation by a committee; and the valuation, expense, and manufacturing accounts of these yards, prepared in the manner which has been approved by the committee, will be laid before parliament. A committee of practical officers has been engaged this year in inquiries, with the view of enabling a comparison to be made of the cost of manufactures in the dockyards with that of productious in private trade, and investigating the difference in the cost of similar produce in the several yards; and revised instructions for keeping the manufacturing and conversion accounts have been issued. It is intended in future to present to Parliament the three following balance-sheets:—A plant account, showing the value of land, buildings, and premises, repairs, replacements, and alterations; a stock valuation account, giving the value of remains of stock of timber and stores on hand, and of receipts and issues in the year, and depreciation or enhancement of value of stock; and a general halance-sheet, or expenditure and production account for ships, services, and conversions. Thus will be shown the extent and value of the works executed, and the amount of the expenses with which they should be charged, in accordance with the principles of account observed in the commercial world.

PROGRESS OF HULL.—In 1821 Hull contained 9,004 houses; in 1831, 11,888; in 1841, 13,927; in 1851, 18,428; in 1861, 20,581; and in June, 1865, 24,768. In 1821 the number of inhabitants was 44,965; in 1831, 54,112; in 1841, 67,095; in 1851, 82,502; in 1861, 96,509; and in June, 1865, 117,648. In 1836 the rateable value of property in Hull was £176,559; in 1861, £231,504; and in 1864, £280,000. In 1836 the burden of the vessels frequenting the port of Hull upon which dock dues were levied by the Hull Dock Company was 503,165 tons; in 1860, 1,215,203 tons; and in 1864, 1,216,815 tons. The value of the goods exported from Hull in 1859 was £12,980,587; in 1863 it had increased to £13,556,254.

NEW SCIENTIFIC PROJECTS.—Among the recent scientific discoveries in France may be mentioned a method invented by M. Neaute for keeping afloat a vessel about to sink, and putting out any fires that may happen to break out on board. His plan is to attach a certain number of balloons made of india-rubber and inflated with air, to the sides of the sinking vessel. M. Chattenmann proposes to render vessels externally incombustible by whitewashing the wood with chloride of lime. This, he thinks, would prevent the rapid propagation of the flames, and allow sufficient time for extinguishing them.

THE FOLLOWING PROCESS OF ENCAUSTIC is given by M. Bocklin:—Moist plaster of Paris is painted with water colours as usual. When the design is perfectly dry, it is painted over with a hot solution of wax and resin, and this coating is burnt in with a strong heat. The wax sinking in fixes the colour, and gives together with its compound with resin a solid transparent surface which effectually protects the painting from injury by damp or dust, the colours at the same time being greatly heightened and improved.

THE QUANTITY OF IRON IN BLOOD.—M. Pelouze has been making investigations respecting the quantity of iron contained in the blood of various animals. He finds that the blood of birds contains, per ten thousand parts by weight, from three to four parts of iron, and that the blood of man, and that of mamiferous animals generally contains from five to six parts of iron per ten thousand parts of blood.

COMBUSTIBLE MUD.—At the proceedings of the Asiatic Society of Bengal lately, Major Risely described a combustible mud, which exists in large tracts, notably in the Pertabghur district in Oudh, where there is a jheel or swamp of it, which looks like ashes and smoulders like wood. The mud, when dried, blazes quite freely. It has been tried by a locomotive foreman, and found to give very nearly as much steam as wood. The Calcutta analyzers call it an impure peat, resulting from the continued deposition of vegetable matter at the bottom of a marsh. It is curious that the natives, though well aware of its properties, make no use of it; their reason being that it owes its origin to "enormous sacrifices of ghee aud grain burnt *in situ* by godlike people in old time."

NEW AMERICAN FURNACE.—The *American Artisan* gives particulars of a patent recently issued to Horace Boardman, for an improved ironmaking furnace. A smelting or reducing fire in combination with a gas or combustion chamber, with tuyeres for admitting atmospheric air, and provided with openings in the division wall between the reducing fire and a gas or combustion chamber, is so arranged as to permit the ignited gases at a high temperature to act directly upon the ore while it is in contact with the carbonaceous fuel within the reducing fire; the gases being at the same time aided in their passage through the openings in the division wall by a vacuum in the upper portion of the reducing fire by means of a steam-jet or any equivalent device. This smelting or reducing fire may also be combined with a reverbatory furnace and a balling-hearth, so that the converted ore, in a metallic state, can be separated from the cinder or slag, and be balled ready for the shingling-hammer, while the escaping gases from the grate of the reverbatory furnace, having been applied to the balling-hearth, are conveyed to the gas-chamber, and after receiving a second portion of oxygen are made to aid in smelting and deoxydising the ore; thus greatly reducing both the consumption of fuel and the labour in the process of making wrought iron.

ANGLO-FRENCH ENGINEERING COMPETITION.—The Graffenstaden Works, in Alsace, have obtained the contract for 22 out the 46 locomotives for which the Baden Government recently invited tenders, the remaining 24 being taken by local Baden manufacturers. The respective prices demanded were—By the French manufacturers, £1,800; by the Badeners, £2,228 16s.; and by the English, £2,828 16s. each.

TITANIC IRON SANDS.—The object of this invention patented by Mr. Bonnet F. Brunel, of Brussels, is to reduce titanic iron sands, such as those found in Italy and at Taranaki, to powder, fit for various commercial uses, and amongst others—First, to the manufacture of inoxydisable paint; second, to all purposes to which emery is applicable; and third, as the chief base in the composition of metallic cements used for luting the joints of metal pipes and other articles. He first subjects the sands to the action of grinding-mills, in which the grinding surfaces are composed of iron and steel, to reduce them to fine powder, and he introduces during the reduction a stream of water and steam to beat the stuff to from 140° to 175° Fahr. The powder is thrown out of the mill into a receiver, it is taken damp from the receiver, and placed into retorts made of refractory earths, and is carried to a brigh red-heat, and well stirred; during the stirring he introduces for about half-an-hour, more or less, a current of steam; he then shuts off the steam, and introduces powdered charcoal, and agitates the mass for about a quarter-of-an-hour, and then, by means of a fan or blower, passes over the mass, for about half-an-hour, a current of atmospheric air coming from the direction of the magnetic pole. After this the contents of the retorts are removed while still red-hot, and are allowed to cool in the air, being well stirred. The powder is afterwards sifted, and is ready for employment in substitution for emery as the base for metallic cement, and as a paint for general use. For the manufacture of paints for painting iron and steel, he introduces the powder prepared as before described into cylinders, for the purpose of magnetising it. The cylinder is surrounded with copper wire, and connection is made with the battery: at the end of about five minutes the titanic sand will be found to be permanently magnetised.

Petroleum.—The imports of petroleum appear to have been almost suspended in July. In that month only five tuns were received, as compared with 2,241 tuns in July, 1864, and 3,259 tuns in July, 1863. The five tuns which came to hand in July were from the United States, while in July, 1864, the receipts from the same quarter were 2,140 tuns, and in July, 1863, 3,134 tuns. In the seven months ending July 31, this year, the imports of petroleum have been only 3,652 tuns, as compared with 7,893 tuns in 1864, and 24,320 tuns in 1863 (corresponding periods). The great decline in the imports is traceable almost entirely to the diminished deliveries from the United States, from which only 2,026 tuns were received to July 31 this year, while the arrivals from the same quarter were 6,538 tuns in the first seven months of 1864, and 23,200 tuns in the first seven months of 1863.

Petroleum as Fuel.—The petroleum boiler at Woolwich Dockyard, lately experimented with, is now undergoing considerable alteration, in order to assimilate it more to the simple form of the present marine boiler. The long course of experiments under Mr. Richardson's supervision at Woolwich has proved the system to be not only available but utterly free from danger; the experiments are now to be carrried on with great vigour. When the alterations are completed the boiler will be able to burn the Rangoon, Barbadoes, or Trindad petroleum, together with the English coal and whale oils alternately, as well as every other kind of hydrocarbon, to obtain any degree of speed that may be required, and without waste.

Manufacture of Hydrocarbons.—Mr. John Watson, of George-yard, Lombard-street, provisionally specified the manufacture of hydrocarbons from the upper and middle lias shales—a material not previously employed for that purpose.

Manufacture of Flat Chain.—An invention has been patented by Mr. James Webster, of Birmingham, which consists in forming flat chain either in bands for pit chains, driving bands for machinery, and other similar purposes, or in sheets for armour-plating, bridge building, and various other like purposes, by interlacing or screwing together separate lengths of coiled metals rods or wires. Each of these metal rods or wires is first formed into an open twist or coil of any desirable length and thickness. Two of these coils are then screwed or interlaced together, coil within coil, and any additional number of coiled rods or wires are similarly interlaced. until the length or area of the chain is formed.

Large Wire-Ropes in America.—The Lehigh Coal and Navigation Company have had recently manufactured at the wire mill of Messrs. Hazard and Company two immense wire-ropes. The largest of the two has been conveyed over the Lehigh Valley Railroad, and will be placed on the Canal Company's plane near Wilkesbarre. Its length is 5,200ft., which is within 80ft. of a mile; it is 1⅝in. in thickness, and weighs 22,480lbs.

Gunpowder and Electricity.—It is stated as a remarkable fact that electricity travels so rapidly that it may be sent through gunpowder without igniting it; and it is only when the current is retarded that an explosion takes place.

Welding Iron.—An invention has been provisionally specified by Messrs. Standly and Prosser, of Cockspur-street, which consists in the employment of hydrogen or its compounds, alone or mixed with oxygen or atmospheric air projected from blow-pipes, for the purpose of welding plates or masses of iron, or other metals. They prefer to mix the gases in a reservoir at the base of the blow-pipe.

Lendy's Patent Topograph.—This instrument which has been recently submitted to our inspection may be used:—1. As a prismatic compass alone; 2. As a plane table alone with its sight ruler; 3. As a plane table and a compass, combined to facilitate the finding of stations. It may be employed without any alteration, simultaneously or successively, as a plane table or a compass, when in the same survey the ground alters from undulating ground to open country, and *vice versâ*. In all cases no scales, compasses, or protractors are needed, the machine itself protracting the angles and laying down distances at the scale. Also the Topograph may be used:—1. As a level; 2. As a clinometer, to obtain angles of elevation or depression, to find the difference of altitude of two stations, and to lay down contours. All these properties combined in one machine, light and cheap (it weighs about 16oz. troy), will no doubt render it popular among the military public, as well as among the civil surveyors.

A Dwarf Engine.—One of the most curious articles of the Wakefield Exhibition is, perhaps, a steam engine and boiler in miniature, and described as the "smallest steam engine in the world." It stands scarcely 2in. in height, and is covered with a glass shade. The fly wheel is made of gold, with steel arms, and makes 7,000 revolutions per minute. The whole engine and boiler is fastened together with 38 screws and bolts, the whole weighing 14 grains, or under ¼oz. The manufacturer says of it that the evaporation of six drops of water will drive the engine eight minutes. This piece of mechanism is designed and made by a clock manufacturer at Horsforth.

Improved Friction Pulley.—Fast and loose pulleys, the first to transmit power, and the second to carry the belt when not at work, have been used for years, but there are many objections to them which render some other device desirable. Friction pulleys as a substitute have been employed with advantage, and many are now in use. An improved form of this contrivance has recently been patented in America by Mr. L. H. Olmstead, of Newark, New Jersey, which is described in the *Scientific American* as being novel in design and very efficient. By a simple movement of the shipper bar the pulley is made to drive the machine, and runs free without imparting power when the bar is thrown back. The outer pulley has a secondary wheel cast upon its arms. Both the inner side of the large pulley, and the outer side of the small one, are accurately turned, and between these faces is a cam-block of peculiar shape constructed in such a way that it will bite or jam between the runs when the coupling is slipped up on the shaft by the shipper. There are no parts to rattle when in or out of use, or to stick so that they cannot be readily worked.

Public Works in France.—It appears from official returns that the great viaducts constructed on the lines of the French railways form a total of more than seven leagues in length. That of Mendon, which is about 150yds. long and 100ft. high, cost £22,400. The viaduct of Chamont, on the Eastern line, cost £232,025; that of Mirville on the Western Railway £92,025; and that of Brunoy Lyons line, £60,400. The tunnels are said to be more than 800 in number, and to exceed 37 leagues in total length. The longest tunnel in France is that of La Nerthe, on the Lyons and Mediterranean Railway, Marseilles, which cost £420,000; that of the Credo, between Lyons and Geneva, cost £260,000. The total cost of the whole of the viaducts, bridges, and tunnels on the French lines is given at £17,307,278. The new park of the Buttes Chamount, is proceeding rapidly towards completion. It is said that a million and a half of trees and shrubs will be required for its plantation. In the same neighbourhood will be the new reservoirs for the supply of the higher parts of the city with water, and the new cattle market and general abattoirs; There are said to be 50,000 men, 6,000 horses, 20 locomotives, and 500 waggons now employed on these various undertakings. An important work, and one that has long been required, is now going on between the Rue Richelieu, and the Rue St. Honoré, namely the formation of a square in front of the Théatre Francais, three of the most miserable streets in Paris, the Rue du Rempart, the Rue Jeannisson, and the Rue Fontaine Moliere, as well as a number of wretched houses in the Rue St. Honoré and the Rue Richelieu, will be wholly or partially swept away by this improvement. The Rue du Rempart stands on the site of one of the ancient ramparts of the city in front of which Joan of Arc was wounded in the thigh when besieging Paris. Two large new churches, one on the Boulevard Malesherbes, and the other at the end of the Chaussee d'Antin, are rapidly approaching completion, and another church is about to be commenced on the South side of the Seine, to be called Notre Dame des Champs. The cost of the last named is estimated at £180,000. Estimates are proverbially elastic in France as well as elsewhere, and it is whispered that the new opera house, which was to cost about a million sterling, will absorb more than double, some say three times that sum.

Cornish Pumping Engines.—In the month of July, 31 pumping engines consumed 1,913 tons of coal, and lifted 13·9 million tons of water 10 fathoms high. The average duty of the whole was 48,900,000lb., lifted 1ft. high by the consumption of 112lb. of coal. Ten engines exceeded the average duty.

NAVAL ENGINEERING.

Trial of the Minotaur.—The *Minotaur* left Portsmouth harbour on the 8th u for the trial course in Stokes Bay. The ship drew 23ft. 1in. of water forward, an 24ft. 1in. aft, and had her safety valve loaded at 25lb. The wind was light from S.W., and sea perfectly smooth. Several runs were made over the measured mile, but owing to a deficiency in the vacuum, a priming of the boilers, and other *contretemps*, growing out of these facts, the trial of the ship's speed was postponed until the next day. Nothing, therefore, remained to be done except to give the ship a run out S.E. clear of the east end of the Isle of Wight, and test her when there in making circles with her ordinary wheel apparatus, and also with her hydraulic steering gear. The results of the trials as far as they went were as follow:—Circles.—Ordinary steering-wheel, but with men at relieving tackles; full boiler power; helm to starboard.—Time in getting helm up, 1min. 45sec.; turns of wheel, 3; men at wheel and the relieving tackles, 47; half circle made in 3min. 33sec.; full circle made in 7min. 28sec.; revolutions of engines, 49; angle of rudder, 26°. The same with helm to port.—Time in getting helm up, 1min. 4sec.; turns of wheel, 3; men at wheel and tackles, 47; half circle made in 3min. 47sec.; full circle made in 7min. 15sec.; angle of rudder, 19°; revolutions of engines, 39. Ordinary steering wheel, with half boiler power (helm to starboard).—Time in getting helm up, 51sec.; 3½ turns of wheel, with 53 men; half circle made in 4min.; full circle made in 7min. 56sec.; angle of rudder, 33°; revolutions of engines, 40. The same with helm to port.—Time in getting up helm, 53sec., with 56 men; turns of wheel, 3½; half circle made in 3min. 51sec; full circle in 7min. 43sec.; revolutions of engines, 40. Circles.—Hydraulic apparatus—Full boiler power—Helm aport—Time in getting up helm, 27sec., with 2 turns of wheel; 1min. 5sec. with 2½ turns. Half circle made in 3min. 35sec.; full circle in 7min. 58sec; angle of rudder, 26°. Helm astarboard.—Time in getting up helm, 10sec., with 1½ turn of wheel, 24sec. with 1½ turn, 1min. 35sec. with 2 turns. Half circle made in 4min. 11sec.; full circle in 8min. 4sec.; angle of rudder, 19°. Hydraulic Apparatus—Half boiler power—Helm to port.—Time in getting up helm, 13sec., 2 turns of wheel; 1min. 20sec., with 2½ turns of wheel; half circle made in 4min. 13sec.; full circle in 8min. 16sec.; angle of rudder, 30°; revolutions of engines, 40. Helm to Starboard.—Time in getting up helm, 18sec., 2½ turns of wheel; 39sec. with 2½ turns of wheel; half circle made in 4min. 4sec.; full circle in 7min. 56sec.; angle of rudder, 34°; revolutions of engines, 39. The *Minotaur* resumed and concluded her official trials under steam at light draught of water on the 9th ult. The ship's anchor was weighed from Spithead shortly before noon, her draught of water being the same as on the previous day—23ft. 1in. forward and 24ft. 1in. aft, and her safety-valve loaded at 25lb., the immersion of the upper blade of the screw being 6in. Six runs were taken over the measured nautical mile course in Stokes Bay with full boiler power, and four runs afterwards with half boiler power. The following were the results:—

Full-boiler Power.

Run.	Time. M. S.	Speed of Ship. Knots.	Run.	Time. M. S.	Speed of Ship. Knots.
1	3 57	15·190	4	4 20	13·846
2	4 8	14·516	5	3 47	15·859
3	3 55	15·319	6	4 27	13·483

Mean speed of the ship	14·778 knots.
Mean revolutions of the engines	57½
Maximum ditto	59
Minimum ditto	56½
Pressure of steam in boilers	25½lb.
Vacuum	23in.

Half-boiler Power.

Run.	Time. M. S.	Speed of Ship. Knots.	Run.	Time. M. S.	Speed of Ship. Knots.
1	4 20	13·846	3	4 21	13·793
2	5 28	10·976	4	5 27	11·099

Mean speed of the ship	12·406 knots.
Maximum revolutions of engines	49
Minimum ditto	47
Pressure of steam in boilers	20lb.
Vacuum	27in.

The engines worked throughout from the start to the finish with astonishing ease and smoothness, and without a hitch of any kind occurring.

A New Steam Pinnace, intended for her Majesty's iron-clad steam ram corvette *Pallas* has been launched at Woolwich, and has undergone a trial of her machinery and speed. The engines, which were supplied by Messrs. Maudslay and Co., and were in charge of Mr. Warrcher, are of the nominal power of eight horses. In the trial they made 312 revolutions, with 60lb. steam pressure. The mean speed of six runs was 6·795. The draught of water was 2ft. forward and 3ft. aft. The size of cylinder, 5in. in diameter; length of stroke 6in. It appears that we have now resolved to imitate our French neighbours in all that may be likely to benefit the service, and are now fitting our line-of-battle ships with these useful steam launches, which are to carry a couple of guns each, fore and aft, and which will prove most formidable in shallow waters out of range of ships' guns.

The Screw Steam Frigate "Arethusa," 35 guns, 3,141 tons, 500-horse power, made the final trial of her machinery at the measured mile, off Maplin Sands, on the 13th ult., previous to her departure from Sheerness for foreign service. The vessel left the harbour about 7.30 a.m., the draught of water being 21ft. forward, and 23ft. 6in. aft, and her load on the safety-valve 25lb. Six runs were made on the measured mile with the following results:—First run, 5 min. 58secs., averaging 10·051 knots per hour; second run, 6 min. 17secs., averaging 9·545 knots; third run, 5 min. 33 secs., averaging 10.813

knots; fourth run, 6 min. 20 secs., averaging 9.396; fifth run, 5 min. 44 secs., averaging 10·465 knots; sixth run, 6 min. 10 secs., averaging 9·737. The mean speed of the ship was 10 knots per hour; revolutions of engines, 65; pressure of steam, 25; vacuum, 26½. The circle was turned in 8 min. 2 secs., the angle made by the helm being 21 deg. to port, and the diameter of the circle 600 yards. The engines worked throughout, a period of eight hours, with perfect ease and smoothness; and it is thought by the officials that when the bottom of the vessel is cleansed from marine accumulation a still more satisfactory working of the ship will be obtained.

The Russian Monitors.—On the 25th of August last the Russian monitors *Veshun* (Wizard), *Koldun* (Sorcerer), *Bronenosetz* (Coat-of-mail Man), *Jedinorog* (Unicorn), *Streletz* (Sharpshooter), *Perun* (Jupitor Tonans), *Lava*, *Typhoon*, and *Ouragan*, escorted by two frigates and some smaller craft, returned to Cronstadt from Stockholm, where they had sailed with a squadron, under the command of the Grand Duke Constantine the Grand Admiral. On setting out the monitors were eleven in number, but the *Smertch* (Water-spout) foundered and sank in the Finnisn Archipelago, and the *Levya* struck, and had to be taken to some neighbouring port for repairs. This and the fact of the other monitors returning at noon, when they had been ordered to accompany the Grand Ducal squadron in its progress to Copenhagen and Kiel, gave occasion to disquieting rumours respecting the sea-going qualities of the new iron-clad fleet. To allay these apprehensions the *Cronstadt Journal* inserts an official *communique* on the voyage, and the trials of the ships were subjected to and gallantly stood out in the Finnish Gulf. They fell in, we were told, with a heavy gale, but floated much more buoyantly on the waves than could have been expected from their size and shape. On getting near the isles, where they had to tread their course amid the intricate channels of the Swedish coast, they proved the most easily governable of all ships ever built. They cannot, however, make above sixty miles in twenty-four hours; and as it would have taken them twenty-two days to proceed to Stockholm, Copenhagen, and Kiel, and return thence to Russia across the Baltic, the Grand Admiral having sufficiently convinced himself of their excellence, preferred not exposing them to the dangers of the season, and the additional difficulties which they might have had in procuring an adequate supply of coals.

The "Bellerophon."—On the 21st ult. the iron-clad frigate *Bellerophon*, 16, of 4,270 tons burden, entered on the preliminary official trial of her machinery, to enable the Admiralty officials to ascertain her rate of steaming at light draught. Her draught of water forward was 16ft. 4in., and aft 23ft. 6in., the quantity of coals on board being 174 tons, and other stores about 50 tons. Her screw was set at a pitch of 21ft. 8½in., with the immersion of the upper edge of 1ft. 11⅜in. On reaching the measured mile at the Maplin Sands, it was determined to test the vessel, although at the time the screw could only be brought to realise a *maximum* of 53 revolutions, while the contract guaranteed that the revolutions were to be 70 per minute, but at no time were 60 revolutions reached. After a short delay four runs were taken with the following results:—First run, time, 3 min. 57 sec.; speed, 15·190 knots; steam, 22lb.; vacuum, 26½; revolution of engines, 59; second run, 4 min. 54 sec.; speed, 12·245 knots; steam, 22lb.; vacuum, 26; revolution of engines, 58; third run, 4 min. 9 sec.; speed, 14·457 knots; steam, 22lb.; vacuum, 26½; revolution of engines, 57½; fourth run, 4 min. 39 sec.; speed, 12·903 knots; steam, 21lb.; vacuum, 26; revolution of engines, 55½. The above readings would give an average speed of 13·698 knots, but from the fact that the engine showed a falling off in the working of the screw after each run, no proper estimate can be formed of the true speed of the vessel. The adoption of the balanced rudder on board a vessel of the *Bellerophon* class was at first considered to be a doubtful experiment, but the results of the trials made were in the highest degree satisfactory. With the helm at port, and the angle of the rudder 32 deg., the helm was put over in four turns by eight men in 23 secs., and the complete circle accomplished in 4 min. 30 secs., and the half circle in 1 min. 50 sec., with the helm to starboard, the rudder was brought to an angle of 37 deg. by eight men in 25 sec. On the following day the *Bellerophon* resumed, and brought to a conclusion, her official full-boiler trials of speed at the measured mile, the conditions under which the trials were made on this occasion being far more favourable than on the previous day. The frigate's draught of water was slightly in excess of that on the previous day, her forward draught being 16ft. 6in., and that aft 23ft. 6in.; pitch of screw, 21ft. 8½in.; diameter, 23ft., with the upper edge out of the water 1ft. 11¾in. On running down past the Nore the engines were found to be doing their work most satisfactorily, there being abundance of steam, although, from causes which soon became evident, the screw could not be made to revolve more than 58 times per minute, which appeared to be the *maximum*. The vessel's displacement was 5,630 tons, or less than 1,000 tons of her true displacement when at her deep draught. With all the attendant favourable circumstances stated, the *Bellerophon* was placed on the measured mile for her full speed trials, and seven runs were taken, with the following results:—First mile—time, 5 min.: speed in knots, 12·000; steam, 22lb.; vacuum, 26½in.; revolutions of screw, 57. Second mile—time, 3 min. 57 sec.; speed, 15·190 knots; steam, 22lb.; vacuum, 26in.; revolutions of screw, 58. Third mile, time, 4 min. 59 sec.; speed, 12·040 knots; steam, 23lb.; vacuum, 26in.; revolutions of screw, 56. Fourth mile—time, 3 min. 56 sec.; speed, 15·254 knots; steam, 24lb.; vacuum, 25in.; revolutions, 58. Fifth mile—time, 4 min. 56 sec.; speed, 12·162 knots; steam, 24½lb.; vacuum, 26in.; number of revolutions, 57. Sixth mile—time, 4 min. 1 sec.; speed, 14·938 knots; steam, 24lb.; vacuum, 26in.: revolutions of screw, 58. Seventh mile—time, 4 min. 47 sec; speed, 12·543 knots; steam, 24lb.; vacuum, 26in.; revolutions, 57½. Rejecting the first of the runs, so as not to interfere with the calculations, the first means of the above figures will be 13·615, 13·647, 13·708, 13·550, and 13·741 knots; and the second means 13·631, 13·677, 13·629, and 13·645 knots, giving the true mean speed of the ship as 13·645 knots per hour. With regard to the fact of the *Bellerophon* not having made a *minimum* speed of 14 knots per hour on her trial, as was intended by her designer, the causes must be sought for in various quarters. Chief of them is undoubtedly the character of the screw. When the *Bellerophon* was designed it was never intended to fit her with a four-bladed screw only a little smaller than that supplied to the *Minotaur*, which is 100ft. longer, and driven by engines of one-third greater horse-power.

The Light Draught Trial of the Iron Frigate "Valiant," 4,063 tons, and 800 horse-power of engines, was made at Portsmouth on the 18th ult. The *Valiant*, having no guns or crew on board, and being incomplete in stores, drew but 23ft. 6in. of water forward and 24ft. 6in. aft on leaving the harbour for the trial ground in Stokes Bay. The weather was very favourable for the trial of the ship's speed. There was a light wind and smooth sea. Under these conditions the *Valiant* made six runs over the measured mile, which brought out the following results as to the speed of the ship:—First run, 13·284 knots; second run, 11·863; third run, 13·844; fourth run, 11·009; fifth run, 14·516; sixth run, 10·814: the mean speed of the ship at full boiler power was 12·670 knots; at half-boiler power the ship attained a mean speed of 9·600 knots. The pressure of steam was 22lb., and the mean vacuum 23in. At full boiler power, to port, the ship made her full circle in 6 min. 13 secs.; to starboard in 5 min. 6 secs. At half-boiler power, to starboard, the full circle was made in 6 min. 53 secs.; to port in 6 min. 19 secs.

Naval Appointments.—The following appointments have taken place since our last:—E. E. Lucas, promoted to First-class Assist.-Engineer, to the *Cockatrice*; H. Hull, Engineer to the *Indus*, for the *Thais*; J. Roberts, W. Hardie, and R. Taylor, Chief Engineers; H. Payne, J. Ellis, J. C. Gray, J. W. Hewitt, G. Millis, J. J. Blunden, S. M'Callum, W. C. P. Jones, W. Owen, and W. Herd, Engineers; J. Jefferies, J. Ferguson (B), R. H. Cooper, G. Thomson, A. Loug, J. Croll, G. J. Barker, W. Joues, T. G. Woodfield, D. M'Veau, R. B. Nicolson, and F. T. Russell, First-class Assist.-Engineers; R. J. P. Jones, W. J. Fellows, J. A. Cooke, J. H. Willis, and R. Burridge, Second-class Assist.-Engineers; G. T. Stronach, W. Annan, and H. G. Cocking, Acting Second-class Assist.-Engineers, additional, to the *Princess Royal*, for disposal; W. R. Henry, First-class Assist.-Engineer, to the *Hector*; G. Treves, Chief Engineer, additional, to the *Asia*, for the *Euryalus*; Ebenezer Clements, Chief Engineer to the *Indus*, for the *Satellite*; T. E. Miller and D. P. Steddy, Engineers, to the *Helicon*; L. J. Croome, Engineer to the *Cumberland*, for the *Pigeon*; F. M. C. Richards, First-class Assist.-Engineer, to the *Helicon*; G. F. M. Kent, Clerk to the *Donegal*; J. Cox, Acting Second-class Engineer to the *Dromedary*; W. Brown, Chief Engineer, to the *Basilisk*; G. F. Booth, Chief Engineer, to the *Greyhound*; W. Gibson, Engineer, and J. M'Garahan and W. N. Taylor, First-class Assist.-Engineers to the *Basilisk*; R. W. Topp, Engineer, and H. G. Johnston, Acting Second-class Assist.-Engineer to the *Greyhound*; J. Cooper, First-class Assist.-Engineer, to the *Princess Royal*; O. A. Davies and W. H. Croxall, Engineers, additional, to the *Hastings*; W. M'Dowall, Engineer to the *Asia*, for the *Whiting*; J. M'Master, First-class Assist.-Engineer to the *Asia*, for the *Warrior*; T. Coombes, Second-class Assist.-Engineer, to the *Medusa*; W. Tichlin, Acting Second-class Assist.-Engineer to the *Victory*, for the *Fire Queen*; R. J. Butler, Acting Second-class Assist.-Engineer to the *Cumberland*, for the *Wildfire*; J. Monk, Acting Second-class Assist.-Engineer, to the *Dee*; W. H. Gulliver, Acting Second-class Assist.-Engineer to the *Indus*, for the *Ocean*; J. J. Ellis, Acting Second-class Assist.-Engineer to the *Hastings*, for the *Advice*.

STEAM SHIPPING.

Steam Shipbuilding on the Clyde.—The *Buffalo*, a sister vessel to the *Wolf* and the *Llama*, has been put on the Irish mail service; she was built by Messrs. Caird, of Greenock. Messrs. W. Denny and Brothers, of Dumbarton, have launched a composite screw of about 1,000 tons, builders' measurement, and to be supplied with engines of 300-horse power nominal. This fine ship is named the *Wisconsin*. The blockade-runners *Fanny* and *Alice*, which were recently thoroughly overhauled and repaired at Dumbarton, have been put on the station between Stranraer and Ireland. The *Mongolia*, screw, built by Messrs. Scott and Co., and engineered by the Greenock Foundry Company for the Peninsular and Oriental Steam Navigation Company, has left the Tail of the Bank for Southampton. The dimensions of the *Mongolia* are:—Length, 330ft. over all; breadth, 40ft. 4in.; depth of hold, 34ft. She is fitted with oscillating engines of 590-horse power, steam winches at each hatch on the spar deck, Downton's patent pumps, &c. She has a ventilating fan, worked by machinery, for sending a current of air along the main or troop deck. The *Count van den Bosch*, screw, has made a trial run of 150 miles. She accomplished the stipulated speed with 350 tons dead weight, at a consumption of 2⅝lb. of Scotch coal per indicated horse power per hour. As the *Count van den Bosch* is intended for Indian service, this economy in respect to coal is a very important consideration. The burden of the *Count van den Bosch* is 850 tons, and she is fitted with a steam windlass, three surface condensers, &c. She is the property of the Netherlands Steam Navigation Company, and was built and engined by Messrs. W. Simons and Co., of the London Works, Renfrew. Messrs. Hedderwick and Co., of Govan, have on hand an iron screw of 600 tons for the East India trade, and two paddle saloon steamers for the Saloon Steam-packet Company, London, to be engined by Messrs. J. Howden and Co. The *Arno*, paddle, built and engined by Messrs. Caird and Co. for the West India Royal Mail Company, has gone into service. Messrs. Caird and Co. have closed a contract with the Norddeutscher Lloyd, of Bremen, for two sister steamers to the *Hermann*; the first is to be completed at the end of next year, and the second in the spring of 1867. The steamers will be each about 2,100 tons burden. The *Cisne*, a twin screw of 330 tons, builders' measurement, has been launched by Messrs. Aitken and Mansel. The vessel has been built to the order of Captain A. Santos for trading on the River Plate, and will be fitted with engines of 60-horse power by Messrs. James Aitken and Co., Cranston-hill. The *Limena*, paddle, built and engined by Messrs. Randolph, Elder, and Co., with engines on the double cylinder principle, for the Pacific Steam Navigation Company, has made a run between St. Vincent and Montevideo, a distance of 3,686 nautical miles, in 11 days 20 hours, thus attaining an average speed of 12½ knots per hour, on a consumption of 24cwt. of coal per hour. The Liverpool, New York, and Philadelphia Steamship Company has contracted with Messrs. Todd and M'Gregor, of Glasgow, for a new steamer to be 15ft. longer than the *City of Boston* brought into use this summer. The new steamer, which will be named the *City of Antwerp*, will be 327ft. long by 29ft. beam, and her engines will work up to 1,456 horse power. Mr. A Denny, of Dumbarton, has launched a paddle intended for towing purposes on the Hooghly. She is to be fitted with powerful engines by Messrs. Denny and Co., and is the fourth vessel of the same class launched this year at Dumbarton.

Shipbuilding in Aberdeen.—Aberdeen, already famous in the shipping world for the beauty of build and swift sailing qualities of its clippers, is fast obtaining additional celebrity in the same branch of industry through a new class of vessels—the iron and composite. At present there are no fewer than 19 vessels on the stocks in the various building yards, representing an aggregate tonnage of some 15,000 tons, and worth when finished at least a quarter of a million of money. A considerable number of years back iron shipbuilding was commenced in Aberdeen, but, strange to say, through the opposition of the working boiler makers, who arrogated to themselves the sole right, as well as the ability, to execute such work, little comparatively was done in this line. The enterprise of the shipbuilders, with the aid of their own men and labourers, has surmounted this illiberal opposition, and the manufacture of iron and composite vessels is being carried on briskly. The latter class of ships is highly thought of by practical seamen and leading owners. Whatever the advantages of purely iron vessels, it is urged there that when they come in contact with the ground they soon "hole"—an accident frequently equivalent to their total loss. Vessels on the composite principle, the combination of iron and wood in the hull, come through a crisis better, while they at the same time realize for fair weather purposes many of the advantages of iron construction. "An iron skeleton with a wooden skin" is the short and graphic term given to these "composites," and, judging from the favour in which they now stand, it is not unlikely that a large number of them will in the course of a year or two be found included in the lists of Britain's mercantile navy.

An Improvement in the Screw-Propeller.—A series of important trials has been completed on the Thames and Medway to discover the best form of screw-propeller for the propulsion of steam vessels, by which some exceedingly valuable data have been arrived at. The vessel experimented upon was a screw steamer belonging to Messrs. Rennie, fitted with an improved Griffith's propeller, as supplied to the ships of the Royal Navy, with the addition, and in which lies the improvement, of what may be termed a fixed screw, or "boss," having a number of arms attached, similar in form and design to the sails of a windmill, the invention of Mr. Rigg, a civil engineer at Chester. The attention of Mr. Griffith has been directed to this subject from the fact that nothing has been done during the last few years to improve the propellor invented by him. The new invention may be described briefly as a "boss" attached to the rudder-post of the vessel, behind the ordinary screw. Emerging from the "boss" are a number of blades, which, for the sake of description, may be called a fixed screw, which in reality it is. These blades are set at a directly opposite angle to the screw, and on the latter being set in motion the water acted upon is ejected at an angle corresponding with its pitch and velocity. At the instant of the water being thrown off by the screw it is arrested and caused to deviate by the fixed blades already described, as it impinges upon them. The result of this operation is that the water is thrown off at nearly a line with the vessel's keel, taking away all vibration, rendering the action of the rudder more perfect, and, as a consequence, enabling the ship to be more easily steered. The result of the trials, which were conducted personally by Mr. Griffiths and Mr. Rigg, under the supervision of Mr. Rumble, late chief inspector of machinery of the steam reserve in the Medway, was in the highest degree satisfactory. The new system, it may be remarked, has been tested in juxtaposition with the improved Maugin screw now introduced into the Royal Navy, and fitted, in the first instance, to the iron-clad frigate *Achilles*, built at Chatham Dockyard, as well as to the iron-cased frigate *Bellerophon*, now preparing for sea at the same establishment, and the results obtained are somewhat surprising. With the Griffith screw working in conjunction with Mr. Rigg's invention the mean speed attained was 7·574 knots per hour, with 184 revolutions per minute. With the ordinary screw now in use by the Admiralty in the new ironclads, the average speed attained by the same vessel was only 5·871 knots per hour, with 227 revolutions of the screw per minute. The results of the experiments were consequently ascertained to be an increase of 1·703 knots per hour in speed, with forty-three revolutions less per minute; or, in other words, a gain of 22·48 per cent. in speed, with a saving of 18·94 per cent. in power.

EXTRAORDINARY RECOVERY OF A SUNKEN STEAMER.—Some 18 months ago the *Iowa*, five-masted screw steamship, 2,500 tons register, belonging to the London, Havre, and New York line of packet-steamers, got ashore in a bay on the French coast, near Cherbourg, after leaving Havre for New York, where she subsequently fell over on her beam ends, filled, and sunk. There were nearly 300 people on board at the time—passengers and crew, who were safely landed. A court of inquiry was held on the wreck, which terminated in exculpating the master from all blame, it being shown that the compasses on board were affected by the land, and that the captain was misled as to her actual position. Attempts were in the first instance made at an expense of nearly £14,000 to raise the vessel, but they did not succeed, and the wreck was abandoned at a total loss to the underwriters, the vessel being insured at Glasgow, Liverpool, and other places for £70,000. Special agents were then despatched from London to survey the sunken wreck and to report upon the chance of saving her. The result was that an agreement was entered upon with Messrs. Barter and Co. to raise her. Their plan was very simple, that of sending divers down and making the ship watertight; this accomplished, by means of powerful steam pumps the water was pumped out of the several compartments, and as soon as buoyancy was obtained in the ship she was by degrees righted and finally she floated, and was towed safely into Cherbourg Harbour, where she is having her engines and machinery oiled and made good.

THE STEAMSHIP RHONE.—The Royal Mail Company's fine new screw steamship *Rhone*, was taken to Stoke's-bay on the 21st ult. for an official trial of her speed at the measured mile, when she obtained an average of about 14 knots per hour. The results of four runs were as follows:—First run, 4min. 55sec., or 12·205 knots per hour; second run, 3min. 58sec., or 15·126 knots; third run, 4min. 47sec., or 12·543 knots; fourth run, 4min. 7sec., or 14·575 knots. Revolutions of engines, 58½; vacuum, 27½in.; steam, 25lb. The *Rhone* is one of the finest vessels in the service, and she has accommodation for 253 first-class passengers, 30 second, and 30 third, and has stowage capacity for 1,200 tons of cargo and coals. Her total length is 310ft.; beam, 40ft.; depth to main deck, 25ft. 6in.; and height between main and spar decks, 7½ft. She has engines of 500 horse power, with tubular boilers, superheaters on Mr. Ritchie's plan, as applied to all the company's vessels, and surface condensers, which can be changed to jet condensers almost instantly, without either slowing or stopping the engines. The cylinders, which are 72in. diameter and 4ft. stroke, are fitted with expansion valves, which can be adjusted with the greatest nicety while everything is working. The screw is Griffith's patent, diameter 18ft., and 29ft. pitch. The tonnage of the vessel is 2,434 tons old measurement. The temperature of the feed water was 126deg. The whole of the machinery worked with the greatest ease during the trial. The *Rhone* is a noble-looking vessel, and all her passenger and other arrangements are of the most superior character. The chief saloon is a very handsome apartment, occupying the full width of the ship, and chastely decorated. The *Rhone* will take out the Brazil and River Plate mails on the 9th inst.

TRIAL TRIP OF THE "DAKAHLIEH."—this fine ship, the latest of the new fleet of trading steamers built for the Egyptian Government, under the supervision of the Peninsular and Oriental Company, sailed on the 9th ult. for Alexandria. Previous to her departure, the *Dakahlieh* made a trial trip at the measured mile in Stokes Bay, and, being favoured with fine weather, the following result were obtained:—

	Revolutions.	Time.	Knots per hour.
First run ...	74¼ ...	4 m. 58 s. ...	12·081
Second " ...	75 ...	3 m. 47 s. ...	15·859
Third " ..	76 ...	4 m. 54 s. ...	12·245
Fourth " ...	75½ ...	3 m. 42 s. ...	16·216

Giving an average speed of 14·100 knots, or about 16¼ statute miles per hour. At the time of her trip she had on board 177 tons of coal, 8 tons of water, 50 tons of stores, 80 tons of pig iron, and 5 iron barges weighing 100 tons each. The draft of water was 15ft. 6in. forward, and 18ft. aft; displacement at this immersion, 2,220 tons, and area of midship section 384 square feet. She is 1,553 gross tonnage, and 1,108 register, horizontal engines 350-horse power, with all the recent improvements, including surface condensation, superheating, &c. Her engines were constructed by Messrs. J. and G. Rennie, of Blackfriars, London, to whom the greatest credit is due for the satisfactory results obtained. The average indicated power was 1.923 (about five times the nominal), and the slip of screw propellor was ¼ per cent. only. The hull, which was designed and built by Messrs. Money Wigram and Sons, of Blackwall, is a beautiful model of marine architecture. The *Dakahlieh* is sister ship to two others, the *Charkieh* and the *Ramanieh*, which were despatched to Egypt within the last few months, the tonnage and horse power of the three ships being about the same. The two latter ships were built by the Thames Iron Shipbuilding Company and Messrs, Samuda respectively, and engined, the former by the Messrs. Rennie, and the latter by Messrs. Penn and Son, of Greenwich. The results attained by the *Dakahlieh* have, however, supassed those of her sister ships, and she has proved herself considerably the fastest of the trading fleet of which the Egyptian Government have become possessed.

FROM NEWHAVEN TO DIEPPE.—On the 9th ult., a steamship race of great interest in the present state of naval architecture took place on the passage across the Channel between Newhaven and Dieppe. The new vessel, named the *Bordeaux*, tried for the first time, belongs, as in the former case, jointly to the London and Brighton Railway Company and to the French company whose lines run from Dieppe to Paris in connection with the English company, and has been built and engined by Mr. Charles Langley, at Deptford-green, whose method of constructing fast steamers was so signally successful in the case of the *Marseilles*. The great interest of the trial lays mainly in the fact that the new sectional form of bow, which has been introduced in Her Majesty's paddle despatch steamer *Helicon* with marked advantage, and likewise in the armour-clad frigates *Bellerophon*, *Pallas*, *Lord Clyde*, &c., has been adopted independently and simultaneously by Mr. Langley with remarkably good results. The *Bordeaux* has been built not for speed or even for passenger traffic exclusively, but to combine with these a great cargo-carrying power, which is becoming continually more and more necessary on the Newhaven and Dieppe line of steamers, owing to the great development of trade between England and France that has marked the progress of the last two or three years. She is 210ft. long, of 23½ft. beam, 14ft in depth, tonnage 578 (builder's measurement), and fitted with engines of 180 horse-power (nominal), on the oscillating principle, with brass tubular boilers and patent feathering floats, the engines as well as the ship having been constructed at Mr. Langley's establishment. The vessel selected to compete with the *Bordeaux* was the *Lyons*, a very fast steamer, built with almost exclusive regard to speed, by the late firm of Messrs. Scott Russell and Co., and now furnished with new and powerful boilers to prepare her for this trial. The two vessels left Newhaven at about 11 a.m., the *Lyons* having the advantage by about two minutes, and when the more burdensome and commodious *Bordeaux* followed it involved a reversal of all old established ideas of shipbuilding to suppose that she could ever overtake, even with so slight a difference at starting, the sharper and fleeter-looking vessel. A very short time, however, sufficed to enable the *Bordeaux* to overhaul the *Lyons*; but she had scarcely done so before some cause for a temporary stoppage of the former ship arose, and she was soon left far behind. This incident, however, only showed the new vessel to greater advantage, for after again starting on her stern chase she gradually drew up to her competitor, passed her, and entered Dieppe harbour at least seventeen minutes in advance of her.

LAUNCHES.

LAUNCH OF THE "JUDGE KING" AT KINGHORN.—The launch of another large iron, plated steamer took place at Mr. John Key's iron shipbuilding yard at Abden, Kinghorn, on the 6th ult. The *Judge King* has been expressly built for a Liverpool Company, and was originally intended as a blockade runner. She is 1,151 tons, old builder's measurement. Her dimensions are—Length between perpendiculars, 258ft. 6in.; beam (moulded), 30ft.; depth moulded, 14ft. 10in.; depth of hold, 14ft. She has been fitted up by the builder with a pair of oscillating engines, of 320 horse-power, with two cylinders, 65in. in diameter; and with feathering paddle-wheels of the most improved construction, 24ft. 8in. in diameter. She has thus been expressly built with a view to speed; and she is expected to steam at the rate of 15 knots an hour. Her saloon is arranged for 36 first-class passengers, but it is not yet finished. She has a large bridge midships, with berths for engineers and officers, and with a topgallant forecastle fitted up for the accommodation of crew. She is the fifth and largest vessel launched from this yard, and the only one with paddles.

TELEGRAPHIC ENGINEERING.

INSULATING MATERIAL.—Mr. W. A. Marshall, Leadenhall-street, London, has invented an insulating material for telegraphic and other purposes. It consists in the employment of asbestos or amiantus (amiante) for insulating purposes. The invention also consists in protecting and completing the insulation of telegraphic wire, especially for submarine and subterranean purposes, previously covered with the asbestos or amiantus by surrounding or enclosing it in a metal tube, by preference of tin.

SUBMARINE CABLES.—In Europe, Asia, Africa, and Australia there are 52 submarine cables, which are of the aggregate length of 5,625 miles, and the insulated wires of which measure 9,783 miles. The longest of these is 1,550 fathoms, and the shortest 1½ fathom. There are 95 submarine cables in the United States and British North America which measure 68 miles, and their insulated wires 133 miles. The overland telegraph line between New York and the west coast of Ireland, through British Columbia, Northern Asia, and Russia, will be 20,479 miles long, 19,740 miles of which are completed. It has at length been resolved that this line shall cross from America to Asia at the southern point of Norton Sound, on the American side to St. Lawrence Island, and from thence to Cape Thadeus on the Asiatic continent. Two submarine cables will be required for this, one 835 miles long, and the other 250 miles long. Cape Thadeus is 1,700 miles from the mouth of the Amoor river.

RAILWAYS.

WE ARE GLAD TO SEE, by the *Ceylon Government Gazette*, that Mr. G. L. Molesworth, Mem. Inst. C.E., whose appointment as Engineer to the Ceylon Railway we noticed some little time since, is now appointed Director-General of the Ceylon Railway. Mr. Molesworth is, perhaps, best known to our readers from his very useful "Pocket-book for Engineers." Mr. D. J. Scott is appointed Chief Resident Engineer of the same railway, and a Board of Management, consisting of the Director-General as chairman, and the Chief Resident Engineer, the Locomotive Engineer, and the Traffic Manager, as members of the Board, has also been appointed. The Director-General is also appointed Manager, and the Traffic Manager Assistant Manager, for carrying into effect the provisions of the Railway Ordinance, No. 6, of 1864.

FRENCH RAILWAYS.—It appears that the line round Paris is the most productive piece of railway in all France. The receipts per mile are double the amount earned on either the Great Northern, or Paris, Lyons, and Mediterranean main lines, favoured as those systems are with an important international through traffic. Further, the traffic on the line round Paris has been increasing this year at the rate of about 12 per cent.

THE REPORT OF THE DIRECTORS OF THE LONDON, CHATHAM, AND DOVER COMPANY shows in a tabular statement that the receipts of the general undertaking, 72½ miles open, amounted for the half-year ending the 30th of June to £146,619, and for the same half of last year to £125,207, showing an increase of 17·10 per cent. The total receipts on the same mileage for the half-year ending the 30th of June, 1863, amounted to £82,318. The aggregate number of passengers conveyed on the Company's lines and branches during the past three half-years was 11,383,157, of which 8,658,693 were third-class, 1,832,362 second-class, and 892,102 first-class passengers; and of the total number of passengers mentioned, 8,873,550 were conveyed over the Metropolitan Extensions, of which 6,706,962 were third-class, 1,428,586 second-class, and 737,002 first-class.

NEW RAILWAY SCHEME.—A scheme will be proposed next session under the title of the Hull, Lancashire, and Midland Counties Junction Railway. Upon this affair the *Eastern Morning News* says:—"The scheme to bridge the Humber, to run an iron way across it, and thereby to utilise to the whole East of Yorkshire all the railway accommodation south of it, is now perhaps the foremost topic of conversation and inquiry at Hull. Two questions suggest themselves. Will the Legislature sanction it? and, if they do, will it pay? Besides a very determined opposition from the North-Eastern, Manchester, Sheffield, and Lincolnshire, and probably the Lancashire and Yorkshire—to which, however, we may expect *per contra* the support of the Great Northern, and perhaps Midland—there will, no doubt, be something said about interfering with the navigation of the Humber. It is not likely that this will produce any serious obstacle. The arches would, no doubt, be so large as to give "ample verge and room enough" for all the shipping requiring to go up the Humber beyond the bridge, and we may assume that Government sanction would be given. To express an opinion on the subject of cost is more difficult. Constructing railways, and especially railway bridges, is like going into a court of law—the cost is often more than you bargain for. If the promoters of the present scheme calculate on expending £800,000, it may, perhaps, be assumed that they are allowing half a million for the bridge. The river cannot be less than a mile broad at low water anywhere between Barton and Hessle; the bridge which will require to be built as strong as possible, could not be much less than a mile and a half long, so that half a million would not seem more than a sufficient allowance. The place chosen is one of the best that could be found for a high-level bridge in England. There is a firm chalk rock on each side of about the same height—grand solid abutments provided by nature—whilst we are assured by one who knows almost every yard of it, that the bed of the river all the way across is formed of the same hard material, giving a ready-made foundation of the utmost value. Since we have heard of railways costing twice as much as they were to cost, it may be prudent to take the estimated total of £1,000,000, which, to pay well, should realise from £80,000 to £100,000 a year. There is no doubt the traffic would be enormous, and probably the net profits would not be far short of the sum just named; at any rate it would be quite as good a speculation as the Atlantic Telegraph or the *Great Eastern*, and quite as great an undertaking."

The East London Railway Company took formal possession of the Thames Tunnel on the 26th ult. This line, when completed, by the junction of the narrow-guage lines on the north with those on the south side of the Thames, will afford to the east-end of London the facilities already enjoyed westward of a shorter through route for all kinds of traffic, and especially coal, over the Brighton, Chatham, and South-Eastern lines.

RAILWAY ACCIDENTS.

Railway Collision on the South Western.—A collision took place at the Woking station of the London and South-Western Railway on the 19th ult. Between four and five o'clock the special train which conveys cattle to Aldershott camp, while stopping at the Woking station, was run into by the 2.45 a.m. direct Portsmouth goods train. The engine of the latter was overturned, and the break van of the cattle train broken to pieces. The fireman was thrown upon the tender, and for a time remained insensible. The engine-driver jumped from his engine just as it was upsetting, and escaped without injury.

Railway Collision on the Great Western.—On the 20th ult. a collision took place at the West Junction, near the Reading Station of the Great Western Railway Company, and although unattended with loss of life, or injury to the driver or guard, caused serious damage to the company's stock. It appears that a goods train, which left Basingstoke for Wolverhampton at 3.40 on the above morning, was taking on trucks at the West Junction, about a mile below the Reading Station, when a goods train which left Paddington at one o'clock for Gloucester came down the line. A fog prevailed at the time, and the driver did not notice the train at the junction in sufficient time to prevent the collision, by which his engine was greatly damaged, and four trucks were thrown off the metals.

Accident on the Great Western Railway.—An accident, but one which did not terminate fatally, occurred on the Great Western line on the 9th ult. When the fast train leaving Paddington at 3.40 p.m. for Birmingham had passed Banbury, and was running at express speed, one of the wheels of the engine came off the main axle. The train ran about fifty yards along the metals, and then suddenly departing from the rails went into the adjoining field. The engine became detached from the tender and fell on one side. The tender turned upside down and drew the guard's van along with it. Next came a second-class carriage, which was turned on its side. A first-class carriage following was also pitched into the field on its side, but the two remaining carriages (second-class) were left on the permanent way. The driver and stoker were uninjured.

BOILER EXPLOSIONS.

Boiler Explosion at Manchester.—On the 14th ult. a boiler explosion took place at the dye-works of Mr. John Furlong, Collyhurst, Manchester. The explosion occurred about five o'clock in the morning, just as the workpeople were assembling to commence the labours of the day. The boiler was riven into fragments, and the building in which it stood reduced to ruins. The fireman was standing near the boiler, and sustained fractures of one thigh and of one of his arms. A boy standing near the boiler had one arm broken and was badly scalded. Several fragments of the boiler were hurled to great distances, and the greater part of the boiler itself was lifted to a distance of nearly 300 yards. An eight-horse engine and a donkey engine were destroyed. An iron flue of enormous proportions was carried over the premises and found at a great distance from them. The principal engine escaped injury, but the damage is estimated at £3,000. The boiler was 31ft. long and 8ft. diameter; it had been in use about eight years, and when it burst the steam was at a pressure of about 40½lb.

DOCKS, HARBOURS, BRIDGES.

New Lighthouses at Buddonness.—The foundation stone of the new lighthouses at Buddonness, the works in connection with which have been in course of erection for some months, has been laid by the Masters and other members of the Fraternity of Masters and Seamen of Dundee. The new lighthouses—the plans of which were prepared by Messrs. Stevenson, of Edinburgh, the engineers to the Northern Lights Commissioners, as well as to the Dundee Seamen Fraternity—are to be considerably higher than the present ones, by which the lights will be seen at a greater distance at sea. The height of the largest of the two is to be 101ft. above high water, and it will be seen at a distance of fifteen miles; while the present is 71ft. in height, and is seen at thirteen miles. The lower light will be 61ft. above high water, and will be seen at twelve miles and a half; while the present is 48ft., and is seen at eleven miles and a half.

Fall of a Railway Bridge in Birmingham.—The Great Western Company have sustained a loss by the partial destruction of one of their bridges, in Birmingham, the accident, however, being attended with serious injury to one man only. The occurrence took place at Livery-street Bridge, the line of the Great Western Railway passing on a diagonal line beneath Livery-street at this point. The roof of the bridge is formed of large iron girders, supported on strong brick arches, and between it and the street pavement are courses of brick and a mass of soil. There seems nothing to account for the accident, a great portion of one end of the bridge having given way with no warning whatever.

Railway Bridge between Canada and the United States.—The International Bridge, which is to cross the head of the Niagara river from Fort Erie in Western Canada, to Buffalo, in the state of New York, will obviate the use of the dangerous ferry which at present receives the traffic of the two Canadian lines of railway terminating at Fort Erie. When the bridge is finished, a perfect connection will be established between the Buffalo and Lake Huron section of the Grand Trunk Railway and the Erie and Niagara Railway on the Canadian side, and the Atlantic and Great Western, the Erie, the New York Central, and the Lake Shore Railways, on the American side of the river. The International Bridge is to be a massive structure of stone and iron, and with two stories, to serve the purposes respectively of the railway and ordinary traffic. The contracts for its construction have lately been signed in England, and it is to be completed and ready for opening within the term of two years. There are also proposals to build international bridges connecting Sarnia with Port Huron, Morrisberg with Waddington, and Windsor with Detroit.

Dockyards of Three Nations.—The *New York Times* gives us the following amusing information:—England has nine dockyards—Deptford, Woolwich, Chatham, Sheerness, Portsmouth, Plymouth, Pembroke, and, in time of war, Deal and Yarmouth. France has six—Cherbourg, Toulon, Brest, L'Orient, Rochefort, and Indret. America has eight. Portsmouth, New Hampshire, has an area of 63 acres, but nearly 5 acres must be filled in before the land can be used. The yard is situate on an island, and has a water front of about 1,000ft.; it has one floating dry dock, and three building slips. Charlestown, near Boston, covers 80 acres of ground, but 16 acres of this are marsh, and must be filled in. The water frontage that is of any value is only about 600ft. The yard has one stone dry dock, and two building slips. Brooklyn covers a surface of 80 acres of available ground, and 40 acres of marsh that can be filled in—120 acres in all. There is at present an available water frontage of 1,200ft., one stone dry dock, and two building slips. Philadelphia yard has only 15 acres' surface, and 1 acre of this must be filled in to be available. The yard has one floating dry dock, two building slips, and a water front of about 600ft. Washington yard has an area of 42 acres, 2 acres of which are marsh. There is a useful water frontage of 900ft., with two building slips. The yard has no dry dock. Norfolk and Pensacola yards were destroyed by the rebels, and at present no work of any importance is done at either of them; and Mare Island, on the Pacific, is yet unfinished, and is used only as a place of temporary repair. The British dockyards above enumerated contain 1,000 acres of ground, 50 building slips, and 34 dry docks. The French Imperial yards cover 1,129 acres, and comprise 75 building slips, and 26 dry docks. The five navy yards of the United States now in use contain only 218 acres, 12 building slips, and 4 dry docks. It is easy to refer to the "brilliant record" of the war just passed, and to thousands of miles of coast guarded by a navy created in six weeks; but it must be remembered that it consisted almost entirely of merchant-built craft, unsuited to naval service; and had our enemy been a naval Power they would have been almost worthless. . . . Without the aid of private establishments our navy would have made a very poor show in our late war. But England and France also, in addition to their immense public works have the vast resources of their private shipyards, which in one case are as great as our own, and in the other case much greater, to draw upon. The French Government are empowered by law to seize private establishments in time of war, and either work them by their own *employés*, or else have Government work done by the private owners. England, it has been calculated, could turn out war vessels at the rate of one a day, indefinitely, of all sizes in the proper proportions for a navy. Hard pressed as we have been, we have not turned out one in a week. We want a yard and works for the construction of iron vessels, of which our Government has never built one. We want also a rearrangement of all our navy yards. They are for the most part badly planned. The Brooklyn yard, with 120 acres all told, has one dry dock, two building slips, and 1,200ft. of wharf front. Compare it with Deptford, the smallest of British yards, which, with 38 acres extent, has two dry docks, one of them double, so as to contain two ships at once, five building slips, and 1,700ft. of wharf. Besides these, it has a wet basin covering more than an acre. The want of our yards is not more space (except at Philadelphia), so much as it is better arrangement, and that they should have at once. . . . England and France are both in trouble about their principal dockyards—Plymouth and Cherbourg. England has planned and begun fortifications for the defence of Plymouth which are to cost 20,000,000 dollars. But the yard is situated so near the Channel that our Monitor Dictator, or any of the other Monitors for that matter, could steam under the shore batteries, calmly receive their shot, and plant her 15-inch shell in the docks, shiphouses, and machine-shops of the Cherbourg is in precisely the same predicament. The harbour is an artificial one, formed by the construction of a breakwater, and is ont of the finest pieces of engineering skill in the world,—so very fine, in fact, that it cost 40,000,000 dollars to construct all the works at the station. But the officers of the yard frankly acknowledged to our emissary sent over by our Navy Department that a few ironclads could easily destroy the whole place. The French, as a consequence, no longer add to the works of Cherbourg. They bend their efforts to perfecting Brest, Toulon, and Indret. But the English, with John Bull obstinacy, work away at Plymouth all the while, confessing that when it is done it will be unsafe in war.

MINES, METALLURGY, &c.

A New Source of Coal Supply for Mediterranean Steam Shipping.—Despatches of considerable interest and importance to the steam shipping and coal trades have been received in Liverpool, intimating that a very extensive bed of coal has been discovered at the foot of Mount Olympus, thirty miles from Salonica. It would appear that the Viceroy of Egypt having received a hint that coal was to be found in the vicinity of Mount Olympus, secured possession of that wild district, and immediately commenced operation for the striking of the stratum. These operations were successful, and the result is that after reserving for the Steam Company Azizie, of Alexandria, full supplies to the extent of its requirements, the Viceroy proposes to throw open to all nations the delivery of the fuel, which can be furnished at the rate of 10 francs per British ton, a figure immensely below the present cost of coal in any depot along or around the Mediterranean seaboard. The importance of this discovery cannot be too highly estimated, for not only will it effect an immense saving in the working of the steamers of the various companies trading to Alexandria and the eastern ports of the Mediterranean, but it is not improbable that depots may be formed to meet the requirements of the Red Sea traffic, because coal can be shipped from Olympus and stored at Suez at a cheaper rate than coal drawn from other resources of supply. The only obstacle which at present presents itself is the probable anger of the immortal gods at having their favourite resort turned into a colliery, but this is little likely to disturb the infidels who have projected the desecration, and whose immediate object is worldly gain.

Gun-Cotton in the American Mines.—The application of Messrs. Prentice's (Stowmarket) gun-cotton is becoming very general in the mines of California and Nevada, the greatest satisfaction being expressed with regard to it in every instance in which it has been employed. At the New Almaden Quicksilver Mines it has been largely used, and Mr. C. E. Hawley, the chief engineer, reports that the gangue rock of the Almaden vein is very hard magnesian limestone, in many places worth 30 dols. per foot (lineal) to work in ordinary drifts of 6ft. by 5ft. In other parts of the mine the rock is partially decomposed and easy to work. To his surprise, the miners in soft rock were more desirous than any others of using gun-cotton. He considers that the most valuable quality it possesses for their use is its freedom from smoke. This vein is extremely irregular, and its workings of great extent. Good ventilation cannot be maintained everywhere, and smoke of the richest "labores" in the mines are now seriously delayed by the smoke of blasting powder. The perfect freedom from smoke of the gun-cotton would warrant the using a limited quantity at considerably greater cost than powder. In Nevada City district and Calaveras the opinions expressed are equally favourable, and may predict that in the Pacific States the use of gun-cotton for mining purposes will eventually be universal.

The Tin Plate Trade.—From the commencement of the American war to its close a few months ago, the tin plate trade of this country suffered severely owing to the great falling off in the demand from the States, which were previously such important customers. Many of the works were only employed three or four days a week, and makers, as a rule, preferred to stock their plates rather than sell at the exceptionally low prices that prevailed. The result of this was at the end of last year the stocks in all the makers' hands had reached the enormous quantity of something like 300,000 boxes, and this was quite independent of the heavy stocks in the warehouses of buyers. About the commencement of 1865 the trade moved a little, and from that time up to the present there has been a gradual improvement in both demand and prices. The stocks in America being necessarily low, gave confidence to makers that there must ultimately be a brisk demand from that country, and their confidence was not misplaced, for already a number of orders have arrived, and large ones are reported to be coming. This and other circumstances have given remarkable firmness to the trade, and there is every prospect that, if the political horizon keeps clear, the tin plate trade will be in a prosperous position before long.

Our Iron Exports.—It is only when we cast a retrospective glance at the last ten or or fifteen years that we realise the enormous development of British commerce during that period. Thus, the total value of iron and steel exported from the United Kingdom in 1850 was £5,350,056; in 1851, £5,830,370; in 1852, £6,684,276; in 1853, £10,845,422; in 1854, £11,674,675; in 1855, £9,465,642; in 1856, £12,966,109; in 1857, £13,603,337; in 1858, £11,197,072; in 1859, £12,314,437; in 1860, £12,154,997; in 1861, £10,326,646; in 1862, £11,365,150; in 1863, £13,150,936; and in 1864, £13,214,294. Comparing 1864 with

1850, we have thus an increase of £7,864,238, or 146·91 per cent. Every description of iron has contributed to this progress, with the exception of old iron for re-manufacture. Thus, the value of the pig and puddled iron exported in 1850 was £348,074, while it was £1,411,513 in 1864; the value of the bar, angle, bolt, and rod iron, and of the railway iron of all descriptions, rose from £2,801,043 in 1850, to £5,819,790 in 1864; the value of the wire exported, from £86,573 in 1850, to £396,757 in 1864; of the cast-iron, from £215,332 in 1850, to £656,085 in 1864; of the hoops, sheets, boiler-plates, and wrought iron of all sorts, from £1,454,010 in 1850, to £4,017,393 in 1864; and of the unwrought steel, from £393,748 in 1850, to £881,503 in 1864. The value of the old iron for re-manufacture, exported in 1850, was £50,876, but it had declined to £31,253 in 1864.

THE MINERAL RESOURCES OF EGYPT.—In a paper entitled "Remarks on the Geology of Parts of the Sinaitic Peninsula," the Rev. W. Holland stated that the Peninsula of Sinai is composed of three great geological elements. The first and most extensive is the northern table land of limestone known as the Desert of Tih. The next element is the sandstone formation, and this is especially interesting, as having formed the great mining district of the Egyptians. A few hours south of Mount Sinai is also a curious patch of sandstone, occurring in the midst of the granite district, which has been quarried for stone for building at the Convent of St. Catherine. The principal Egyptian mines were apparently turquoise, and were extensively worked at Serabit-el-Kadim and Wady Mughâra. Twenty years ago Major McDonald visited this spot, and succeeded in obtaining a large quantity; the specimens produced were of his discovery. The author was also of opinion that copper did not exist on this peninsula, although Dr. Stanley speaks of "the copper mines of Serabit-el-Kadim and Wady Mughâra." It would appear, however, that the hematite iron which abounds here and in Wady Mokatteb, was worked by the Egyptians, and perhaps by an earlier race, for undoubted stone hammers and flint instruments are frequently found. Large quantities of crystallised rock salt exist. But though no traces of copper exist at the above mentioned spots, there is undoubtedly copper in the peninsula, as a year and a half ago an Arab appeared with a camel load of stone, which contained apparently a very large amount of copper, but owing to some mistake the man was allowed to leave without questioning. Major McDonald has also found a large heap of copper slag, which, if in a less remote region, might be re-smelted with profit. The granite formation is the next element, and includes the greater part of the peninsula. The granite mountains are frequently seamed from top to bottom with veins of porphyry and basalt, and present a peculiar striped appearance, which adds much to the beauty of the country; but they are destitute of metal ores. Dr. Wilson speaks of finding the sides of a mountain on the east of Wady Mokatteb peeled and excavated to a great extent; but the author of this paper states that he searched several times for this mountain without success, and Major McDonald thinks t at the gentleman must have mistaken the Arab charcoal furnaces for ancient smelting places. Specimens of iron ore were also obtained from the Arabs. Many of the granite mountains between Serabit-el-Kadim and West Mughâra are capped by a stratum of sandstone of considerable depth, and in all cases it is perfectly horizontal, showing that it was deposited after the upheaval of the igneous rocks; an additional proof of this was the apparent absence of any change in the nature both of the limestone and sandstone rocks at the juncture with the granite. The author also alluded to the boiling sulphur springs and hot caves of Jebel Hammam and the tepid springs at Tor, and stated that the heat of the latter springs had been much exaggerated, for fish were to be seen swimming within a few yards of the fountain head.

MOVEMENT IN GOLD.—It appears that the imports of gold into the United Kingdom in July amounted to £605,597, as compared with £1,057,873 in July, 1864, and £1,689,112 in July, 1863. The great contraction disclosed by these figures was due to the decline in the imports of gold from the United States, which fell to £93,794 in July, as compared with £546,739 in July, 1864, and £507,694 in July, 1863. The total imports of gold for the seven months ending July 31 this year were £7,796,959, as compared with £10,297,075 in 1864, and £11,425,555 in 1863 (corresponding periods). The imports from Australia to July 31 were £1,411,761, against £1,913,265 in 1864, and £3,592,044 in 1863 (corresponding periods); from Mexico, South America (Brazil excepted), and the West Indies, £1,672,536, against £3,014,540 in 1864, and £2,495,611 in 1863 (corresponding periods); and from the United States, £2,276,189, against £4,760,240 in 1864, and £3,988,393 in 1863 (corresponding periods). The exports of gold from the United Kingdom in July amounted to £749,957 as compared with £1,532,514 in July, 1864, and £760,545 in July, 1863. The principal quarters to which gold was exported in July were France and Spain, but the shipments in those directions were on a largely reduced scale as compared with July, 1864, although they were considerably in excess of the corresponding figures for July, 1863. The total exports of gold from the United Kingdom in the seven months ending July 31 this year were £4,280,212, as compared with £9,111,893 in 1864, and £9,414,163 (corresponding periods). The export of gold to Russia, which attained a considerable total in 1863, wholly ceased in the first seven months of 1864 and this year. The exports of gold to France declined to £2,207,072 to July 31 this year, against £4,821,971 in 1864, and £2,268,189 in 1853 (corresponding periods); the exports to Spain and the Canaries amounted to July 31 to £891,802 against £1,250,491 in 1864, and £935,114 in 1863 (corresponding periods); to Egypt, to July 31, to £291,127, against £1,441,800 in 1864, and £1,009,983 in 1863 (corresponding periods); and to Brazil, to July 31, to £362,898, against £891,413 in 1864, and £1,011,693 in 1863 (corresponding periods).

CAST STEEL IN GERMANY.—The manufacture of cast steel makes rapid progress in Germany, and at present an establishment for the manufacture thereof on a very extensive scale is erecting at Hagen, Westphalia. The Saxton cast steel manufactory at Dochlen did very well last year, and, besides writing off a large amount, paid the shareholders a dividend of twelve per cent. per annum; highly favourable results have likewise been obtained by Mr. Krupp in Essen, and the mystery in which this gigantic establishment was veiled hitherto has been to a great extent disclosed by a lecture given by Mr. Bug at the last meeting of the Lower Austrian Trade Association. The establishment, with the buildings now in the course of erection, occupies an area of about seven hundred acres; there are altogether eight thousand hands employed on the premises, whose aggregate fortnightly wages amount to £12,000 sterling. Seventy-five steam engines, of from 3,000 to 4,000 horse-power in the aggregate, and varying in capacity from one to 1,000 horse power, supply the moving power, while one hundred and fifty boilers consume six hundred tons of coal in twenty-four hours, and evaporate 170,000 cubic feet of water. The forging is done by means of thirty-five steam hammers, varying from one to fifty tons in weight; the last is reported to be the largest in the world; it rests upon a foundation weighing fifteen hundred tons, and cost £90,000. The steel is prepared in crucibles, for the reception of which two hundred and forty ovens have been built. The production of cast-steel in 1863 amounted to 11,150 tons, and in the first six months of 1864 to 8,035 tons. To light up the whole, 200,000 cubic feet of gas are consumed in the average during twenty-four hours. Krupp's cast steel is well known in England, but his establishment is especially famous for turning out good guns.

GAS SUPPLY.

NEW GASWORKS FOR SEVENOAKS.—Owing to the rapid increase of building in the Sevenoaks neighbourhood, and the certainty of a new town springing up in the immediate vicinity of the new South-Eastern Railway Station, the present gasworks have been found inadequate to the supply, and the directors determined upon erecting new works, and a piece of ground near the London, Chatham, and Dover station has been secured.

THE EASTBOURNE GAS COMPANY have declared a dividend of 10 per cent. and a reduction in the price of their gas from 5s. 10d. to 5s. An opposition to this company is springing up, on the ground of the high price still charged by the company.

THE STAFFORD GAS COMPANY are largely extending their works, in order to supply the greatly increased demand for gas in this town and neighbourhood. A new tank and gasholder are in course of erection, at an outlay of about £5,000. The new works, it is said, will enable the manager to make gas at a cheaper rate.

GAS SUPPLY TO THE CITY.—Dr. Letheby, as the gas analyst of the City, has reported that in the course of the quarter ending in August last there had been 656 examinations of the illuminating power of the gas supply by the three City companies, and the results were that the illuminating power of the Great Central gas had averaged 14·23 standard sperm candles, that of the Chartered 14·33 candles, and that of the City Company 14·19 candles; and the illuminating power had not in any case been under the requirements of the Act of Parliament. With respect to the chemical quality of the gas, he had to report that the City and Great Central gas had always been free from ammonia, but that of the Chartered had always been highly charged with it; and as regards the proportion of sulphur in the gas, the weekly average of the City and Chartered Companies had rarely showed an excess of that impurity; but the gas of the Great Central Company had been always overcharged with it. While, for example, the average of the City gas had been 18·7 grains, and that of the Chartered 19·58, the proportion of the Great Central gas had been nearly 26 grains. Lastly, he had to report that the gas of each company had been always free from sulphuretted hydrogen, and that the average pressure at which the gas had been supplied to the public had been above an inch of water.

WATER SUPPLY.

THE HUDDERSFIELD WATER SUPPLY.—At the last monthly meeting of the Huddersfield Improvement Commissioners, it was stated by Mr. Hobson that the Waterworks Commissioners were going to apply to Parliament for power to increase the present water supply. They had to furnish 500,000 gallons daily, to supply the town adequately; but, for the last five months, the gauges showed that all their sources of supply furnished less than 250,000 gallons; and the result was great inconvenience to the inhabitants.

APPLIED CHEMISTRY.

NEW SOURCE OF OXYGEN.—The expense of obtaining oxygen from the ordinary sources, even by the most approved methods, is so considerable as to preclude the possibility of its employment for domestic, or even industrial purposes. This difficulty, it is supposed, is likely to be removed; and a company has been established at Paris which proposes to furnish oxygen so cheaply that it may be employed in the combustion of gas for illuminations, not only without increasing the expense, but actually lessening it 50 per cent., besides getting rid of certain inconveniences—such as the production of a large amount of heat and of gases injurious to health, and the consumption of air required for respiration, &c. This company expects to be able to supply oxygen at the rate of about threepence the cubic foot—a quantity which costs for the Drummond light, and derived from chlorate of potash, fifty or sixty times as much—and to forward it to the consumer, under a pressure of four or five atmospheres, in receptacles similar to those used with portable illuminating gas. It is calculated that the use of oxygen, for the same amount of light, will diminish the quantity of coal gas required to one-eighth of what is consumed at present; and no danger is anticipated from explosion, as the oxygen will meet the hydrogen only at the mouth of the jet. With this, however, we can scarcely coincide, since, to burn the mixed gases safely, requires some important precautions. The oxygen is obtained by acting on sulphate of lime with silex in a furnace of peculiar construction, the results being silicate of lime, sulphurous acid, and oxygen—

$$S_2\,O_3 + Ca\,O,\,S\,O^3 = Ca\,O,\,Si\,O_3 + S\,O_2 + O$$

The gaseous mixture is conducted into a chamber, where it is exposed to a pressure of three atmospheres, which liquefies the sulphurous acid; the oxygen is purified by transmission through lime-water, and then compressed.

ALKALI METALS ON GUN COTTON.—Mr. W. S. Scott recently stated that in the course of some experiments he accidentally dropped a piece of potassium on some gun cotton lying on his laboratory table, and was surprised to see that the gun cotton immediately exploded. He then instituted a series of experiments to ascertain what conditions were essential for explosion to take place—whether the explosion was due to moisture, whether other metals would act similarly on gun cotton, &c. He found that by taking precautions to prevent friction, the gun cotton still exploded. When sodium was used a like result was obtained, even though the gunpowder was rendered perfectly anhydrous. If amalgam of potassium or sodium were used no result was obtained. Various metals were tried, but decided effects were obtained only with the metals of the alkalies. In the course of his paper, the author stated that if metallic arsenic were mixed with gun cotton a blow of the hammer was sufficient to fire it. In illustration of his discovery, Mr. Scott demonstrated in the room that a piece of potassium fired instantly a piece of gun cotton, into which it was dropped.—In reply to Prof. Wanklyn, Mr. Scott said he referred the action to that class of phenomena known as catalysis.

ON A NEW SERIES OF BODIES INTERMEDIATE BETWEEN NITRIC ACID AND AMMONIA, BY DR. A. W. HOFMANN, F.R.S.—In the course of a discussion on a paper read at the Birmingham meeting of the British Association, Section B, by Dr. C. Calvert "On the Action of Acids on some Metals and Alloys," Dr. Hofmann asked Professor Calvert whether, in his experiments on the action of acids, and more especially of nitric acid, upon the metals, he had met with some of the extraordinary bodies lately observed by Dr. Lossen. This young chemist, at one of the late meetings of the Berlin Academy, had laid before that body an account of several substances which had attracted general attention. It was well known that among the products of the action of nitric acid upon certain metals ammonia invariably occurred. But it appeared that ammonia was only the last product of the reaction, and that a whole series of intermediate compounds existed between nitro-ammonia acid, the substance acted upon, and the last product of its reduction. One of these bodies Dr. Lossen had succeeded in isolating. It was a compound which, from its composition, might be termed protoxide of ammonia, having, in fact, the formula H_3NO. This substance, like ammonia, combined with acids, producing a series of magnificent salts remarkable for the facility with which they crystallise. The simplest method of producing this interesting compound consisted in submitting nitrate of ethyl to the action of metallic zinc in the presence of an acid. It would be observed that the derivation of the new body from nitric acid was perfectly analogous to that of aniline from nitrobenzol.

Nitrobenzol.	Aniline.
$C_6H_5NO_2$	$C_6H_5NH_2$
Nitric acid.	Hydorylamine.
HO,NO_2	HO,NH_2

The new body might be looked upon as ammonia, in which one atom of hydrogen is displaced by what might be called the rump of water, the atomic group HO, which by some had been called hydroxyl, by others hydoryl.

Ammonia	Hydorylamine.
$\left.\begin{matrix}H\\H\\H\end{matrix}\right\}N$	$\left.\begin{matrix}HO\\H\\H\end{matrix}\right\}N$

It was certainly interesting to see the simplest of reactions, familiar to every chemist, still yielding a harvest of such splendid results!

LIST OF APPLICATIONS FOR LETTERS PATENT.

We have adopted a new arrangement of the Provisional Protections applied for by Inventors at the Great Seal Patent Office. If any difficulty should arise with reference to the names, addresses, or titles given in the list, the requisite information will be furnished, free of expense, from the office, by addressing a letter, prepaid, to the Editor of "The Artizan."

Dated August 29th, 1865.

2214 R. T. Hulmes—Disengaging runaway horses from carriages
2215 G. Robinson—Moulds for casting metallic pipes
2216 A. Gwilt—Condensing and utilising sulphurous smokes and vapours
2217 R. Laming—Invention of improvements in electrical telegrophy
2218 G. Zanni—Rendering every description of sewing machine self-acting
2219 H Terrell and T. Don—Treating peat and other plastic materials
2220 W. H. Gummer—Stench trap and sink pipe protector
2221 W. P. Gregg—Invention of an improved roller skate
2222 I. Bailey and W. H. Bailey—Combing wool and other fibrous substances
2223 W. Clark—Improvements in apparatus for propelling vessels
2224 G F. White and H. Chamberlain—Apparatus for elongating and contracting waist and other belts
2225 T. Cope and W. Guest—Manufacture of rope cordage and such like fabrics

Dated August 30th, 1865.

2226 W. Brookes—Construction of cast and other iron bridges
2227 J. C. Green—Permanent way of railways and in carriages for the same
2228 J. Fellows—Handles for saucepans and other cooking utensils
2229 W. Crookes—Separating gold and silver from their ores
2230 C. F. Anderson and D. Durant—Apparatus to be applied to pockets to ensure the safety of their contents
2231 J. H. Johnson—Preparation of extracts to be used in tanning
2232 T Wrigley and M. B. Westhead—Preventing the vibration of windows
2233 W. H. P. Gore—Securing corks in the necks of bottles
2234 S. L James—Improvements in traction engines and other vehicles
2235 S. Gilbert and S. Gilbert the younger—Tilling land
2236 G. Smith and C. Ritchie—Improvements in brushes
2237 M. Judge—Manufacture of the bottoms of boilers and tea kettles

Dated August 31st, 1865.

2238 E. Cowpe and D. Haicock—Applying electro magnetism as a break power on railways
2239 M. Woodfield—Apparatus for carrying securely railway and other tickets, so as to afford a ready inspection thereof
2240 W. Carron—Improvements in the manufacture of screws
2241 W. H. Brown—Manufacture of cast steel and other metallic tubes
2242 W. George—Preventing the jolting of two-wheeled carriages
2243 G. Smeaton—Cleaning the outside of windows from the interior
2244 H. C. Ash—Invention of improvements in ice safes
2245 O. Bennett—Steam blower or blast apparatus for furnaces
2246 W. T. Read—Improvements in apparatus for stopping bottles
2247 W. E. Newton—Obtaining spirits of turpentine from wood
2248 W. E. Newton—Improvements in the manufacture of paper pulp
2249 J. Ward—Covers for saucepans and other cooking utensils
2250 J. Ward—Fixing the bobbins of winding machines on to their spindles
2251 J. Leslie—Cutting the terry or loops of fustian cords and similar fabrics

Dated September 1st, 1865.

2252 T Lomas—Separating the sulphide of iron from carbonaceous matter
2253 R. Knowels & J. Lindley—Protecting the edges of counterpanes
2254 J. M. Carter—Improvements in shirts and other garments
2255 A. V. Newton—Invention of an improved steam beating apparatus
2256 W. Clark—Improvements in the permanent way of railways
2257 W. Clark—Laying and maintaining submarine telegraph cables
2258 R. Davies—Improvements in propellers for ships and boats
2259 C. Hersley—Apparatus for measuring water or other fluids
2260 J. Lake—Generators for agricultural or other locomotive engines

Dated September 2nd, 1865.

2261 J. Sproul—Invention of laying ocean telegraph cables
2262 K J. Perceval—Apparatus to be used in laying cables in deep water
2263 J. Elverson—Improvements in apparatus for sawing curved designs
2264 W. Barford—Invention for improvements in mills for grinding
2265 S. Chatwood—Manufacture of metallic safes and strong rooms
2266 C. Reichen—Preparing charges for fire-arms and for blasting
2267 H. Ellis—Production of silicated alkaline inks, colours and dyes

Dated September 4th, 1865.

2268 S R Freeman and A. Grundy—Connecting railway carriages
2269 J. Drabble—Apparatus used for removing axle-boxes from wheels
2270 S. Kettle—Water-closet apparatus, urinals, and the like
2271 P. Mavraud—Disconnecting horses from carriages and other vehicles
2272 J. Howard, W. Stafford, and W. P. McCallum—Preventing incrustation and likewise explosion in steam boilers
2273 A. V. Newton—Improvements in life rafts and surf boats
2274 R. A. Brooman—Winding-up watches and other time-keepers

Dated September 5th, 1865.

2275 J. Snider—Improvements in the construction of fire-arms
2276 J. C. Evans and W. Fairlie—Raising and lowering heavy bodies
2277 J. Graud—Cast steel for the manufacture of wheel tyres
2278 J. Neat and F. Ford—Hair brushing machinery or apparatus
2279 T. T. Ponsonby—Ornamenting and surfacing articles of wood
2280 T. B. Baily—Ornamentation of fringes and trimmings
2281 W. Bauger—Melting sealing wax, glue, and other substances
2282 H. H. Doty—Splitting, shaving, and paring hides

Dated September 6th, 1865.

2283 L. Gachin—Heating irons for curling or frizzling hair
2284 S. Soutar—Fixing and unfixing the tubes of steam boilers
2285 J. Pilkington—Preparing cotton and other fibrous materials
2286 W. Clark—Improvements in steam engines and valves
2287 R. A. Purkis and G. Calloway—Stitching or sewing machines
2288 W. Mycock—Lubricating shafts and other running surfaces
2289 T. Nicholson—Apparatus for making caustic liquor
2290 T. C. Gibson—Machinery for mixing or grinding paints
2291 E. Green and E. Green the younger—Boilers and furnaces
2292 A. W. Parker—Ice houses, and in glaciaria or skating places

Dated September 7th, 1865.

2293 F. Tolhausen—A new fire-work to be called Pharoah's serpent
2294 J. M. Hart—Construction of iron safes and strong boxes
2295 J. Smith—Certain improvements in looms for weaving
2296 J. Dawson—Supplying charcoal to sugar decolourising vessels
2297 W. Oldham—Improvements in machinery for winding yarn crops
2298 A. Duvernois—An improved fire-place with turning grate
2299 A. Morel—Combing wool and other fibrous substances
2300 W. L. Wise—Apparatus for hulling and winnowing grain
2301 J. Askew—Improvements in apparatus for stoning raisins
2302 W. Cory and J. H. Adams—Unloading vessels containing coals or grain

Dated September 8th, 1865.

2303 A. Mackie and J. P. Jones—Composing or setting type for printing
2304 J. Weems and W. Weems—Construction of hydrostatic presses
2305 J. Webster—Improvements in hydraulic and hydrostatic pumps
2306 J. Walker—Working guns in ships, forts, and batteries
2307 W. Unwin—Improvements in the manufacture of iron
2308 A. Mackie and J. Paterson—Improvements in the method of lighting gas, and in apparatus connected therewith

Dated September 9th, 1865.

2309 J Anderson—Apparatus for signalling and indicating on railways
2310 J. Brigham and R. Bickerton—Reaping and mowing machines
2311 H Shanks—Improvements in the winding of knitting cotton
2312 W. E. Newton—Improvements in machinery for making lace
2313 J. Hose—An improved wheel feed for sewing machines
2314 J. Casthelaz and N. Basset—Manufacture of oxalic acid
2315 G. T. Bousfield—Manufacture of flexible tubing or hose
2316 R. P. Roberts—Cleansing and coating the bottoms of ships
2317 R. C. Newbery—Improvements in articles of wearing apparel
2318 A. E Nordenskiold and J. W. Smith—Fire-proof safes
2319 J. Pennington—Opening and closing carriage and other windows

Dated September 11th, 1865.

2320 S. Davis—Invention of an improved stirrup latch bar
2321 W. Tyne, S. Tyne, and R. Clayton—Improved mode of removing and preventing the incrustation of steam boilers
2322 W. Hewitt—Preventing the incrustation of steam boilers
2323 H. Hackett, T. Wrigley, and E. Pearson—Safety valve
2324 C. T. Burgess—Invention of improvements in reaping machines
2325 C. A. McEvoy—Improvements in pipes used for smoking
2326 S. Inkpen—Covering submarine telegraph cables
2327 J. Lightfoot—Dyeing and printing fabrics and yarns
2328 C. Huntley—Improvements in cricket, racket, and foot balls
2329 C. J. Webb—Apparatus applicable to the lighting and reviving of fires
2330 D Keys—Winding up fusee watches and pocket chronometers

Dated September 12th, 1865.

2331 J. Badger and J. H. Steff—Harrows and similar agricultural implements
2332 J. Macintosh—Constructing and insulating telegraphic conductors
2333 G. Tangye and J. Jewsbury—Pulleys for raising and lowering heavy bodies
2334 J. Welch—Improvements in the manufacture of swivels
2335 J. Halliday—Preparation of certain colouring matters
2336 T. D. Stetson—Improvements in clothes wringing machines
2337 W. J. Murphy—Hydraulic break for railway and other purposes
2338 R. A. Boyd—Improvements in cooling bacon-curing rooms or chambers

Dated September 13th, 1865.

2339 J. Dunbar—Improvements in the construction of boots and shoes
2340 J. Dunbar and J. W. Butler—Distribution of perfumes
2341 J. O. C. Phillips—Construction of submarine telegraph cables
2342 J. Dodd—Improvements in mules for spinning and doubling
2343 A. V. Newton—Invention of improvements in spinning frames
2344 J. P. Woodbury—Invention of a new locomotive car
2345 F. W. Prince—Breech-loading fire-arms and in cartridges
2346 S. Soutar—Improved apparatus for cleaning the tubes of steam boilers
2347 D. Hyam and J. Hyam—Fastening for purses and such like articles
2348 S. Fox—Manufacture of umbrellas and parasols
2349 S. Wales—Invention having reference to windows or the sashes thereof

Dated September 14th, 1865.

2350 T. Bell & T. L. G. Bell—Calcining and roasting copper and other ores
2351 G. P. Harding—Tubes for gun barrels and other purposes
2352 I. Beamish—Invention of improvements in lubricating
2353 J Lewis—Machinery for making rivets and such like articles
2354 W. B E. Ellis—Improved form of rifling for fire-arms
2355 J. Wakefield—Machinery for the manufacture of rivets
2356 W. Clark—New improvements in magnetic telegraphs

Dated September 15th, 1865.

2357 L. G. Sourzac and L. Bombail—Rendering leather more durable
2358 J. Whitehouse—Improvements in the manufacture of iron boxes
2359 E. T. Read—Improvements in apparatus for cutting tobacco
2360 R. A. Brooman—Locks for trunks and other like articles
2361 W. Blundell—Improvements in cooling, heating, and evaporating
2362 S. Myers—Improvements in smoking pipes and cigar holders
2363 A. V. Newton—Improved machinery for cutting wood
2364 H. Law—Caissons for closing the entrances of docks and canals
2365 R. M. Lowne—Vent pegs for casks or vessels from which beer is drawn
2366 W. Clark—Invention for improvements in saddles and harness
2367 F. Meyer and J. W. Freestone—Manufacture of night lights

Dated September 16th, 1865.

2368 J. K. Hoyt—Bobbins used in spinning and winding yarns
2369 H. A. Bonneville—Invention of improvements in snve-alla
2370 H. A. Bonneville—Safety lamps for mines and other localities
2371 J. H. Johnson—Apparatus for shaping metal articles
2372 W. Esson—Improvements in the construction of gas meters
2373 F. Carlier—Arrangement of apparatus for extinguishing fires
2374 A. J. Sedley—Propulsion of vessels

Dated September 18th, 1865.

2275 M. Henry—Railway breaks
2376 F. Dainn—Apparatus for condensing the steam of steam engines
2377 O. W Jeyes—Improved method of making effervescing drinks
2378 H Venables—Improved method of ornamenting the surfaces of tiles
2379 R. Aitken—Inventions of improvements in locomotive engines
2380 G. A. Keene—Feathering paddle wheel
2381 A. V. Newton—Projectiles

Dated September 19th, 1865.

2382 C Worssam—Consuming smoke in furnaces
2383 J. C. Broadbent—Safety apparatus for cages and hoists
2384 R. Fox—Securing or fastening metal plates to beams
2385 J. Fletcher—Apparatus for the treatment and manufacture of sugar
2386 G. Smith and C. Ritchie—Brooms and brushes for sweeping and dusting
2387 E Clark—Dry ducks
2388 R. A. Brooman—Engraving on metal
2389 H. Lloyd—Sun shades for perambulators and other wheeled carriages
2390 I. S. McDougall—Manufacture of insoluble oils and greases
2391 E. A. Cowper and C. W. Siemens—Separating dust from the gases evolved from blast furnaces for smelting iron
2392 J. Gillespie—Bricks

Dated September 20th, 1865.

2393 L. Villette—Cutting and shaping cork
2394 J. H. Johnson—Railway carriages and other vehicles
2395 J. Edmondson—Looms for weaving
2396 H. A. Duferne—Screw wrenches
2397 D. J. Fleetwood—Spoons, forks, and other similar articles
2398 W. Purter—Bricks and tiles
9399 J. Tye—Crushing and grinding wheat and other grain
2400 E. Petito—Communicating between the occupants and drivers of vehicles
2401 D. Spink—Casting metals

Dated September 21st, 1865.

2402 N. B. Thoyts—Billiard marker
2403 J. B Hulme—Improvements in machinery for excavating earth
2404 S. Trotman—Paper
2405 W. Watkin—Furnaces for the consumption of smoke
2406 J. Goulding—Bobbin holders
2407 E. W Collier—Securing the labels of goods conveyed on railways
2408 A. V. Newton—Railways and in the wheels for railways
2409 W. Clark—Decolouring sugar and other sacchorine matters
2410 H. Hibling—Boots and shoes
2411 B. Chaffer, J. Thompson, and C. Thompson—Polishing stones
2412 H A. Davis—Affixing postage stamps
2413 R. A. Brooman—Blast furnaces
2414 W. R. Lake—Hoisting machines
2415 A. Bird—Purifying water

Dated September 22nd, 1865.

2416 W. Boggett—Wire conductors for electro telegraphic purposes
2417 F. T. Brandreth & J. H. Brandreth—Brushing hair by machinery
2418 R. Atkin—Applying the screw propeller to vessels
2419 C. W. Orford—Collecting and diffusing of water or other fluids
2420 H. Rankin—Bags and envelopes made of paper and other fibrous materials
2421 W. Moseley—Indicator for electric bells
2422 J. Sheldon—Binding gr in
2423 M Cartwright—Adaptation of elastic material to articles requiring a bellows arrangement
2424 A. Schultz Colouring matter
2425 G. B. McNicol—Obtaining motive power
2426 J. Davidson—Casks
2427 P. Spence—White lead
2428 C. White and T. White—Socks for boots and shoes

Dated September 23rd, 1865.

2429 H. A. Bonneville—Lubricating machinery
2430 J. E. Tuchet—Fastening envelopes
2431 E. T. Hughes—Sewing machines
2432 W. Turner, S. Shore, and W. Halliwell—Cards used in carding machines
2433 G. Davies—Horse-shoes
2434 W. J. M. Rankine—Feathering paddles and oars
2435 J. H. Johnson—Generating illuminating gas
2436 T. V. Lee—Preparing peat or turf for fire-lights and fuel
2437 J. Donnell—Machinery for cutting or mincing meat
2438 W. E Newton—Breech-loading fire-arms
2439 A. V. Newton—Generating illuminating gas
2440 G. E. Rolland and E. L. Rolland—Cleansing various substances
2441 J. Parkins—Bordering paper and envelopes

Horizontal Boring Machine.

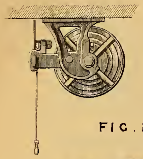


FIG. 1

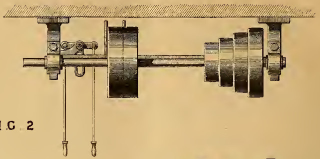
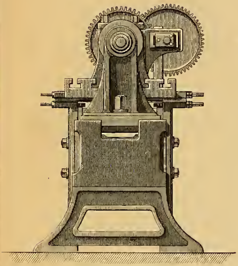
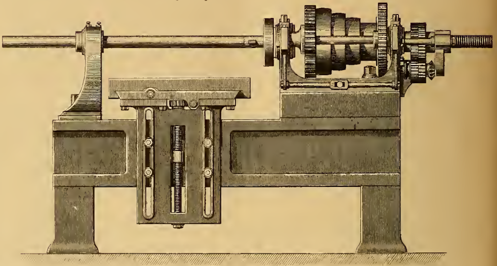


FIG. 2





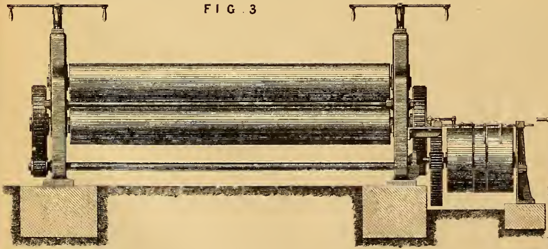
12 6 0 1 2 3 4 5 6 7 feet

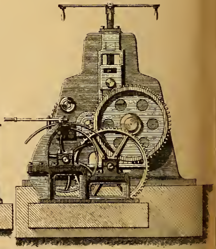
Scale to Figs 1 & 2

Plate Bending Machine.

FIG. 4

FIG. 3





12 6 0 1 2 3 4 5 10 15 feet

Scale to Figs 3 & 4

W. Smith C.E. direx.

THE ARTIZAN.

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NOVEMBER 1st, 1865.

WORKSHOP MACHINERY.

Improved Boring, Plate Bending and Punching, and Shearing Machines.

(*Illustrated by Plate* 288.)

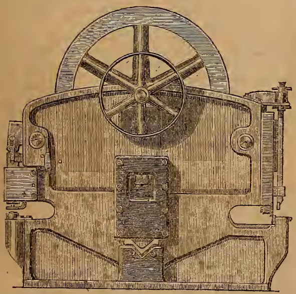
In continuation of our former remarks upon the subject of workshop machinery and machine tools, we now proceed to give some account of the most recent forms of this description of machinery as manufactured by Messrs. W. Collier and Co., of the Greengate Mills, Salford, Manchester. In the accompanying Plate, No. 288, figs. 1 and 2 show respectively an end and side elevation of a horizontal boring machine, which, from its simplicity, combined with the great variety of work which it is capable of performing, renders it worthy of especial attention.

The driving head stock can be used either as single or double geared. The table upon which the work to be bored is fixed, admits of vertical and horizontal adjustment, thus giving great facilities for centering, and obviating the necessity of using loose packings, thus effecting considerable saving of time and insuring accuracy.

The boring head is caused to progress by a self-acting feed operating through the hollow head stock spindle. This machine is capable of drilling the hole requisite to allow the boring head to be entered, and the largest made by Messrs. Collier will bore a cylinder 4ft. in diameter and 8ft. long. Figs. 3 and 4 represent one of Messrs. Collier's plate bending machines. The rollers are 12ft. 3in. in length and 18in. in diameter, and are made with wrought iron centres passing through their entire length. The top roller is adjustable by means of screws and cross handles, by means of which the machine is set to give the requisite curve to any plate which may be undergoing the process of bending.

The accompanying woodcuts, figs. 5 and 6, represent respectively an

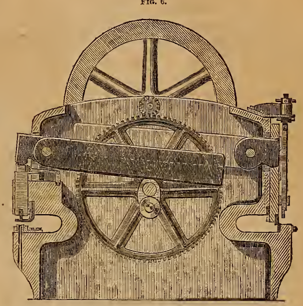
Fig. 5.



elevation and section of one of Messrs Collier's double lever punching, shearing, and bar-cutting machines. The massive framing of the machine is planed at each end to receive the punching and shearing slides, which are actuated by levers resting upon cams on the main driving shaft; of these cams there are two so fixed as to be diametrically opposite, and thus the punching and shearing portions of the machine are actuated alternately.

The cams are furnished with circular rollers, which act upon the levers during the operations of punching and shearing, the objects of using these being to reduce the friction. The levers are made of wrought iron, and

Fig. 6.



those portions of their surfaces upon which the cam rollers act are protected by being coated with steel, as also are their working surfaces in contact with the shearing and punching slides. The punching slide is provided with a block placed under the end of the lever by which it is operated, and by withdrawing this block the punch is thrown out of gear. At the shearing end of the machine an adjustable stop is added immediately in front of the shearing block, to hold down the metal being sheared, which insures its being cut square on the edge, and at the same time relieves the workman of the strain of holding the plate upon which he is operating. This is a great advantage, inasmuch as it is impossible by manual power to hold a plate perfectly steady.

By this arrangement short pieces of metal are also prevented from getting down between the cutter, and so breaking the machine.

Upon the end of the centre shaft is forged an eccentric which works within a block placed upon guides, so as to give it a vertical motion, and the lower end of this block carries blades of a suitable shape for cutting angle iron. This cutting apparatus is provided with disengaging gear in order to allow of its being thrown out of action while a long bar of angle iron is being placed between the cutters and set to the proper mark.

The cams are of such construction that the operation of punching or shearing a plate is completed in half a revolution of the driving shaft, the slide remaining stationary during the other half revolution, thus allowing the workman ample time to adjust his work for the next stroke. This enables the machine to be worked one-third quicker than the ordinary punching and shearing machines driven by eccentrics in which the punch and shearing blade are always moving. The levers are made sufficiently long and heavy at the tale end to overcome the weight of the slides, and the friction between the punch or shearing blade and the work. Great advantage is derived from the use of the anti-friction rollers to operate upon the levers; for whereas in the old machines not provided with such rollers there was so much wear that the strokes of the punch or shear blade were gradually lessened, now the friction is reduced to an inappreciable quantity, and the rollers tend to keep the oil on the wearing surfaces instead of acting as plane cams do in tending to scrape off the lubricating material.

HISTORICAL AND DESCRIPTIVE SKETCH OF THE MERSEY DOCKS AND HARBOUR.

By J. J. Birckel.

(*Illustrated by Plate* 289.)

We now have illustrated upon Plate No. 289 those portions of the Birkenhead Dock works, the details of which, as well as the scheme as a whole, have been for a period of twenty years a subject of so much controversy, namely, the low water basin, and the sluicing works connected with it.

The dimensions of that basin as finally adopted by Mr. Hartley are approximately as follows:—length, 1,650ft.; width at entrance, 300ft.; width along the face of the sluices, 400ft.; and its area, 14 acres, which it was proposed to scour by a discharge of water from the great float through two series of ten sluice gates 8ft. by 5ft. in cross section at the point where the clough (or sluice valve) is inserted, the twenty openings thus presenting an aggregate area of 800 sq. ft. The openings, however, are bell mouthed, and their height reduced proportionately in order to preserve as near as possible the same area throughout, the obvious object of this arrangement being to obtain, practically speaking, the discharge of a continuous sheet of water over the whole extent of the sluicing front. A 50ft. lock connects the low water basin with the great float, and the sluice gates are arranged symmetrically on both sides of this entrance, ten of them on each side communicating with an internal chamber or vault fed by a canal 30ft. in width, with a maximum depth of 19ft., sewer shaped over the greater part of its length, but terminating at its junction with the float by a square canal 30ft. wide, and entirely open at the top, fitted with gates, and prepared to be closed by means of a caisson 50ft. long, similar to that which has been illustrated in one of our previous numbers.

The area of cross section of this canal is about 450 square feet, that is a little more than the total area of the ten sluice gates which it feeds—for Hartley's rule upon the whole of these works has been to make the areas of his sewers equal to the sum of the areas of the cut waters which they feed, and he has adhered to it in the present instance also, apparently forgetting that while such a rule may answer very well in the case of a small sewer feeding the cut waters of an ordinary dock entrance, when applied to a system of sluices of such magnitude as the one which we are describing it must lead to very bad results. Thus, it may be shown that while the capacity for discharge of the sluice openings may practically be represented by the product of their areas into the velocity due to the effective head of water measured from the centre of the sluice gates, the capacity of discharge of their feed channel could, at most, be equal only to the product of its area by two-thirds the velocity due to the same head, but in reality would never reach to anything like that amount, owing to the great loss of velocity occasioned by friction against the sides of the channel. The consequence must be—and experience has demonstrated it—that a natural slope of the surface of the water will form, down which it will precipitate itself with great velocity, and partly destroy its momentum against the outer wall of the sluicing chamber, issuing through the sluice gates with a velocity considerably below that due to the apparently effective head. In Mr. Lyster's report, reproduced below, it will be seen that so great was the velocity with which the water precipitated itself from the float into the feed channels, that the ponderous gates with which they were fitted at their upper extremities were wrenched from their fastenings like mere sticks, although they were drawn tight into their recesses. In Mr. Lyster's second report it will be seen also that the disturbance of the water in the sluicing chambers was so great that it completely uprooted the floor of one of the chambers; and as we went down after it had been pumped dry, we are able to say that the havoc committed there was so great that it would be difficult to form an adequate conception of it without having actually seen it. It may, therefore, with justice be affirmed now, that in the detail of the feed channels the works were defective in their very design, since, even under the best possible circumstances, the areas of these channels should have been 1½ times the sum of the areas of the sluice gates.

In its structure the masonry of these works is similar to that described in our paper treating specially of that subject, and need, therefore, not now again be dwelt upon.

Various details, not specially pointed out here, are described plainly enough in the reports reproduced below, and it will probably be sufficient to state that both systems of sluices communicate, by means of sewers, with a couple of chain pumps, similar in every respect to those already illustrated, these being driven by the engines which work the force-pumps of the accumulator. The paddle-valves are worked by hydraulic power, but, as a measure of precaution, each sluiceway is provided with a second clough, to be worked by hand, in case of accident to the first; and, moreover, a third shaft is provided in front of the two first clough shafts, and for a similar purpose.

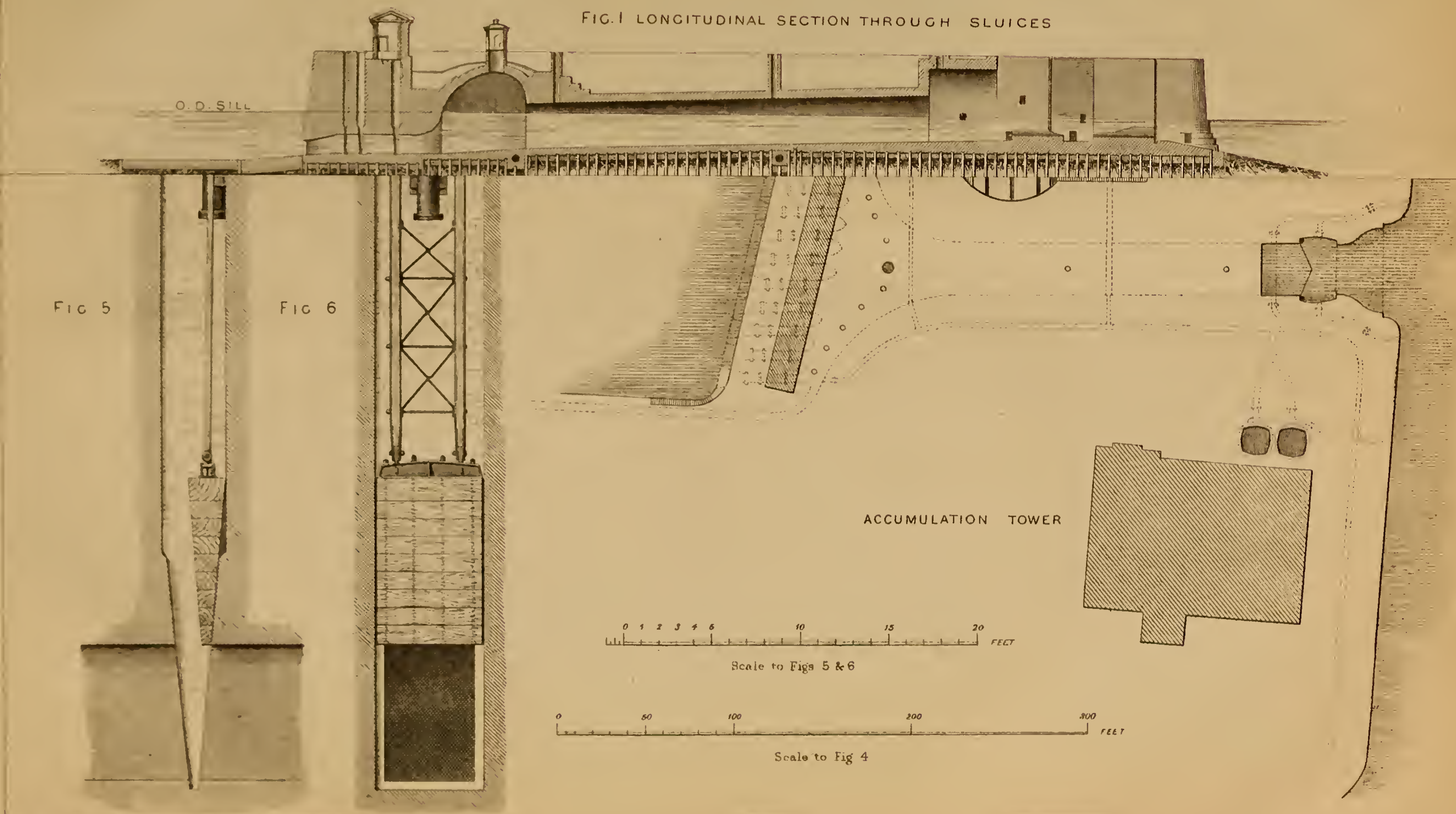
In the accompanying Plate 289, fig. 1 is a longitudinal section through one of the sluicing systems, shewing also a section of the shed which contains the machinery for working the paddle valves; fig. 2 is a longitudinal section through the 50ft. lock; fig. 3 represents cross sections through the lock and through the sluicing channels; fig. 4 is a general plan of the sluicing works, showing the air shafts over the sluicing chambers, the sewers, the position of the pump wells, the outline of the engine house and accumulator tower, the swing bridge over the 50ft. lock, and part of the low water basin, cross sections through the lock and through the sluicing canals; and figs. 5 and 6 are respectively an elevation and section of one of the sluice-valves, showing part of the hydraulic machinery and the shed.

In the accompanying woodcut we have also shown a cross section and a partial elevation of the coffer dam thrown across the mouth of the low water basin to shut out the sea from the area which is covered by it and by these works. This dam was constructed in the shape of a vertical arch, whose outer face was 540ft. in length; its chord, measured from the inner face, had a length of 467ft., and its versed line was 76ft. In cross section its width at the top was 16ft. 9in. inside, and its height above the original surface of the river bed was about 34ft; the piles which constituted its foundation, and the walings which bound them together, were made throughout of timbers 13in. square; the walings were disposed symmetrically on both its faces, and were bound together by 2in. tie bolts. Its cost, including removal, reached the high figure of about £35,000, and, as its cubic contents, calculated from the above measurements, are about 378,000 cubic feet, the cost per cubic foot does not fall far short of 2*s*. The only other feature of interest of this structure is that, like many other dams, it was tight until the sea broke through it by undermining it, after which it was made good again, or partially so, by backing it up with clay puddle.

We now produce Mr. Lyster's report on the first series of sluicing experiments, and the apparent results produced by them:—

"On the 12th of October last a partial attempt at sluicing was made by running water from the float through the large culvert, which is con-

DETAILS OF BIRKENHEAD DOCK WORKS.

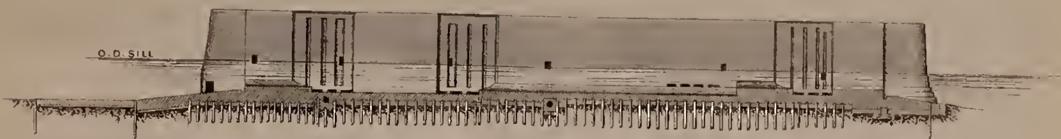


W. Smith. C.E. direx

DETAILS OF BIRKENHEAD DOCK WORKS.

FIG. 1 LONGITUDINAL SECTION THROUGH SLUICES

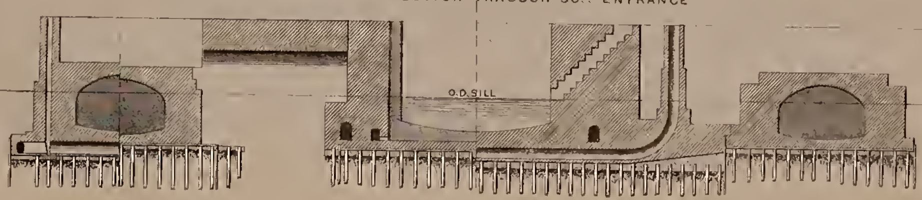
FIG. 2 LONGITUDINAL SECTION THROUGH ENTRANCE



0 10 20 30 40 50 100 150 200 FEET

Scale to Figs 1 & 2.

FIG 3 CROSS SECTION THROUGH 50FT ENTRANCE



0 10 20 30 40 50 100 150 FEET

Scale to Fig 3.

FIG 5

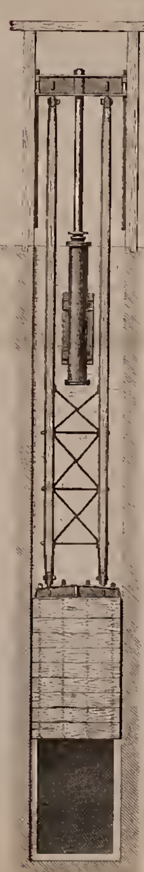
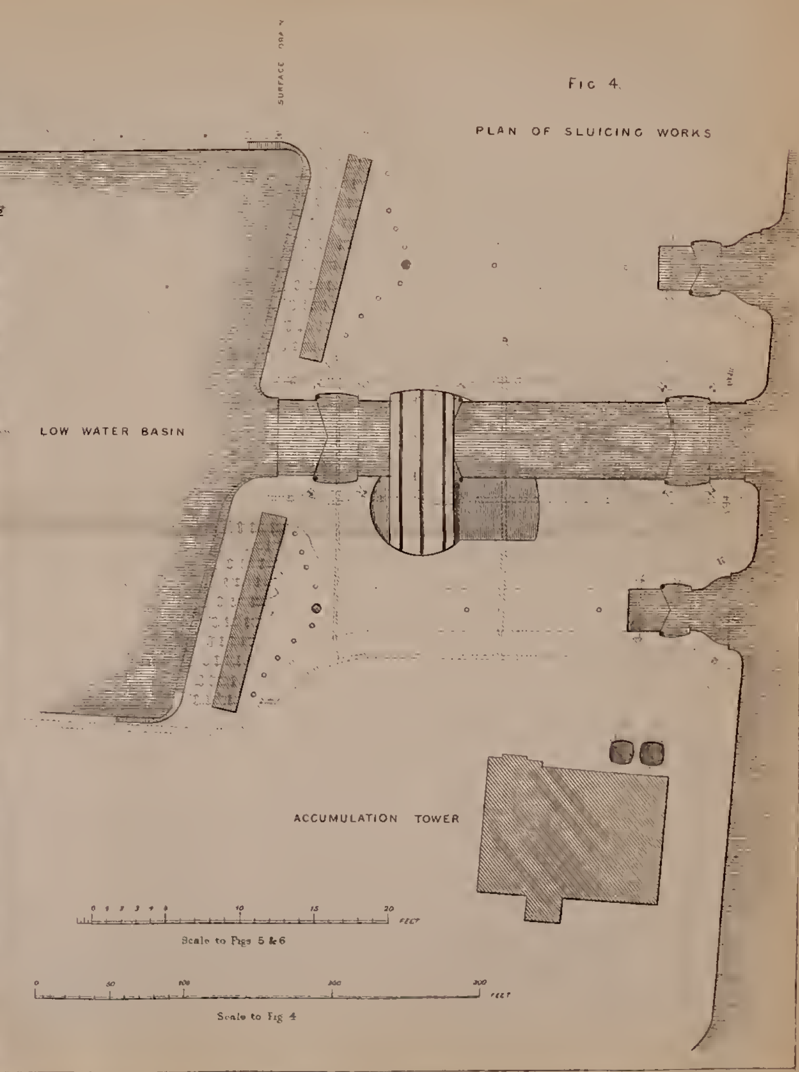


FIG 6

FIG 4.

PLAN OF SLUICING WORKS



0 1 2 3 4 5 10 15 20 FEET

Scale to Figs 5 & 6

0 50 100 150 200 FEET

Scale to Fig 4

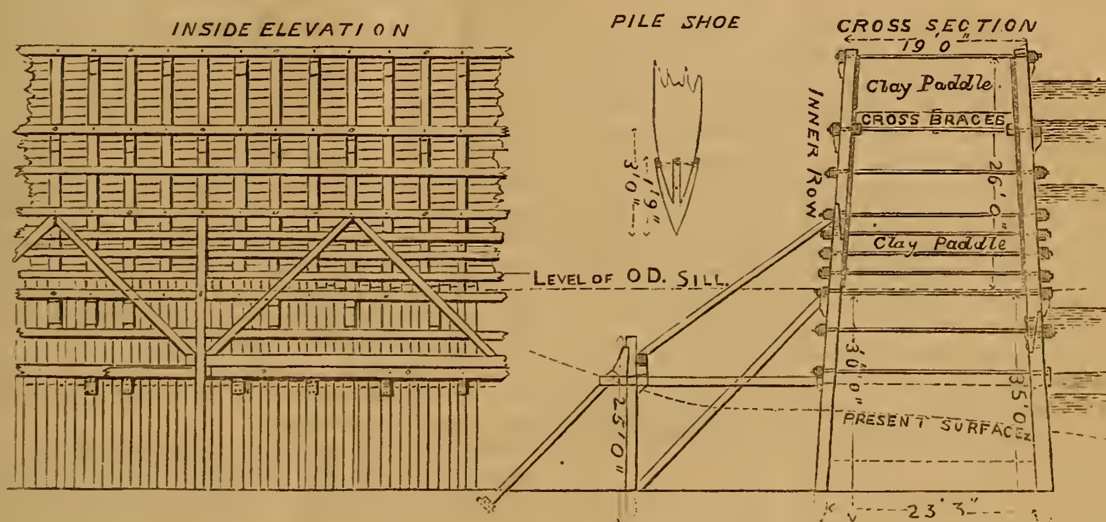
W. Smith, C.E. direx

structed within the wall forming the south side of the basin. This trial was for the purpose of scouring away a bank of sand, &c., that had accumulated outside the south pier of the entrance. The result of that operation, as already reported, was a sudden shock and injury to the wall, sufficient to foreshadow the great risk that will always attend large volumes of water of high velocity and pressure scouring through masonry constructions of that description.

"On the 20th ult. the removal of the coffer dam had so far advanced as to admit of the sluices being tested, and the first trial of the power then took place,

"A moderately low tide was selected for the purpose, the height or head of water in the float being only 14ft. 3in. above that of the low water basin. The experiments were continued for two and a half hours, by lifting and lowering the paddles slowly and alternately—sometimes singly, at other times in sets of a few only, and then altogether, and thus assuring ourselves of the perfect control we had over the machinery.

"By these means fifty-four and a half million gallons of water were run out, thereby lowering the level of the float 21in. Throughout the trial everything went on satisfactorily. A great disturbance was caused in the basin, and, judging by the agitation and discolouration of the water, and the rapidity of its outflow, the scour from the sluices seemed to be effectually doing the work required of it. On Friday, the operation was repeated with a head pressure of 22ft. 6in., the sluices having been kept open for twenty-five minutes, during which time thirty-nine million gallons of water were run out from the float, which was lowered 15in. by the operation. On this occasion it was found necessary to close the sluices on the north side soon after they had been opened, owing to the *volume of the current* having broken away from her moorings a large wrecked vessel that had been secured and grounded along the north wall, and near to the north-west angle of the basin. On Saturday, the trials were continued; the head of water was 20ft., the sluices ran 22 minutes, 86 million gallons of water were run off, and the level of the float lowered 33in.



"On Monday, the 25th, the accident occurred which swept away the gates of the northern sluice tunnel. The head of water was 20ft. 3in., but the operation was only in force a few minutes before the mishap to the gates, so that the practical results usually recorded were not taken.

"The superficial observations noted on these occasions serve to show that the rush of water from the float into the sluicing chambers was so great, that unless some precautions were taken, serious results would inevitably arise from the powerful indraught. Its effect was felt at the extreme end of the float, and a slight damage was thereby occasioned to the Duke-street bridge by its being fouled by two vessels which were improperly adrift at the time; and although any accident arising from this cause would not affect the question of efficiency in the sluicing operations, still, as a contingent danger, inseparable from the process, it must always be considered as a grave objection, and, to my mind, a most serious practical disadvantage. The speed of the rushing water through the chamber was at the rate of fifteen miles an hour. The current out of the basin, when at its greatest, was about four miles an hour.

"The bottom of the basin, as your committee are aware, was excavated to the depth of 21ft. below the level of the Old Dock sill, and that finished depth is shown upon the accompanying sectional drawing by a strong brown shade. The yellow shade represents the amount of deposit that had accumulated in the interval between the breaking in of the dam and the first trial of the sluices. This deposit varied in thickness from a minimum of 18in. to a maximum of 4ft. 3in., giving an average of 2ft. 10in. over the whole surface of the basin. The sills of the sluices are laid at the level of 18ft. 6in. below the Old Dock sill, and a paved apron, 80ft. in width, slopes down from the openings to the bottom of the basin, and is strongly secured by rows of sheet piling. The object of the apron is to receive the impulse of the water as it rushes from the sluices, and to prevent the tearing up of the clayey material of the bottom that would otherwise ensue. The result of the sluicing operations were found to be twofold. First, the removal of that portion of the silty deposit adjoining the scouring-head, and described on the section by a blue tint; and secondly, the deposit of the same in a new position, as shown by the red tint, when the action of the current had become so languid as no longer to be sufficient to hold the particles in suspension. The blue tint serves to show that the uplifting and scouring-off power of the sluices was expended at a distance of 300ft. from their mouths, and that immediately on leaving the stone apron it acted with dangerous downward violence on the adjoining clay bottom. At this point the material swept away was 6ft. in thickness, leaving a hole 3ft. 5in. in depth below the originally finished bottom of the basin. The red tint shows that the suspended matter began to deposit itself over the parts unaffected by the scour directly after its removal, and with the exception of one or two places situated about 150ft. from the entrance, none of it appears to have been taken out into the river. The thickness of the deposit arising from the re-distribution of the material sluiced out averages 8in., which, added to the former deposit, makes 3ft. 6in. as the existing average thickness of the accumulations.

"Having thus stated the result of our short trials of the sluices, which, however, were intended more as experiments as to the efficiency of the machinery rather than as a test of the scouring power of the system, I cannot close this report without drawing the serious attention of your committee to what I conceive to be the sources of danger connected with the operation. The first is that arising from *the rushing power of the water* from the float into the sluicing chambers, thereby causing immense friction and pressure on the masonry, and which, in time, will go far to dislocate the whole mass. It also involves the probability of frequent accidents to the appliances and mechanical arrangements peculiar to the work, and of which the destruction of the gates may be taken as a premonitory instance. Further, flats and small craft will be constantly liable to be drawn into the current and carried through the chambers, and for this I see no remedy, except such as would impair the action of the sluices. The disturbance to the shipping within the float by the sudden lowering and raising of the water, will no doubt affect its convenience as a dock, and therefore injuriously interfere with its practical working. The indraught of the tidal water to supply the place of that removed for scouring will also involve a silting process within the float, which will prove inconvenient and expensive.

"There is yet another danger, but possibly more remote than any of those alluded to, namely, that which might take place if the water of the float should ever find its way underneath the masonry of the sluicing dam. In consequence of the soft and yielding character of the soil which originally formed part of the bed and channel of the Wallasey Pool, the whole of this work had to be built on piles, and although it is of the strongest possible character, and its foundations secured by lines of heavy sheet piling carried across within the float, as well as through the body of the masonry, and again in front of the paved apron, still, in the event of any extensive deepening of such a hole as has already been formed, an underneath water channel might force itself from the float to the basin, and cause the destruction of the whole of the surrounding work.

"In laying the foregoing report before your committee, I have been careful to deal only with the facts as they stood, and to draw attention to the possibility of accidents occurring, so as to enable the important question to be fully discussed, and to admit of such precautionary measures being taken as may be considered desirable."

Of this report it must be said that it takes a careful review of all the disadvantages which attach to the system, without inquiring into the immediate causes of some of them, especially those consequent upon the strong indraught of water from the great float, and the great momentum with which it precipitates itself into the sluicing chambers, although it cannot be doubted for a moment that Mr. Lyster knew perfectly well where the cause of these does or did reside, and the fact of him not making mention of it must be considered an act of courtesy to his predecessor Mr. Hartley.

Of the same facts, and of the opinions emitted in the foregoing report Mr. Hartley speaks as follows :—

"Having received from your secretary a copy of your engineer's report upon the sluicing operations at Birkenhead, together with the resolutions of your committee referring that report to me for my opinion and report, and having also received a tracing copy of the plan referred to by the engineer in his report, I have given the subject my careful consideration. Since the summer of 1855, when the subject of the completion of the Birkenhead Docks was first referred to me, and during the various applications to Parliament which have since been made, the unfavourable expectations I had formed of the result of the construction of a low-water basin, in which a depth of 12ft. was to be maintained at the low water of spring tides by the power of sluicing, have been often expressed, and have been well known to yourself and many members of your board. When I had the honour of attending your committee on the 22nd ult., after the first sluicing operations had been witnessed, but before the result was known, I again explained to you what my anticipations were, and I fear those anticipations are likely to be realised.

"From the report of your engineer, and from the sections of the low water basin referred to therein, the effect produced by the sluicing power appears to be limited to the tearing up the soil where the water impinges upon the bottom of the basin as soon as it leaves the protecting apron, and to the removal of the material thus torn up to other portions of the basin, depositing it gradually towards the entrance. It must be borne in mind, however, that this sluicing was confined to the low water of the three tides of the 20th, 22nd, and 23rd of January. On the 25th it was again commenced, but was almost immediately stopped, owing to the accident which occurred to the gates of the northern sluice canal. I do not think it will be wise to rest satisfied with the experimental trials thus made. I think it very desirable, before you come to any final decision as to the result of the system, to give the sluicing power a full and continuous trial during one set of spring tides, most carefully noting as before the condition of the bottom of the basin before and after such trial. I think this should be done to prove beyond all doubt what the effect is after continuous sluicing. I believe it will be similar to that already produced, only in a more extended form, and that there will be a further heaping up of deposit a little beyond where the sluicing force is checked by the dead water, and a gradual shoaling of the water in the basin towards the river. I anticipate a considerable deposit forming inside the entrance piers of the basin, and I am of opinion that the power of the sluicing water will be ineffectual in removing that deposit, and the longer the sluicing operations are continued, the more will these results be made manifest.

"If the result be such as I have described, it will then become evident that no means short of perpetual dredging will be sufficient to keep open the low water basin to the depth proposed, and to which it was excavated, and this, I need scarcely observe, will almost amount to practically closing it up from general use by the public, and involve a very serious expenditure with very small advantage, and I think it will become a question for your serious consideration whether steps should not be taken for bringing this costly work into use in some other form.

"In recommending a continuance of the sluicing experiments, it is right that I should refer to the dangers connected with the operation apprehended by your engineer.

"With regard to the effect produced upon the great float and the shipping lying therein, by the current caused by the sluicing, such was always foreseen, and was one of the objections taken to any system involving the drawing off of so great a body of water in so short a time; The effect being now known, I think there will be no difficulty in guarding against any evil results by the issue of proper regulations, and taking all necessary precautions. It will be necessary to erect barriers of piling in front of each of the sluice canals, extending a sufficient distance therefrom to prevent any small craft or boats from being drawn into the run of the stream. This I see no difficulty in effecting, and might be for the present of a temporary character, until the effect of the sluicing is determined. A greater difficulty will, I think, arise in securing the sluices from being injuriously affected by loose timber and other matter not unfrequently found floating in the docks. The most efficient method to guard against this would, I think, be to place a wrought iron grating in front of the inside of each sluice opening in the water chamber. As to the danger which Mr. Lyster describes as 'arising from the rushing power of the water from the float into the sluicing chambers, thereby causing immense friction and pressure upon the masonry, which will, in time, go far to dislocate the whole mass,' I feel but little anxiety upon this point. During the height of the sluicing, when the full force of the head of water was running through, and the whole of the sluices were open, I felt but very trifling vibration in the main wall in which the sluices are placed, and upon which the greatest strain and shock would be produced by the velocity of the current being checked in passing through the sluice openings.

"This, I must confess, is a matter which caused me very considerable anxiety in designing these sluices, and, more especially, I feared the effect that would be produced by the sudden closing of the sluices at any time in an emergency; and it was to meet this contingency that I provided the large air chambers and apertures above the inner mouths of the sluices, to permit of the expansion of the water and air upwards when thus suddenly checked.

"From the description given of the effect produced by the sudden closing of the north sluices when the gates gave way, a column of water is said to have been driven some 20ft. upwards through the air apertures. This satisfied me that my precautions were wise, and that no evil result need be apprehended from this source; at the same time, all such sudden closing should be as much as possible avoided.

"In all works of this character, and more especially in those, like this, erected upon artificial foundations, an unequal settlement of the mass will occur, and drafts or cracks in the masonry are more or less the result. In this work they have been exceedingly small; these, however, such as they are, constitute the weak points, which will require watching with care. There is no portion of the sluicing chambers or vital parts of this work to which I have not taken the precaution of providing the means of access for examination and repair; and, if care is taken to have a frequent and thorough survey made, and all needful repairs promptly and efficiently attended to, I do not think any anxiety as to its perfect stability need be felt.

"With respect to the anticipated frequent accidents to the appliances and mechanical arrangements peculiar to the work, of which the destruction of the gates may be taken as a premonitory instance, I think a very short experience will remove any difficulty. The cause of those gates giving way can only be ascribed to some accidental circumstance, and not to any inherent defect in the design, as they had stood the test of three days' previous sluicing, and those at the south canal remain intact.

I have no doubt, however, that many improvements and additional means of security in the details of the appliances will suggest themselves as experience in their working is obtained; and I cannot but express the great gratification I felt in finding the work I had unfortunately been obliged to leave in an unfinished state completed in all its details in so perfect a matter.

"The evil arising from the indraught of the tidal water to supply the place of that removed for scouring purposes, involving a silting processs within the float, can only be regretted as one of the objections consequent upon the adoption of the low water basin scheme, and can be provided against but by dredging as the necessity arises.

"The remaining danger apprehended by your engineer from a continuance of the sluicing operations, is the contingency of the water of the float finding its way underneath the masonry of the sluicing dam.

"On this head I had very grave and great anxieties during the construction of the earlier portions of this work, for the nature of the soil upon which this vast mass of masonry had to be placed was of the worst possible description, being a loose mixture of bog and quicksand, and consequently I took every precaution that my experience in many works on similar foundations dictated, and happily with complete success, for as soon as ever sufficient of the masonry had been constructed to allow of the inner gates of the lock and sluice canal being erected, or in other words, when about one third of the masonry and piling which now form the dam and retain the waters of the float was finished, these waters were impounded, and the remainder of the work completed without the slightest appearance of any underrun from that head of water, although we had to excavate far below the bed of the float. Since then twice the amount of masonry has been constructed, several more rows of cross sheet piling have been added, and a security has been arrived at that removes all anxiety on that head from my mind. There is, however, no doubt if the sluicing is continued some protection will be required in face of the sheet piling in front of the sluice apron, and also against that at the foot of the side walls of the basin so far as the tearing up tendency extends; but were the apron destroyed, I have no fear of the integrity of the dam itself from any passage of the water under it from the float. If on further sluicing it becomes evident that the scooping out of the material in front of the apron increases, I would advise some large Ashlar rubble mixed with concrete being filled in to protect the sheeting.

"Care should also be had to watch the effect of the rush of water into the sluicing canals upon the bed of the float; it is possible that a scour may take place there also, and this should be carefully guarded against.

"It will be seen that, for the reasons I have given, I do not participate to their full extent in the apprehensions entertained by your engineer from a continuance of the sluicing operations. I think, with a further exercise of the great prudence and judgment with which the first experiments were conducted, added to them, experience gained therefrom, a further trial of them may safely be made, though I do not entertain any faith in their producing a successful result."

The sluicing operations afterwards were continued as often as the state of the tides permitted for a period of some seven months or more, but the general result of the scour seems to have been as described by Mr. Lyster, namely, to dig a hole in front of the apron, and to deposit the material at the entrance of the basin. As for carrying it any distance down into the bay, that really never did take place; nothing, indeed, could have been easier than to trace the direction of the stream as it issued from the mouth of the basin, and to ascertain the extent of its progress, owing to the muddy froth which was formed by the violent disturbance in the basin, and which was carried by the current into the river outside: judging from this, it may be said that the current created by the scour was entirely destroyed by the time the waters had reached Seacomb ferry slip (that is about half a mile distant from the mouth of the basin), for there that froth might be seen curling round again, impelled by the current of the rising tide. Thus also is the fact practically illustrated that these sluicing operations would never affect the condition of the sea channels of the port, a result which was so fondly looked for by Mr. Rendel.

After the period of time named it was deemed desirable to examine the sluicing chambers and their feed channels, when the havoc above referred to was discovered in one of them, a circumstance which was officially communicated to the Dock Board by Mr. Lyster in the report reproduced below:—

"Since the late spring tides, and the consequent suspension of the sluicing operations in the low-water basin, I have had the caisson placed in position, and the water pumped out of the north sluicing passage and chamber, with the view to an internal examination of the structure. The masonry of the main passage was found to be in a sound and perfect condition; but I regret to have to add that the heavy stonework in the floor of the bell-mouthed chamber is laid bare to a considerable extent.

"The plan I lay before you shows the position of the damage, and the area of surface broken up. Of the large stones and mass of material thus rooted out, not a vestige remains. All must have been swept through the sluices out into the basin, except one large ashlar block, which, being too bulky to pass through, has jammed itself within the openings (but fortunately clear of the paddle) and there remains.

"The destruction of the work commences just where the cross line of culvert is laid (probably the cast iron cylinders forming the culvert have been the means of checking the damage in that direction), and extends from that point nearly over the whole surface of the floor up to the side walls of the chamber, and to the openings leading into the clough passages. These passages, with the paddle machinery within them, are, so far as can be ascertained, uninjured. I am making arrangements for having the south chamber examined; but I do not expect to find its condition much different from that of the one now described; though beyond the immediate damage detailed, I do not apprehend that any vital injury has arisen to the work, but a thorough repair and restoration of all that has been carried away is necessary, and will be undertaken forthwith.

"I regret to find that the anticipations expressed in my report of the 5th of February last have been thus far realised; and I would beg to draw the attention of your committee to a point of danger which, in my mind, demands especial notice, viz., the risk of the water forcing its way, and bursting through underneath the pile of masonry between the float and the low water basin. The section shows that the excavation caused by the scour from the sluices in front of the apron in the basin is, notwithstanding the constant efforts made to fill it up, is still of considerable depth and increasing area; and the excavation within the sluicing chamber, forming the subject of this report, is a step and an example, though in a lesser degree, of the tendency towards the water communication which is most particularly to be guarded against.

"The repair of the chambers must of necessity occupy some time, and in the meanwhile I will have full sections taken showing the condition of the bottom of the low water basin, with a view to enable you to give the entire question your full consideration."

Since the discovery of this accident the sluicing operations have been entirely discontinued, notwithstanding that the south chamber had remained nearly perfect; and although this may seem somewhat singular, it is possible that a scrupulous carefulness on the part of Mr. Lyster, lest the effect of the scour should be to undermine the whole structure by an insidious backward action from the front of the apron, may have led to this decision, of the wisdom of which, on the whole, there can be little doubt if it be true, as we are informed, that barge load after barge load of large rubble had been deposited into the hole that has been dug out in front of the apron, apparently only to disappear without producing any tangible result in the direction aimed at.

The general conclusion to draw from these various facts is that, as regards their main object the sluicing works are a failure, as had been predicted by Abernethy, Rennie, Hartley, and others, and thus the Dock Board are not entirely without ground for complaint against Parliament, who forced these works upon them in opposition to their own wishes; while Parliament, may think, and rightly so, that the British trading community are able to pay for an experiment of this kind, and on this plea justify its action in this matter. Less justifiable than this, however, was the proviso affixed by Parliament to the Dock Bills of 1864 "that no more moneys should be spent on dock extensions in Liverpool until the Birkenhead works are completed," on the implied ground that those works were studiously kept back ward by the Liverpool interest. This accusation is nothing less than a libel upon Mr. Hartley's character—a more independent-minded man than whom could not easily be found, and who was most anxious to see them completed. As for Mr. Lyster, he had but shortly before arrived, and could scarcely be supposed to have espoused any party predilections.

It is to be regretted, however, that this gigantic experiment should be allowed to remain idle without any attempt being made to take advantage of so fine an opportunity, all the appliances being there, and no outlay of money being required for making experiments on a large scale on the flow of water in canals, and thus endeavouring to settle this much vexed question in hydraulic science. This, however, is but one example of the great apathy that exists among the trading classes here for the pursuit of abstract science. We say the trading classes, because the management of the Dock Estate is entirely in the hands of the ship owners and cotton brokers of this place, who value science only when there is the prospect of an immediate return to them in the shape of jingling brass, and it is just possible if Mr. Lyster were to ask leave to conduct a series of accurate experiments for purely abstract objects that he might be snubbed.

(*To be continued.*)

TWIN SCREWS.

Of late years much discussion has arisen upon the merits of twin screws as compared with single screws and other propellers, consequent upon the revival of the former system, which now appears to have numerous supporters, and although possessing many disadvantages, yet has some points which recommends its adoption under special circumstances.

We will first mention the advantages which it appears to us the twin screws may fairly claim over the single screw and other modes of propulsion; these chiefly consist in increased facilities for handling a vessel to which they are applied, as, for instance, by driving one screw forward and the other astern, it may be rapidly turned in any direction; it is also possible that with two screws a greater amount of power may be brought into operation. Of course, any contrivance which will aid in manœuvring or increasing the speed of a vessel will find favour, as applied to ships of war, although the cost, both in the first outlay and in the subsequent working may be very disproportionately increased; hence, among the generality of naval men, it is but natural to expect a partiality for twin screws.

Now let us consider the demerits; and in doing this it may be remarked that we can impartially discuss the matter without that restraint imposed by courtesy, when dealing with the inventions of living men; as the point of novelty is long since settled, and the inventors of the system have passed away, wherefore no one can be supposed to have any particular feeling in the argument beyond that of wishing to arrive at the truth, with the view of furthering the interests of science generally, and that of naval propulsion specially.

It may be shown that two screw propellers are not so economical as one whose surface is equal to that of the two combined, being in type similar, that is to say, for instance one hundred horse-power will produce a greater speed acting upon one screw, than when divided between two; but of this more hereafter. For the present, let it be assumed that the same power may be used. Two sets of engines of fifty horse-power each will cost more than one set of one hundred horse-power, and they will be heavier. The power of the engines *cæteris paribus*, varies as the square of the diameter of the cylinder or calling that = d and H = horse-power of engine,

$$H \propto d^2.$$

Not so, however, the weight of the cylinders. Let W = weight of cylinder, t = thickness of metal, then

$$W \propto t \cdot d;$$

but t does not vary as d; but according to the best investigations, very nearly as follows :—

$$t \propto \frac{p \cdot d}{440} + \sqrt{d},$$

where p = steam pressure. And in this examination the constant quantities are omitted when they do not affect the *law of variation*. Replacing t by its representative, variable, we have

$$W \propto d \left\{ \frac{p \cdot d}{440} + \sqrt{d} \right\}$$

In both cases let p = 44lbs. per square inch, then

$$W \propto d \left\{ \frac{d}{10} + \sqrt{d} \right\}$$

$$\propto d^2 + 10 \sqrt{d^3}.$$

An example may perhaps serve best to illustrate the effect of the difference of the above laws of variation. Let d and d' represent the diameters of the cylinders of two engines, and for simplicity let $d = 2\,d'$, and distinguishing the other letters in a similar manner, we find

$$\frac{H}{H'} = \frac{d^2}{d'^2} = \frac{4\,d'^2}{d'^2} = 4,$$

and

$$\frac{W}{W'} = \frac{d^2 + 10 \sqrt{d^3}}{d'^2 + 10 \sqrt{d'^3}} = \frac{4\,d'^2 + 10 \sqrt{8\,d'^3}}{d'^2 + 10 \sqrt{d'^3}} = 3 \text{ nearly.}$$

So that while the power of the engine is quadrupled, the weight of the circumferential portion of the cylinder need only be trebled.

Similar remarks may be made about other parts, but they would occupy more space than we have to spare for this subject.

We must, however, before leaving the questions of cost and weight, make some remarks as to the propeller shaft, as some have asserted that two shafts are cheaper than one, because by reason of their reduced diameter they do not cost so much for forging (per ton, we suppose ?)

According to the laws which regulate the strength of shafts to resist torsion, if D = diameter of shaft, and H = horse-power of engine, then other factors being constant,

$$D \propto \sqrt[3]{H}$$

If W = the weight per unit of length, then

$$W \propto D^2$$

and, therefore,

$$W \propto \sqrt[3]{H^2}$$

Taking two examples, let $H = 2\,H'$

$$\frac{H}{H'} = 2$$

and

$$\frac{W}{W'} = \frac{\sqrt[3]{H^2}}{\sqrt[3]{H'^2}} = \frac{\sqrt[3]{4\,H'^2}}{\sqrt[3]{H'^2}} = 1{\cdot}587$$

So that although the power of the engine is doubled, the weight of the screw shaft is for a given length only increased ·587 of its original weight. Thus, where two screws are used for a given combined power, half to pass through each, the increase of weight over one shaft is .

$$= 26 \text{ per cent. nearly}$$

for a given length. This allows a good margin for increased cost of large forgings, to say nothing of the effects of the weight *per se.*

In regard to the actual loss of power in reducing the size of screw propellers, it may be observed that some experiments were tried with model screws a few years back, with a view to determine the actual amount of thrust obtained from given applications of force. The motive power was a descending weight, and it was found that by halving the power the thrust was reduced to about sixteen per cent. below that obtained when the full power was applied to one screw of double size.

This may be accounted for theoretically without difficulty, when we consider the conditions under which the power is applied. The action of the screw propeller is partly to thrust upon the aqueous particles against which it works, and partly to give them a centrifugal motion: thus, by throwing them off around its edges, losing a portion of the abutment, as it may be called, against which the propeller rests, in moving the vessel to which it is attached.

Increased engine power will necessarily be attended by increased speed or increased size of the screw, and in either case it appears probable that the loss by the centrifugal motion of the water will be diminished; for when the size of the screw is increased, the aqueous particles will have further to travel before they reach the edges of the propeller, and when the speed is increased they will have less time to accomplish the distance. It may be argued against this, that the increased size or speed will cause increased centrifugal force; but an analysis of the various circumstances concerning this waste of power will show that still it will diminish as the diameter increases. On some other occasion we will further investigate this matter, when we may also consider the relative positions of the twin screw and paddle-wheel systems.

The importance of saving fuel to our mercantile marine is so great as to render the determination of the most economical mode of working a point of great interest, commercially, as well as nationally, although in our navy saving of expense may be insignificant compared to efficiency in war.

ON THE STRENGTH OF CYLINDERS.

In all matters where mathematical science is brought to bear upon mechanical constructions, it is very necessary to regard most attentively the conditions under which such structures exist, for it may often be observed that those formulæ, which from their simplicity may appear most practical, are not really accurate.

In the case ylinders submitted to external or internal pressure, there is a notable instance of this, for, as will be shown further on, in some cases it is useless to regard the thickness of the material of which they may be constructed, except as an element from which to calculate the amount of sectional area opposed to the strain to which they are subject, whereas, in other instances, this element plays an important part in the distribution of stress through the various cylindrical strata, of atoms from the interior to the exterior superficies of the cylinder.

We will now consider the exact nature of the strains produced upon a cylinder by uniform internal pressure. The first class of strain acts radially, and its resultants tend to tear the cylinder longitudinally, for, by increasing the circumference of a layer of atoms, the individual atoms are separated from each other until, if the pressure be sufficient, their cohesion is overcome and rupture ensues. From the first or internal layer of atoms this bursting force is transmitted to the next outside, but its intensity is reduced as by reason of the material admitting of compression in the direction of its thickness, a portion of the force will be thus absorbed, so that the tangential tension will not be so great on the second as on the first layer of atoms. Thus it is evident that the strain is constantly diminishing from the interior to the exterior of the cylinders, so that a case may be imagined in which the inner layers of atoms in a thick cylinder, under a very heavy pressure, becomes so strained as to be inefficient before all the available resistance of the outer lamina renders them aid in supporting the load to which the mass of metal is subject. The amount of the difference of strain on the inner and outer surfaces will depend upon the bursting pressure, the elasticity of the material of which the cylinder is composed, and the relation of the thickness of that material to the diameter of the cylinder. If we imagine the metal to be so thin that the thickness in regard to the diameter may be neglected, then the calculation of the tension upon it will be simple. Let us take a length of cylinder 1in. (omitting all consideration of support afforded by the ends). Let t = thickness, and r = radius, then the tendency to produce rupture will be represented by the pressure per square inch multiplied into the area, which is

$$= 2\,r \times 1\text{in.}$$

r being taken in inches, if p = pressure per square inch, the rending power on the 1in. length of cylinder will be

$$= 2\,p\,r,$$

the factor, 1in. length, being omitted, not altering the value of the equation.

To resist this strain we have the sectional area on each side of the cylinder, which will be together,

$$= 2\,t \times 1\text{in.} = 2\,t,$$

Hence, the resistance being equal to the strain, calling s the tensile resistance of the metal per square inch, we have the equation

$$2\,p.r. = 2.s\,t.$$

$$t = \frac{p.\,r}{s},$$

which may be taken as a fundamental formula for determining the thickness of cylinders exposed to internal pressure, and which may, in its simple form, be used for thin cylinders.

Next, let us consider the circumstances connected with the resistance of thick cylinders. The whole internal pressure produces partly tangential strain and partly compressive strain upon the material, but this compressive strain does not call into operation a resistance directly available to oppose the bursting force, as the resistance to compression in this case is so located as to act at right angles to the tangential strain. The law of variation of tension upon the various strata of atoms will depend upon the amount of extension of inner layers and the elasticity of the material in opposition to its compression in the direction of its thickness: thus the greater modulus of elasticity in compression, that is to say, the smaller the amount of compression in a given length under a given load, the more uniformly will the strain be distributed in cases such as those to which we are referring. If the material were incapable of compression, each layer of atoms commencing from the interior, would take up its exact proportion of the total strain, passing the remainder on to those surrounding it; but this is not the case, and as each layer of atoms takes up more than its due proportion of stress, the thicker the cylinder is made the more evident will the unequal resistance of its laminæ become.

The mathematical analysis of the resistance of thick cylinders to internal pressure is too lengthy to be here inserted, and therefore having given the rationale of the phenomena connected therewith, we shall merely conclude with the formula deduced by Professor Rankine. Let

R = external radius of cylinder.
r = internal radius of cylinder.
f = strength of material of cylinder.
p = bursting pressure,

then,

$$\frac{p}{f} = \frac{R^2 - r^2}{R^2 + r^2}$$

or,

$$p = f.\frac{R^2 - r^2}{R^2 + r^2},$$

from which the bursting pressure of a thick cylinder may be found.

DEODORISATION AND UTILISATION OF SEWAGE.

The deodorisation of sewage is a matter of no great difficulty, but concomitant with it must be its utilisation, as in merely rendering it innocuous not only is the expense of the process necessary to attain that end incurred, but the removal of the resulting products increases the unremunerative investment. Many mistakes have occurred through the idea entertained by some that sewage deodorised will in all cases form valuable manure, and in the Leicester Works appeared one of the greatest commercial failures attendant upon the perfect attainment of a scientific success.

Hydrate of lime is known to have the power of destroying the noxious effluvia generated from sewage, but at the same time, by its chemical action, the ammonia therein contained is evolved, its carbonic acid is absorbed, and thus are lost those ingredients to which the value of manure is principally due.

If, however, instead of hydrate of lime sulphate is used, a different result is obtained, for by that the ammonia is fixed, putrefaction stopped, and the solids precipitated, leaving a clear inodorous supernatant liquid. In sewage containing carbon, hydrogen, oxygen, nitrogen, phosphorus, fibrine, albumen, gelatine, fat, &c., mineral acids may be used to assist the operation. This forms the system proposed by Mr. Bardwell, which was tested in Glasgow in 1853. The sewage was pumped up into the tank continuously, and clear water alone ran out from its bottom basin, but notwithstanding this success, the mode so clearly proved to be valuable never came into operation.

Setting aside the necessity which will some day be felt of so conserving all the elements of sewage that they may be in the shortest course brought back through the cycle of organic change, to support an organic life succeeding to that from which it was derived, our attention is urgently called to the prevention of disease arising from the accumulation of feculant matter.

The question may be put, does this concern the engineer or the chemist? We unhesitatingly say that it most nearly concerns the engineer, and he, of course, should have knowledge enough of chemistry to deal with such materials as are to be disposed of by his own project.

Where, it has often been asked, does the destructive element exist in putrifying masses? This question is not solved. The most recent authorities seem to think it resides in the yellow colouring matter, combined with chloride of ammonium obtained from sewage, but the determination of its nature rests as much with physiologists as others; the present object is when a means is obtained efficient in its action to urge the adoption of such means, for if it be according to the economy of nature returned to play its useful part in the cosmical system it cannot develop into the cause of disease.

In some localities certain rights of the corporations are used to prevent the purification of rivers. The use thus made of those rights appears to be scarcely worthy of condemnation as the avaricious and homicidal ignorance of those who maintain it exhibit such a character as cannot be touched by ought but compulsory measures, hence it is to be hoped that before long such systems as have already been shown to be in accordance with social economy, both as regards health and commercial prosperity, may be enforced by the legislature, notwithstanding their possible interference with the interests of corporate bodies.

While the organic constituents of our sewage are poured into the ocean we are throwing away the elements which fertilise our fields, and rapidly reducing our land to the condition of those countries in which are discovered signs of luxury and ease beneath the sunburnt clay.

Let it not be argued that we can use manure from foreign climes, for then we are but robbing the soil of another country to supply the waste of our own, but let professional advisers of the Government and local authorities endeavour to impress the importance of the adoption of an economical and sanitary system of dealing with sewage.

ON WORK AND VIS-VIVA.

By JOHN W. NYSTROM, Acting Chief Engineer U.S.N.

[From the Journal of the Franklin Institute.]

(*Continued from p. 151.*)

My "masked battery" opened upon Professor De Volson Wood, of the University of Michigan, appears to have had a greater effect than was anticipated, and I can well afford to slacken my fire, although unaware of my "vulnerable points," which, he says, "cannot stand a fierce assault." It is not necessary to reply to the greater part of Professor Wood's last article, lest the discussion degenerate into a useless squabble. I shall therefore confine myself to the important points, with a view to clear up the confusion which still pervades the questions of power and work, inasmuch as he yet seems to maintain the old stereotyped error that "power is the work done in a unit of time."

The number which expressed the work done in a unit of time will be equal to the number which expresses the power in operation, but that does not prove the two quantities to be alike.

Six cubic feet and six square feet, although identical in number, do not prove that a cubic foot is a square foot, merely because their numbers are alike.

Professor Rankin and others also say that "power is the work done in one minute," which is substantially the same as saying that a square foot 1ft. thick is a cubic foot.

Professor Wood further remarks:—"Again, he (Mr. Nystrom) says $F V T$ is the expression for work. Now, if T = one second, minute, or hour, do we not have $F V$ = the work which is done in a unit of time?" Here it is necessary to resort to the elementary, and inform Professor Wood that T does not disappear in the formula for work, merely because it equals one or the unit, for on his reasoning we may set $F = 1$, and the work will be $= V T = S$ the space, which is equally absurd. It will first be necessary to explain the difference between addition and multiplication.

When a quantity is multiplied by an abstract number, it will not change the nature of that quantity, but the product will be the same as the sum of so many concrete quantities added together; but when a quantity is multiplied by another quantity, the product becomes a third quantity different from the two first.

Let two square feet, for example, be multiplied by the abstract number three, and the product will be six square feet, or the sum obtained by adding together three times two square feet, which will also be six square feet; but if two square feet be multiplied by a thickness of three linear feet, the product will be six cubic feet, which is radically a different quantity from two square feet, or from three linear feet, which constitute its elements.

Professor Wood, however, in his examples above quoted, confounds specific or concrete quantities, such as time and velocity, with abstract numbers.

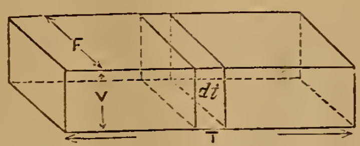
Power $F V = F V \times 1$ the abstract number, and

Work $F V T = F V \times 1$ minute, or whatever time or unit of time is a specific quantity.

Professor Wood quotes my statement that power is the differential of work, and says:—"Do we not rightly infer from this that power is a part of work, an infinitesimal portion of it, and hence of the same kind as work?"

In answering this question it will be best to refer to a parallelopipedon, by which work has before been illustrated.

Let the accompanying cubic figure, F V T, represent the work, then the cross section F V represents the power, and F V dt the differential work. Now let us diminish dt until it becomes infinitely small, say = 0; then the solidity of the differential work F V dt = F D × 0 = 0, or there will be no solidity, or no work, whilst the quantity F V, which represents the power, is unchanged.



It may please Professor Wood better to say that "power is the differential co-efficient of work."

I trust this will satisfy him that power is not the work done in a unit of time, and that the English unit for power is not a unit for work.

The popular expression "force of momentum" is perfectly correct. It does not mean that momentum is force, but that force is an element of momentum; same as we say, "the length of a rectangle" or "the surface of a solid." The momentum divided by time is the force of momentum.

It is to be regretted that in the conclusion of his article he "will pass over many important points," for the object of our discussion ought to be to reveal the subject, not to conceal it. I am, as Professor Wood has remarked, "a truth seeker," and think it unkind of him to "pass over important points."

The "Scientific American" says:—"The main purpose of Mr. Nystrom seems to be to deny the position that work is independent of time, and he succeeds in involving the question in considerable confusion." After which, the editor of the "Scientific American" suggests to "free our minds from confusion" by taking "most important steps to use words always in their exact signification," *par example*. "Regarding work as the overcoming of physical resistance, it is plain that the aggregate amount of any given quantity is independent of the time required for its performance." Does not the "Scientific American" here convey the idea that work is independent of what it requires, namely, the time? The editor evidently means to say, that "a given quantity of work may be performed in any desired length of time," but he does not seem to conceive that the work is dependent on whatever time required for its completion.

PETROLEUM IN CANADA.

We are indebted to our Transatlantic contemporary, the "Journal of the Franklin Institute," for the following interesting particulars upon the above subject, given in a paper read before the Institute by Mr. Theodore D. Rand:—

The Occurrence of Petroleum in Canada.

Petroleum is found in Canada in geological formations lower than in any other region yet discovered. The lowest worked oil bearing stratum is the corniferous limestone of Enniskillen.

Geographical Position.—On an island near Great Manitoulin Island, in Lake Huron, a spring of petroleum flows from the Trenton formation. At Pakenham, C. W., the cavities of large orthoceratites in the same formation contain it in considerable quantity. The same rocks are found to contain oil at Cape Gaspé.

T. Sterry Hunt, "Journal of Science," vol. xxxv., page 168, has described a very interesting development of petroleum in Canada, which throws some light on the vexed question of the origin of the oil.

In a quarry of corniferous limestone in the township of Bertie, on the Niagara River opposite Buffalo, are seen massive beds slightly inclined, composed of a solid crystalline encrinal limestone, which appears destitute of petroleum, and, owing to the presence of water, impermeable to it. In some of these beds are large corals of the genus Heliophyllum, the pores of which are open but contain no oil. Two beds, however, one of 3in. and one of 8in., which are interstratified with these, are in great part made up of species of Heliophyllum and Favosites, the cells of which are full of petroleum. This is seen in freshly broken masses to be absent from the solid limestone which forms the matrix of the corals, and resembles in texture the associated beds. As the fractured surfaces of the oil-bearing beds become dry the petroleum spreads over them. A thin continuous bed of Favosites is met with, which is white, porous, and free from oil, though beds above and below are filled with it. The facts observed here appear to show that the petroleum, or the substance which has given rise to it, was deposited in the beds in which it is now found at the formation of the rock. We may suppose in these oil-bearing beds an accumulation of organic matters whose decomposition in the midst of a marine calcareous deposit has resulted in their complete transformation into petroleum, which has found a lodgment in the cavities of the shells and corals immediately near. Its absence from the unfilled cells of corals in the adjacent and interstratified beds seems to forbid the idea of the introduction of the oil by distillation or infiltration.

Although petroleum has been found in these and many other less important localities over a wide area in Canada, there is but one county in which it has been sufficiently developed to make it of commercial importance, or to entitle it to the name of an oil region. This is Lambtno County, C. W.

This county lies near the centre of the western part of the peninsula formed by Lakes Erie and Huron and the St. Clair River. The River Thames runs through this peninsula, following nearly the course of an anticlinal axis, stated by Logan to extend from the north-western part of Lake Erie to the south-western part of Lake Ontario. Wells have been recently put down along the Thames at Bothwell, in Zone township, with considerable success. The central and most important point, however, lies about 18 miles north west of Bothwell at Oil Springs, in Enniskillen township. There wells have been sunken, and immense quantities of oil obtained. The surface of this region, unlike that of the Pennsylvania and West Virginia regions, is a perfect level, hollowed out to a depth of 20ft. to 30ft. by the largest streams, but without the slightest apparent undulation. A vast forest of large trees—oak, elm, beech, walnut, ash, hickory, and basswood—covers the soil everywhere. Six miles north of Oil Springs is Petrolia, where also several wells have been sunk.

The town of Oil Springs has sprung up in a very short time. It contains about 1,000 inhabitants, several hotels, good stores, two churches, and a school-house, besides refineries, blacksmith and cooper shops, &c. It is connected with Wyoming, a station on the Great Western Railway, 12 miles north of Oil Springs, by a plank road, and by a similar road also with Sarnia (on the St. Clair River opposite Port Huron, Michigan), which is 18 miles north west.

History.—Oil springs were known to exist in this vicinity at a very early period. There were chiefly three—one at Petrolia, one or more at Oil Springs, where in addition the dried-up petroleum forms two "gum beds," as they are termed, of some acres in extent, and in the township of Mosa on the Thames.

These gum beds consist of a deposit from an inch to some feet in thickness, of a bitumen hard in winter, but becoming soft though not fluid in summer. It is generally mixed with vegetable matter, but sometimes is nearly pure.

In 1861 numerous wells were sunk, many through the surface clay only, others one or two hundred feet in the rock. Oil was everywhere obtained in fair quantity. During the winter of 1861-62, and the following spring, the great flowing wells which have made this region so famous were struck one after another. The yield from these was enormous, ranging by estimate from 1,000 to 7,000 barrels a day. This enormous supply brought down the price to 10 cents a barrel at the wells, and, of course, rendered all the pumping wells worthless for the time being. The shipments of oil over the Great Western Railway for six months ending January 31, 1862, were 6,246 barrels, while for the six months ending January 31, 1863, they were 57,550 barrels. In 1863 these wells ceased flowing, and became filled with water.

The pumping wells had mostly been abandoned, and, through careless tubing and neglect, had caved and ceased to yield oil when again examined. The machinery at all of them was of the rudest possible kind, constantly getting out of order.

In 1864 several companies were organised for petroleum mining in this district. They have gone to work in a thorough manner, with proper derricks and machinery, and soon will be in a position to test thoroughly the oil value of the region.

Geology.—The surface stratum of this region is a clay, probably of the drift period, containing fragments of limestone, and occasionally well-preserved shells. This is from 30ft. to 80ft. in thickness. Through this the surface wells are sunk, which have yielded largely. The clay from a depth of 16ft. near the gum beds contains oil in fissures. Under this, throughout the whole region, is the corniferous limestone. Between the two, in Enniskillen and its vicinity, occur shales of the Hamilton group, from 100ft. to 200ft. in thickness; and where these shales are absent and the limestones covered by the clay only, the rock, though impregnated with petroleum and pierced by springs yielding it, as at Oxford and Mosa, does not yield it in paying quantities. The shales seem to have served as barriers to prevent the exudation of the oil. The strata met with in boring are as follows:—

Clay (with sometimes gravel)	30 feet to	80 feet		Drift.
Shale (sometimes absent)	0 „	100 „		Hamilton.
A soft clay shale (called soapstone)	60 „	80 „		
Limestone	3 ins. to	6 „		
Soft clay shale	10 feet to	15 „		
Limestone	15 „	30 „		
Soft clay shale	15 „	30 „		
Limestone (not bored through)	350 „	unknown		Corniferous.

The softness of the shale gives rise to frequent cavings where wells are not properly tubed.

The Wells.—The following are the most important wells in tbis regiou. We give the local estimates of past yields:—

Concession II.—Lot 17, Enniskillen. Fairbank's Well. This yields about 60 barrels a week at the present time, and nearly all of it during the last three days of the week. None of the wells are pumped on Sunday. It is stated that when this well was pumped after a stoppage of about a month, hardly any oil was obtained for three weeks, the pump yielding abundance of water, with but a fraction of oil; and even now, after the stoppage over Sunday, the yield on Monday is almost all water; but the proportion of oil daily increases until on Saturday it sometimes reaches 40 barrels, with comparatively little water.

Concession II.—Lot 18. Shaw and Bradley Wells. These wells when first struck yielded by estimate 2,000 barrels each per day. They were soon tubed, and the flow shut down to 400 or 500 barrels a day for about a year, when the flow ceased. The Shaw well flowed a full stream of pure oil from a pipe 2½in. in diameter.

Concession I.—Lot 18. Black and Madison Well. This is one of the most famous wells, aud is frequently called the Bruce well. It is 35ft. to rock, 237ft. to oil vein, and 27ft. below it. Nothing unusual was observed until the pumps had been worked for a short time, when suddenly the oil and gas burst forth, throwing the pump out of the well, which spouted oil like a fountain, 7ft. or 8ft. bigh, for forty hours. Its supposed yield was 7,000 barrels a day, and the ground is said to have been covered a foot deep witb oil. Indeed, the trees and stumps for some acres around it bear marks of the oil upon them with a regularity that nothing else could have produced. Tbis well has been purchased by the Little Falls Company. Near it is a natural spring of oil, and two other wells, one of lubricating, the otber of rock oil—such are here the distinctive designations.

On the same lot was the Phero well. This spouted up 3ft. or 4ft. from the mouth of the conductor, which was 6in. square, and yielded some 3,000 barrels a day for three or four days, when it was shut off, and not opened for three or four months, when it tailed to flow.

A surface well on this tract, sunk a few feet in the rock with crowbars, yielded by pumping with a spring pole, 6,000 barrels, at the rate of 30 or 40 barrels a day. There were in all twenty-seven flowing wells, all of which were witbin a square mile. No wells except those at Petrolia were bored outside of an area about two miles square until recently.

While these wells were flowing, immense quantities of oil flowed down the creek and were lost. Several times it took fire on the creek, and blazed above the tops of the tallest trees. Evidence of this is even now to be seen in the track of the creek, marked by a border of lofty forest trees charred to their very summits, tbose further off beiug charred on the creek side only, and those a little further off uninjured.

At Petrolia, six miles north, is the only well in the region now flowing. It flows six or seven barrels a day, and has done so for three or four years quite steadily.

The present yield of the whole region is small. This is in great part due, as has been stated, to tbe abandonment of wells and unskilful pumping. Many of the wells were sunk by men of small capital, who, even if able to finish the well, were not able to erect proper engines and pumps. The machinery is, in almost all cases, very defective, and it is probable that the present engines, properly geared and with proper pumps, would greatly increase the yield of oil.

The Oils.—The lubricating oil is of very good quality, commanding 12 dols. per barrel in gold. The rock oil is heavy, containing little or no benzine, and has a peculiar and offensive odour. It is this odour which, without due care, creeps into the refined oil, that has given the Canada oil a bad reputation; but oil is now being produced that equals in all respects the best Pennsylvania. This odour seems to be due in part to a volatile sulphur compound. Some of the wells discharge sulphuretted hydrogen gas, and the same gas is given off during distillation. There are a number of small refineries both at Oil Springs and at the towns along the Great Western railroad. The largest and best in the region is at Petrolia.

Paraffine.—We believe that there is yet to be in this region a great manufacture of paraffine. The crude oil contains very little benzine, the absence of which diminishes its value, but some 10 per cent. of paraffine can be obtained from it in the winter at little expense, and without injury to the other products. This manufacture, now attracting much attention in England, is comparatively new here, and bas not been as successful as we think it must be in the future—not alone for the manufacture of candles, for which it is so admirably suited, but also for other purposes, in which its indestructible properties will make it in time almost invaluable. As a varnish for metal work exposed to the air or to corrosive vapours, it bas no equal, for it is entirely unchanged by acids or alkalies, lengthened exposure to the air, or indeed by anything except high heat. Already a patent has been taken out for preparing wooden vessels to hold petroleum or benzine, by filling the pores of the wood with paraffine; and it is very probable that barrels lined with it might be used, with certain precautions, to contain acids, &c., in place of the present expensive and fragile glass carboys. The crude paraffine can be manufactured and delivered in Canada at 10 or 15 cents a pound, and afford a fair profit to the refiner. It is not difficult to purify, and there seems to be no good reason why it should not be thrown into the market purified, either in mass or as candles, at 20 or 30 cents a pound, instead of 50 to 75 cents, its present price, in which case it would soon supersede all other candles.

Point Gaspé.—There is another point in Canada, to which allusion has heretofore been made, which has recently attracted attention as a promising oil field. This is near Point Gaspé, on the Atlantic Ocean, at the mouth of the St. Lawrence.

Public attention was first drawn to this by the geological report of Sir Wm. E. Logan, published by Government in 1863. At page 402 of this report, he says: "There is still to be described the Greenstone dyke, connected with the southern anticlinal at Tar Point. This dyke is of a dark grey colour, weathering to a rusty red, and is traversed by numerous horizontal and vertical joints, and abounds in large and small druses. . . . . These cavities are filled with petroleum. This, in some instances, has hardened to the consistence of pitch. The peculiar odour of this substance, which has given the name of Tar Point to the locality, may be perceived at a distance of fifty yards.

Two petroleum springs occur along the line of this anticlinal. One of these is on the south side of the St. John's river, about half a mile above Douglastown. Here the oil oozes from the mud and shingle of the beach. The other is on a small branch of Silver Creek, six or seven miles from Gaspé basin. The rock adjoining the dyke is a sandstone, but it is not improbable that here, as in Canada West, the source of the oil may be in the fossiliferous limestone beneath.

About a mile aud a half south-east of Gaspé basin is found a layer of inspissated petroleum, resembling on a small scale the gum beds of Enniskilleu, while to the eastward the soil is saturated with petroleum. Many other indications in the same neighbourhood are enumerated.

The fossiliferous limestone spoken of belongs to the Lower Helderberg group, which lies at the summit of the Silurian rocks, and below the corniferous, the oil-bearing rock, of the Enniskillen regiou. It is about 2,000 feet in thickness, and is frequently impregnated with petroleum; the surface of the country is mountainous, and deep valleys, both longitudinal and transverse, frequently occur.

No wells having yet been sunk in this region, it cannot yet be placed among the oil-producing districts; but the indications are certainly sufficient to warrant the sinking of a few wells to test the matter, for the very advantageous location of the region as regards the European market, and the abundance of wood for both barrels and fuel, would make a well of but small yield very profitable.

PETROLEUM IN GALICIA.

By Felix Foucon.

It is certain at present tbat within a period of limited duration, old Europe will no longer be tributary to the new world for illuminating oils extracted from the bosom of the earth. Every day fresh natural spriugs of petroleum are discovered ou tbe continent of Europe. At the same time the geologists are becoming better acquainted with the nature of the oleiferous ground, and its extent. Certain lines of demarcation have already been observed, and witbin these, searches are made with a far greater chance of success than formerly, when they were made without the advantage of this guidance.

Amongst those localities that are already producing petroleum fit for exportation, the Danubian Principalities are of the most interesting, especially for the trade of Marseilles. Several navigable rivers, issuing into the Mediterranean, traverse tbe Danubian Principalities. The Sereth and Pruth are led into it through the Danube. The Dniester, though it leaves Moldavia on its right, belongs essentially to the hydrographical system of the Danubian Provices; besides, this river connects Galicia with the basin of the Mediterranean by forming a direct line of communication between the Carpathian Mountains and the Black Sea.

At present, the port of Havre is the chief market of France for the petroleum trade, of which it is enabled to make a monopoly by reason of its geographical position. On the other hand, Marseilles is likely to become a considerable market for this commodity, as soon as the European oil wells are worked on a larger scale, and mineral oils shipped from Asia across the Isthmus of Suez.

I have mentioned Galicia in speaking of the petroleum of the Danubian Principalities; this is on account of the intimate connection that exists between the strata of the two countries. The two oil regions form in reality but one, which is clearly marked by the general line of the Carpathians. Properly speaking, there is in this part of Europe but one and the same system of petroleum wells, viz., the Carpathian system. The localities in which Galician petroleum has been discovered, and is being discovered every day, are south of the Cracow and Lemberg Railway. The extreme limits of this oil district are—the town of Lendech in the west, and Drohopycz in the east, Jeslo in the north, and Komancza in the south. In this direction a new layer, that of Rzepedz has been discovered lately. These are the *present* boundaries of the region, but they are not likely to remain the same for a year, perhaps not even for a month, as the inhabitants of this country begin to be seized with the oil fever like the Americans, and dig the ground in every direction. Unfortunately, they are destitute of proper guidance, and have no good tools; but their education is being effected gradually. Foreigners are stepping in with machinery and money, and this is all that is needed. The distance of the two points from each other is about 125 miles; from north to south, *i.e.*, in its width, the zone measures about 30 miles. On the whole area of this rectangle (about 3,750 square miles) there are no more than twenty-five oil wells working, most of which have been taken up only in the last three or four years.

From this zone the oilground strides from Drobobiez towards Moldavia from N.W. to S.E., crossing the Bukowina. We shall soon hear more of this part of the Carpathian oil region; in fact, Professor Coquand, formerly of the faculty of Marseilles, has been visiting these grounds lately.

In observing the distribution of the strata in Galicia and the Bukowina, and their general direction across Moldo-Wallachia, we remain convinced of the existence of a great subterranean fissure, crossing Europe diagonally, somewhere from the mouths of the Oder to the mouths of the Danube. This fissure is clearly marked by the line of the notorious salt strata of Wieliczka, Bochnia, Starasol, Drohobycz, Delatyn, and Solka. The latter place, situated in the Bukowina, at a short distance from the Moldavian frontier, is remarkable, like Drohobycz, because both salt and petroleum are found there. The same is the case with Starasol, in Galicia.

These affinities are rather important, from an industrial point of view. The nature of petroleum has been the subject of many controversies. In America it was at first considered as the product of the distillation of pit coal and bituminous slate. But this supposition was soon abandoned as insufficient, and the decomposition of vegetable tissues, and even gelatinous animal matter, during the periods of geological transformation, was put forward to explain the origin of rock oil. No doubt such decomposition has something to do with the phenomenon in question; still, the enormous quantities of petroleum and bitumen that are discovered in the four quarters of the globe, the peculiar circumstances that attend the searches and the working of the oil wells in America, do not admit of this explanation being considered sufficient.

The writer's own observations in Galicia permit him to surmise that there are great reservoirs below that are fed by bituminous currents, coming from the centre of the earth—or, in other words, he thinks that there have been and are still taking place eruptions of bitumen, the same as there have been trachytic, metalliferous, sulphurous, salinous, and other eruptions. Consequently, petroleum would be derived from the heart of the earth, not from its external strata.

When petroleum is met with in ground of recent formation, as *e. g.* in Galicia, its presence is due to the cleaving of menilitic slate, between the layers of which it is always to be found at a depth of from 30 to 55 yards. In all these wells which have been made with the pickaxe, the oil is found in a state of stagnation. The wells must be cleared either by means of buckets or pumps. It is well known that in America spring wells have been reached when once the wells were cleared, and oftentimes at great depths below the wells after the latter had been dressed up.

In Galicia sandstone forms the base and the foundation, so to speak, of the cistern that holds the petroleum in a state of stagnation. This rock being impervious, it is obvious that piercings should not be made at hazard. But by studying the ground and making the opening between two layers of sandstone, lime may be reached, and a position analogous to that of the American explorers attained, so that there will be a better chance for finding spring wells.

However, even in confining their ambition to the working of the mineral oils contained in the basins of the Carpathian formation, the population of the old world will still find a vast field to devote their energies to; but it is very material, to prevent disappointment and obtain the best result with the smallest sacrifice of capital, to be always guided by the light of pure science. Sound theory has this great advantage, that it may always be applied directly to a well-defined practical object. As early as 1863, Mons. de Chancourtois, Superintendent Mining Engineer, submitted to the Paris Academy of Science his views, purely theoretical, on the use of the pentagonal net in searches for bituminous strata. Since then the strata discovered in Galicia have ranged themselves in a line from the Oder to the Danube, as one of the chief elements of the net. In the opinion of the writer, searches pushed in this direction are almost sure to succeed without leading to aberrations.

ON SURFACE CONDENSATION.

By Otto Dingler and Franz Pfeiffer, Engineers to the Austrian Lloyds.

Great differences of opinion exist as to the amount of saving in fuel to be derived in marine engines from condensation of steam on cold surfaces, as compared with that obtained by the injection of water. The theoretical gain which may be realised by feeding the boiler with distilled instead of salt water may be readily calculated, the balance in favour of distilled water being equal to the loss represented by the blowing-off and scumming required, when salt water is used.

The real loss of heat, however, is likely to exceed that found by this calculation, as in all probability a certain quantity of the steam generated will be carried away through the outlet pipe with the waste water, in consequence of the continual oscillations in the level of the water. These quantities, which are thus uselessly abstracted from the boiler, have not to our knowledge ever been measured, but such measurement may readily be made in the following manner:—

Supposing the outlet pipe instead of issuing overboard, to be led into a vessel containing x kilogrammes of water at a temperature t, this quantity will, after the lapse of a certain time, which may easily be measured, have increased to y kilogrammes and assumed a temperature t'. The quantity of heat contained in the original quantity of water was $= x \times t$, the quantity of heat contained in the y kilogrammes is equal $y \times t'$ units of heat, therefore the increase representing the abstraction of heat from the boiler will be $y \times t' - x \times t$ units of heat. Now, supposing it had been ascertained by simultaneous direct measurement, that during the same lapse of time z kilos. of water of a temperature t'' had been let into the boiler, there will obviously remain

$$z - (y - x) = z + x - y \text{ kilos.}$$

that had been usefully employed, and required for their evaporation

$$(z + x - y)(650 - t'') \text{ units of heat,}$$

so that the loss of heat involved by the blowing off will be represented by the expression

$$\frac{y t' - x t}{(z + x - y)(- t'')} \text{ units of heat.}$$

In order successfully to perform such an experiment, the following points should be kept in view. The vessel in question should be as large as possible, and the quantity of water (x) contained therein originally be of a temperature sufficiently low that the duration of the trial may not be too short, and that the steam may be readily condensed. The vessel should be clothed with a non-conducting material, the inlet taking place from below, an aperture of sufficient size being provided for the escape of the air. On the other hand, the steam generated in the boiler and supplied to the engine, representing the quantity of heat usefully employed, should not be liable to priming, and this condition may be complied with, at least with an exactitude sufficient for practical purposes.

We have observed that a loss of heat is involved by a certain quantity of steam being carried off when the saline water is let out of the boiler. The question arises, in what proportion water and steam may be mixed together in this case, and though this question is immaterial from a mere practical, it is sufficiently interesting from a scientific, point of view to justify its being inquired into. This may be done in one of two manners.

If we subtract from the measured *total* loss of heat, as above, the calculated loss that would take place if water only were abstracted from the boiler, the difference between these two will represent the quantity of heat uselessly abstracted from the boiler by the steam that has been carried off, and from this the weight of such steam may be readily deduced. Another method is as follows:—Letters denoting the same as above, and supposing T to be the temperature in the boiler, n the quantity of water, and m the quantity of steam (in kilos.), abstracted from the boiler in the manner alluded to, it is obvious that

$$y t' - x t = n (T - t) + m (650 - t)$$

and as

$$n + m = y - x;$$

we find for the quantity of steam in question,

$$m = \frac{y t' - 2 x t - y T + y t + \times T}{650 - T}.$$

The accurate carrying out of a series of experiments in the described manner would tend to do away with the prevailing differences of opinion on the saving of fuel that may be realised by the use of distilled water in the feeding of boilers, and lead to a proper appreciation of this saving. The latter, however, is not the sole element acting in favour of surface condensation. The question also arises, whether the durability of the boiler may not be affected by feeding it with a different kind of water. On this point, however, the most contradictory and peculiar opinions are met with. This much, however, seems certain, that boilers working with distilled water are liable to a far greater internal oxidation than those in which the deposits of salt prevent a direct contact between the metal and the salt water. The naval engineers of all countries are engaged at present in inquiring into the causes of this increased corrosion, and many controversies have arisen on this subject without having yielded as yet any result beyond the following four hypothetical explanations of the phenomena of oxidation observed in boilers, working with surface condensers, viz.,

1st. The sulphur contained in the vulcanised india rubber rings used for the packing of the condensation pipes, is partly absorbed by the feed-water and transmitted to the boiler itself, and the metal is stated to be affected by the corrosive action of such sulphur.

2nd. In a manner similar to No. 1, copper derived from the condensation, feed, and steam pipes is supposed to be deposited on the sides of the boiler, where it would produce galvanic effects.

3rd. Distilled water is stated to have the property of affecting iron in a higher degree than impure or common spring water.

4th. The greasy substances from the steam cylinders, pumps, &c., introduced into the boiler with the feed water form acids which generate a decomposing action, which operates destructively on the boiler plate.

We need not enumerate all the *pros* and *cons* urged with reference to these hypotheses, but content ourselves with observing that the supporters of the two first named suppositions, which are obviously the weakest of all, seem to attribute to the decillionth parts of a grain of sulphur or copper a very powerful homœpathic action on the colossal masses of iron of the boiler. As regards the supposed action of distilled water, for which no scientific reason can be adduced, our own extended experience enables us to utterly deny it, and we request more particularly engineers engaged in the manufacture of sugar, to ascertain with accuracy when a boiler ffected in the manner alluded to has always been fed with *pure distilled* water, or if the water supplied to the boiler contained a *per centage of sugar*, derived from such apparatus as may have become leaky; as we notice that, in this quarter, the assertions of the injurious effect of distilled water have been chiefly urged and supported. We also have often met with boiler water as black as ink, but only in cases when foreign substances had found their way into the steam generator. On the other hand we certainly profess the opinion that acids produced by *greasy* substances do indeed act destructively on iron, and this view of ours as to the injurious effect of such acids, as well as carburetted hydrogen, is corroborated by the above-mentioned experience relating to feed water mixed with sugar and syrup, and also by the fact, not generally known to engineers, that iron and steel are very injuriously acted upon by heavy liquid carburetted hydrogen substances.*

On the sides of boilers fed with distilled water (and more particularly at the height where the level of the water changes, *i.e.*, within the limits of the water level) a deposit consisting of incrustation, grease, and some oxide of iron may be found which preserves the boiler plate from the contact of the water, there being no adhesion between the water on this rough but very greasy mass. The flues also are covered with a similar deposit, less greasy in appearance, [the existence of which alone should suffice to render questionable the destructive action of *pure* distilled water.

The high temperature of surfaces that are encircled by fire, prevented from contact with water by the deposit alluded to, and consequently very liable to incandescence, and the corresponding high temperature of the deposits themselves, are amply sufficient to decompose the greasy matter, by which the gas generated in the process of decomposition will tear up the incrustation, allowing the water a free access to the overheated iron. Though neither the small quantity of hydrogen gas generated thereby, nor the excessive instantaneous production of steam, may be attended by any danger, still the partial oxidation of the boiler plate cannot be denied, and this process being repeated an infinite number of times, its consequences must become perceptible at length. It is obvious that the minor explosions that are repeatedly observed, as well as the noise that is audible at times, are easily accounted for by this phenomenon.

By the combustion of grease, however, several products, such as combustible oils, acids, &c., are generated, the action of which on metallic iron —though at present not yet sufficiently known—cannot be denied, as will appear from the above statements. The fact of the boiler plates being chiefly affected at the height of the level of the water may be easily accounted for by the separation of portions of the deposit alluded to, effected by the fluctuations of the water, and subsequent action of the acids thus freed, upon the denuded metallic iron surface.†

From this it is clear that, to explain the speedy destruction of the boiler plates, a galvanic action, or a peculiar, not yet discovered, property of distilled water need not be resorted to, these hypotheses being as preposterous as the alleged formation of oxygen and hydrogen gas, and its ignition by a spark produced inside the boiler (*sic.*), the dangerous increase of the pressure of steam by hydrogen gas accompanying it, and so forth.

The question arises, how to neutralise the injurious action of these acids of grease on the metal of the boiler? As we have observed previously, the incrustations of salt preserve the plate from immediate contact, and consequently from the injurious action of the boiler water, or rather of those foreign substances contained therein. It would, therefore, be requisite only to give the sides of the boiler a light coating by feeding it with salt water from the commencement. This preventive is usually resorted to in practice, but by this protective process the greasy substances are not removed but will accumulate in the boiler, and unless removed from time to time by blowing out, they will form over the incrustations of salt the thick deposits alluded to, thus exposing the plates to the danger of combustion and contracting the steam and water space of the boiler. If, however, the remedy of blowing off these substances be resorted to, rather considerable losses of heat are occasioned which will counterbalance a portion of the advantages derived from the production of steam from distilled water. It follows that the problem to be solved consists in

* During four years we have observed, at least once a week, that the iron and even steel valves and steel wire spiral springs of a force pump for gas were decomposed by such substances containing carburetted hydrogen, benzine, euplion, &c., as were separated from the gas at a pressure of from 25 to 30 atmospheres, and had to be let out of the pump every hour. The valves that were made of best English cast steel, after iron had proved inefficient, were corroded by this liquid which gave them the look of raw Damascus steel, and the steel springs were unwound like raw cord. The gas in question was prepared out of distilled eolophorium (so-called colophorium oil) and was free of all foreign substances.

† Some have tried to deny the pernicious action of acids of grease on boiler plates, urging that by the introduction of alkalis into the boiler for the saponification of grease the oxidation of iron could not be stopped; but by this they do not prove the non-existence of acids of grease, but merely that fuller's earth acts on iron in the same manner as non-saponised acids of grease.

preventing these greasy acids entering the boiler at all, *i.e.*, in abstracting them from the feed water before it find its way into the boiler. As far back as two years ago we have been engaged in the solution of this problem, and thought of the employment of a coal filter to remove the grease from the water on its way from the condenser to the boiler, a very old principle, which was patented for England recently by one Mr. James Howden.

Unfortunately we were not in a position to make experiments on a large scale, though those made on a small scale yielded excellent results. We therefore agree with the patentee, but would suggest to use instead of one filter, two filtration apparatus, constructed more in keeping with the purpose, more readily accessible and separate from the engine, and arrange them so that the one may be cleaned, *i.e.*, the coal powder impregnated with grease be replaced by a fresh filling while the other is at work. In this manner the clarification of the water might take place without any interruption in the working of the engine. The waste coal from the filter might be revived by washing and baking, and the grease be saponised or used as a lighting material.

A marine boiler, fed with distilled and clarified water, will work under no less favourable conditions than a stationary boiler, and it is to be expected that, by preventing the external oxidation very frequently on board ships, its durability may be rendered almost equal to that of a stationary boiler. To obtain this result, it would be necessary to put the shell of the barrel which, in a marine boiler is destroyed first, into a condition identical with that in stationary boilers. The more intense corrosion in the barrel in feeding with salt water is produced, on the one hand, by the fact that no protective incrustation is formed above the level of the water, and consequently the salt water, raised mechanically by the balancing of the ship and the ascending steam bubbles, will cover the metallic sides; on the other hand, by the method at present in use of constructing marine boilers, the chimney hood will pass across the barrel of the boiler, and form a heating surface surrounded by steam, not by water; and it is just at the level of the chimney hood that the corrosion will be strongest, a fact which is easily accounted for.

In the quick heating of the cold boiler this part which is touched neither by water nor steam, but by the flame itself, may soon get up to incandescent heat, and this may take place through strong heating, even during the voyage, especially when flues, tubes, &c., are covered only with a thin coating of incrustation, and the gaseous products of combustion passing through are no longer properly cooled; in this case the redhot plate will obviously be oxidised. The chimney hood not being covered with incrustation, the nascent protoxide of iron may be separated by the change of the temperature produced by spray, or dissolved by the acids of grease and their vapours, by means of which the formation of a new layer of protoxide is facilitated.

In feeding, however, the steam generator with *pure* water, oxidation of the plates cannot take place in the barrel any more than in any other part of the boiler, and as regards the usual chimney hood, it will involve no constructive difficulties to suppress it altogether, and in lieu thereof, lead the gases derived from the combustion immediately out of the boiler after their passage through the tubes, and pass them into a copper superheating apparatus at the front of the boiler and thence into the chimney. In such arrangement *all* iron heating surfaces will be surrounded by the water of the boiler, and as copper is not destroyed by superheating, all postulates will be complied will be complied with to secure to marine boilers a durability equal to that of stationary boilers. The additional expense for copper instead of iron in the superheating apparatus would be amply balanced by the economical advantages realised in other respects.

NOTES ON SHIPBUILDING AND THE CONSTRUCTION OF MACHINERY IN NEW YORK AND VICINITY.

(From the Journal of the Franklin Institute.)

THE STEAMER "NEPTUNE."—Hull built by Van Deusen Brothers, New York. Machinery constructed by Henry Esler & Co., Brooklyn, L.I. In government service. Owners, United States Government. Original owners, Neptune Steamship Company.

Length on deck, 218ft. Breadth of beam, 35ft. 8in. Depth of hold, 12ft. 4in. Depth to spar deck, 19ft. 10in. Draft of water, 13ft. Frames, molded, 16in.; sided, 8in. to 10in.; apart at centres, 24in. Four athwartship bulkheads. Rig, schooner. Tonnage, 1,311 tons, O.M. Vertical direct engines. Diameter of cylinders, 44in. Length of stroke of piston, 3ft. Two tubular boilers, located in hold. Fire surface, 4580 square feet. Grate surface, 141 square feet. No blower to furnace. Hibsch's patent propeller. Diameter, 12ft. Pitch, 20ft. Material, cast iron.

Remarks.—The floors of this vessel are filled in solid for 100ft. The keel is of white oak, sided, 14in., molded 24in. Put together in two pieces, each 12in. in thickness, with 4in. coatings, and thoroughly fastenened with galvanized iron bolts.. The stern is of white oak, naturally carved, sided, 13in., and molded, 15in. outside of rabbet. The floors are of white oak, double, sided 8in., well bolted together, and square forward. The side and centre keels are 14in. by 14in., and fastened with yellow metal. The bottom planks are 3½in. thick increasing near the wales to 4in. The deck planking is of thoroughly seasoned white pine, 3in. thick and 6in. wide, fastened with two 6in. galvanized spikes in each beam, and two 5½in. spikes in each carling. The cross timbers are of solid white oak and yellow pine, 10in. thick, and of an even depth with the keelsons.

Her masts are 78ft. and 81ft. in length, and 24in. and 31in. in diameter.

The engine department of this vessel is well fitted in every respect, especial care being taken that all articles were of first quality.

The steamers *Nereus*, *Glaucus*, *Proteus*, and *Galatea* are sister vessels to the *Neptune*, built at the same time, and are also owned by the United States Government.

THE STEAMER "GOLDEN CITY."—Hull built by Wm. H. Webb, New York. Machinery constructed by Novelty Iron Works, New York. Superintendent of construction, Captain Francis Skiddy. Route of service, Panama to San Francisco. Owners, Pacific Mail Steamship Company.

Length on deck, 340ft. Breadth of beam, 45ft. Depth of hold, 23ft. 6in. Depth to spar-deck, 31ft. Draft of water, 17ft. Frames, molded, 15in.; sided, 18in.; apart at centres, 36in. Four athwartship bulkheads. Rig, brig. Tonnage, 3,336 tons, O.M. Vertical beam engines. Diameter of cylinder, 105in. Length of stroke of piston, 12ft. Diameter of piston-rod, 11½in. Diameter of crank-pin journal, 14in. Length of crank-pin journal, 18in. Diameter of beam-centre journals, 15in. Length of beam-centre journals, 21in. Fitted with a Sewell's condenser, having 5,500 brass tubes, 9ft. long, the condensing surface of which is 8,000 square feet. Martin's horizontal tubular boilers, placed in a nest. Diameter of face, 20ft. 4in. Depth, 11ft. 6in. Height, 11ft. 6in. Diameter of smoke-pipe, 10ft. Each boiler has five furnaces. Fire surface in each, 3·379 square feet. Grate surface, 120 square feet. Water-wheels.—Diameter outside of buckets, 40ft. Length of buckets, 18ft. Width of buckets, 2ft. Diameter of water-wheel shaft journal, 22in. Length of water-wheel shaft journal, 30in.

Remarks.—This noble vessel is built of white oak, haemetac, &c., and square fastened with copper and treenails. Around her frames extend iron straps, diagonally, and double laid, 4½in. by ⅞in. Every precaution that could be taken was resorted to in the construction of this steamer, that she should be a vessel of comfort and safety. Her model is almost faultless and she is very fast. Her interior is designed with great skill and care for the comfort of passengers and with a keen perception of the beautiful. Under her deck it is very roomy, and not cut up with band box saloons, like most of our ocean steamships. Her upper and main saloons are very large, accommodating from 1,500 to 2,000 passengers.

THE STEAMER "JAMES T. BRADY."—Hull built by Thos. Stack, Brooklyn, L.I. Machinery constructed by Fulton Iron Works, New York. In Government service. Owners, Arther Leary and others, New York.

Length on deck, 213ft. Breadth of beam, 30ft. Depth of hold, 9ft. Draft of water, 7ft. Frames, molded, 12in.; sided, 6in.; apart at centres, 26in., 28in., and 30in. Rig, none. Tonnage, 585 tons, O.M. Vertical beam engines. Diameter of cylinder, 45in. Length of stroke of piston, 11ft. Tubular boiler Length, 24ft. Width, 13ft. Fire surface, 3,000 square feet. Grate surface 86 square feet. No blowers to furnace. Crooker's adjustible water-wheels. Diameter, 27ft. 2in. Face, 8ft. Dip, when loaded, 3ft.

Remarks.—This vessel is of white oak, &c., and copper fastened. Iron straps extend around her frame; they are 3½in. by ⅜in. She is supplied with an independent steam, fire, and bilge pump, bilge injection, and valves to all openings in her bottom. She has given satisfaction to those connected with her.

THE STEAMER "AJAX."—Hull built by C. and R. Poillon, Brooklyn, L.I. Machinery constructed by C. H. De Lamater, New York. Superintendent of construction, John Baird. Route of service, Pacific Ocean. Owners, Wakeman, Gookin, & Dickinson, New York.

Length on deck, 224ft. Breadth of beam, 35ft. 8in. Depth of hold, 18ft. 6in. Number of decks, 3. Draft of water, 16ft. Frames, molded, 14in.; sided, 9in. and 8in.; apart at centres, 26in. Floors filled in solid under engines. Rig, brigantine. Tonnage, 1,357 O.M., 1,355 N.M. Horizontal engines. Diameter of cylinder, 54in. Length of stroke of piston, 4ft. 4in. Two return tubular boilers. Located in hold. Each boiler has 224 tubes, 10ft. long by 3in. diameter. Propeller of Baird's design. Diameter, 13ft. 6in. Material, cast iron.

Remarks.—This ship was built with the greatest care, both as regards materials and workmanship, the materials being of white oak, haemetac and locust: diagonally braced with iron straps 4¼in. by ⅝in., laid double, extending from floor heads to upper deck, connecting with longitudinal iron bands running from stem to stern. The deck beams are of Georgia pine and Maryland oak; the ceiling in the wake of machinery of Georgia pine; the bottom plank is of white oak; the water-ways of white pine, and the topsides are built in hull. The fastenings used in her construction are yellow metal, copper, iron, and locust treenails.

THE STEAMER "GOLDEN RULE."*—Hull built by Henry Steers, Greenpoint, L.I. Machinery constructed by Morgan Iron Works, New York. Route of service, New York to Aspinwall, C.A. Owners, M. O. Roberts and others.

Length on deck, 310ft. Breadth of beam, 44ft. Depth of hold 12ft. Depth to spar deck, 25ft. Number of decks, 3. Draft of water, 14ft. Frames, molded, 17in.; sided, 15in.; apart at centres, 32in. Four athwartship bulkheads. Rig, foretopsail schooner. Tonnage, 3,080, O.M. Vertical beam engine. Diameter of cylinder, 31in. Length of stroke of piston, 12ft. Two flue boilers. Located in hold, and use a blower. Diameter of water-wheels, 30ft. Material, iron.

Remarks.—This is a very fine vessel, being built of the choicest white oak, haemetac, &c., fastened in the securest and most durable manner, and fitted with all the conveniences and comforts a vessel of her class requires. Her bottom planks are of white oak, 4in. or 5in. thick, and her keelsons are of

* Run on a coral island in the Carribean Sea, May 30, 1865, and was lost.

oak and yellow pine. The *Golden Rule* has made several runs on the route of her service, giving satisfaction to owners, builders, and passengers.

THE STEAMER "GEN. BARNES."—Hull built by Lawrence and Foulk, Greenpoint, L.I. Machinery constructed by Morgan Iron Works, New York. Route of service, New York, Havana, and New Orleans. Owner, H. T. Livingston.

Length on deck, 230ft. Breadth of beam, 35ft. Depth of hold, 18ft. 6in. Number of decks, 2. Draft of water, 11ft. Two athwartship bulkheads. Frames, molded, 16in.; sided, 9in., 10in., and 12in.; apart at centres, 28in. Rig, foretopsail schooner. Tonnage, 1,348 tons, O.M. Vertical beam engine. Diameter of cylinder, 60in. Length of stroke of piston, 10ft. Two flued boilers. Located in hold. Do not use blowers. Diameter of water-wheels, 26ft. Material, iron.

Remarks.—This steamer is of white oak, chestnut, &c., and square fastened with copper and treenails. Around her frames, which are partly filled in solid, extend iron straps, 4in. by $\frac{5}{8}$in., diagonally and double laid, increasing their strength. She is fitted with pumps, injections, bottom valves, &c., as vessels of her class are required to be. Her passenger accommodations are excellent, and in every respect this steamer ranks well.

THE STEAMER "CITY POINT."—Hull built by Geo. Greenman & Co., Mystic, Connecticut. Machinery constructed by James Murphy & Co., New York. In Government service. Owners, James Murphy & Co. and others.

Length on deck, 203ft. Breadth of beam, 30ft. Depth of hold, 9ft. 6in. Number of decks, 1. Draft of water, 7ft. Frames, molded, $12\frac{1}{2}$in.; sided, 6in.; apart at centres, 26in. Rig, none. Tonnage, 555, O.M., 1,110, N.M. Vertical beam engine. Diameter of cylinder, 45in. Length of stroke of piston, 11ft. One tubular boiler. Located in hold. No blowers to furnaces. Diameter of water-wheels, 27ft. Material, iron.

Remarks.—This steamer is of white oak, chestnut, and cedar, and square fastened with copper and treenails. She is strapped with iron straps, $3\frac{1}{2}$in. by $\frac{5}{8}$in., and her bottom is coppered. Her water-wheel guards extend fore and aft and are half sponsoned.

THE STEAMER "NEW YORK."—Hull built by Jeremiah Simonson, Greenpoint, L.I. Machinery constructed by Allaire Works, New York. Route of service, New York to Aspinwall. Owner, Commodore C. Vanderbilt.

Length on deck, 300ft. Breadth of beam, 42ft. Depth of hold, 26ft. Number of decks, 2. Draft of water, 15ft. Frames, molded, 18in.; sided, 10in.; apart at centres, 30in. Rig, foretopsail schooner. Tonnage, 2,551, O.M. Vertical beam engine. Diameter of cylinder, 90in. Length of stroke of piston, 12ft. Two tubular boilers. Located in hold. No blowers to furnaces. Diameter of water-wheels, 25ft. Material, iron.

Remarks.—This steamer is of white oak, locust, &c., and is square fastened with copper and treenails. Her floors are filled in solid. Iron straps diagonally and double laid, 5in. by $\frac{5}{8}$in., extend around her frame, and in other ways she is constructed in the most approved manner. Her bottom is coppered, and she is furnished with pumps, injections, and cocks to all openings.

THE STEAMER "SHAMROCK," NOW THE GUNBOAT "ISNOMIA."—Hull built by Thomas Stack, Brooklyn, L.I. Machinery constructed by James Murphy & Co., New York. Original owners, Arthur Leary and others.

Length on deck, 211ft. Breadth of beam, 27ft. 6in. Depth of hold, 9ft. 6in. Number of decks, 1. Draft of water, 5ft. 6in. Frames, molded, 12in.; sided, 6in.; apart at centres, 26in., 28in., and 30in. No rig. No bulkheads. Tonnage, 585, O.M. Vertical beam engines. Diameter of cylinder, 45in. Length of stroke of piston, 11ft. One tubular boiler located in hold. No blowers to furnaces. Diameter of water-wheels, 28ft. Material, iron.

Remarks.—This vessel is of white oak, chestnut, and hacmetac, and is square fastened with copper, iron, and treenails. She is strapped with iron straps, 3in. by $\frac{7}{16}$in., and her bottom is coppered. She has knees under her main deck, and is considered a fine steamer. The speed shown by her in her trial trip induced the Navy Department to purchase her, and fit her for blockading duty.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

CONTINUED ACCOUNT OF PAPERS READ ON SATURDAY, SEPT. 9.

ON EXTENSIVE AND DEEP SINKINGS OF LANDS IN THE CHANNEL ISLANDS, SEAS, AND ON SOME CHANGES OF THE FRENCH COAST OF THE BAY OF BISCAY WITHIN THE HISTORICAL PERIOD.

By MR. R. A. PEACOCK, Jersey.

Quantities of stumps of trees have at various times been found on the east and west of Guernsey, on the west, south, and north-east of Jersey, all along the west coast of Normandy, and along the eastern half of the north coast of Britanny. And in 1787 thousands of trees, some of them very large, were washed up from Rigdon shoal and Great Bank, which are respectively at two and three miles distance westward from the present west coast of Jersey, which corroborated a well-known record that since a date which proves to be about A.D. 1337, "the sea hath overwhelmed," a tract extending "in breadth from the hills very farre into the sea" on the west of Jersey. The like is true as to the Banc du Viellet, a tract of more than ten square miles of marine rocks on the south of Jersey, as is farther proved by the remarkable angularity of the marine rocks in both localities. They have not had time as yet to become rounded by the action of the tides, having been covered with soil until the date given. There were also plenty of records in middle age chronicles that the whole tract (now sea) between Chausey Rocks and Dol was, up to the great sinking of 709, the forest of Scisey. And that Mont S. Michel, which now only contains twenty acres, was previous to that date six miles long, by four broad, covered with forest. And accordingly, after the hurricane of Jan. 9, 1735, a prodigious quantity of trees was washed up from the sands of the Mont, which have been penetrated in several places more than 50ft. without reaching the bottom of the sands; and in 1780 a barque, which was stranded there, buried herself, masts and all, in the sands in the course of a week. The positions of four monasteries, and of the Bourg of Lhan-Kafruth in the forest are known; one of them stood where the sounding is now 54ft. at low water, and the rise of an equinoctial tide is also 54ft., to which add (say) 10ft. for supposed height above high water, we shall have a total of 118ft. sinking. But there were also records of the former height of Mont S. Michel having once exceeded its present height by a greater amount than that. Ptolemy who lived in the first half of the second century gives latitudes and longitudes in his own way, and the author had reduced some of them to modern latitudes and longitudes, and laid them down on the sailing chart; taking as points of departure Ocrinum promontory (the Lizard), and the centre of the Isle of Vectis (Wight). In this way Ptolemy's Gohœum promontory of the Osismii became 4° 51·21′ W. long. and 48° 33·18′ lat., which nearly agreed with the north-western angle of Britanny. And the harbour Staliocanu becomes 2° 48·81′ W. long. and 48° 38′ lat., which nearly agrees with the present harbour of Portrieux on the north coast of Britanny. These ought to give confidence in Ptolemy's approximate correctness as to these regions. And, now observe, the mouth of his river Argenis becomes 2° 0·91′ W. long. and 48° 52·54′ lat., which give a position about five miles west of Chausey rocks, and *seventeen miles west of the present west coast of Normandy*, which was curiously corroborated by two modern writers having said, each independently of the other, that Mont S. Michel was once ten leagues distant from the sea; which is about the distance from the Mont to the mouth of the river Argenis. So also the mouth of Ptolemy's river Tetus becomes 2° 2·22′ W. long. and 49° 2·21′ lat., which give a position *more than thirty miles west of the present west coast of Normandy*, which ranges very well with Rigdon Shoal and Great Bank, formerly forests. The author had no doubt whatever that Jersey was part of the continent in Cæsar's time. Ptolemy gives no positions anywhere near Guernsey, Sercq, or Alderney, and the author had attempted to get at the alterations there by a threefold process.

1. A unique privilege formerly appertained to the Channel Islands and their seas, which is thus described by Poingdestre, a distinguished and very learned antiquary, and a native of Jersey, in the Harleian MS. No. 5417, chap. xi.:—"I come now to a priviledge of all the islands together, soe singular that the like is not to be parallel'd elsewhere in any age, That a Tract of Islands should have and enjoye by the acknowlegment of all bordering naions the benefitt of a perpetuall peace, not onely in their Ports, but alsoe in ye seas about them, soe farre as the best eye of man can discover in the cleerest day ; where the greatest enemyes, who anywhere else would pray upon one another, within ye Priviledge become good friends and trade one with another as if they were not in warre." There is no record of the cause or origin of this singular privilege, but it was already in operation in 1472, and was not abolished till about 1689. The author thought the neutrality was so co-extensive with the sunken country, which was the private property of individuals, and therefore neutral, not being part of the high seas.

2. By the exhaustive process he had satisfied himself that a remarkable passage in Diodorus's 5th book could only refer to Guernsey, Sercq, and Alderney, between which and the continent, the ground was dry at low water nineteen centuries ago.

3. To restore which state of things the sea bottom, and perhaps, those islands also, must be lifted about twenty fathoms. It is certain that the submarine trees found on the west of Guernsey could not have been the "produce of a low district" as had been supposed, for it was easy to prove that such a district would necessarily have filled with water, and that the trees could not have grown there. Similar events had occurred on the west of Britanny, and the Aunis had risen a few feet.

The President of the Section thought that Mr. Peacock had proved his case, and he wished Sir Charles Lyell had been present, for the paper would be of great interest to him as corroborating some statements in his Principles of Geology. It would also be of great interest to the Geographical Society.

The author had made a large collection of evidences of modern, medieval, and classical authorities, which he proposes to publish (inclusive of the seventy evidences on steam referred to below) if there was sufficient demand for the volume.

ON STEAM AS THE ACTIVE AGENT IN EARTHQUAKES.

By MR. R. A. PEACOCK.

The author distributed a number of copies of a table he had calculated "On the pressures and temperatures of saturated steam," between 25lbs. per square inch and 411·6lbs. per square inch, which table was first printed in this journal, under date June 1, 1865. The converse of the table was that the pressure of saturated steam increases within the limits of the table, in the enormously rapid ratio of the $4\frac{1}{2}$ power of the temperature. He had substantially corroborated the table by similar treatment of M. Regnault's series of experiments *Y* and *Z*.* He referred to seventy evidences of the presence of steam and its constituents in every species of natural disturbance of the earth's crust, of which we also gave in June a classification and an extract. What the pressure of steam is at the highest temperature we do not know, but we have some indications that at a very high temperature it is very great indeed. The Rev. John Mitchell states† that in casting two brass cannon "the heat of the metal of the first gun drove so much damp into the mould of the second, which was near it, that as soon as the metal was let into it it blew up with the greatest violence, tearing up the ground some feet deep, breaking down the furnace, untiling the house, killing many spectators on the spot with the streams of melted metal, and scalding others in the most miserable manner." These great effects were

* Mem. de l'Institut, Vol. XXI.
† Phil. Trans. R.S. 1760. Vol. XI. p. 453.

evidently produced by the steam of a few ounces of water only, for it is called merely "damp." It must, therefore, have been very powerful steam. Now the temperature of melted brass is known to be only 1,869° F., which would be reduced by raising the temperature of the "damp," and the mould. and the neighbouring sand. But the heat of melted stone or lava is 3,000° F., or according to some 3,200°. And since saturated steam, or its constituents, is so very often present in all species of natural disturbances of the earth's crust, it is worth while to remember, on the bare chance of the same law continuing to prevail as in the table, that in that case saturated steam of the highest temperature would have amply sufficient force to cause the greatest effects of earthquakes and volcanoes. The volume of steam, compared to the volume of water, which produced it, when the pressure is 26½lbs. to the square inch is known to be about 941 times as great, whilst when the pressure is 60·6lbs. the volume of steam is known to be only 432 times as great as that of the original water*; and he thought that heat compresses steam in the same way, though not in the same degree, as the force pump compresses water in the hydrostatic press; and that supposing the strength of the containing vessel unlimited, and the supply of water sufficient to saturate the steam, the force or pressure attainable would only be limited by the maximum heat in one case, and the maximum pumping power in the other; and the conclusion he arrived at was that steam certainly operates *quantum valeat* in producing earthquakes, volcanoes, and other similar disturbances.

The President of the Section said he had not the least doubt that Mr. Peacock was quite right in his conclusions. He was satisfied that when steam could get vent, it escaped, and when it could not get vent it caused undulations.

THE RESISTANCE OF WATER TO FLOATING AND IMMERSED BODIES.

Professor Rankine read the interim report of the committee appointed to make experiments for the purpose of ascertaining the difference between the resistance to floating and immersed bodies. The experiments not being complete, the committee deferred a detailed report. The committee had several meetings during last winter and spring, and agreed to a programme of experiments. Two models of ship shape, four feet long and painted, were made and employed in these experiments. The experiments were made according to the method formerly put in practice by Mr. Scott Russell, in which the uniformity of the propelling force was maintained by means of a regulating weight hanging from a pulley, under which the hauling cord passes, the model being guided in a straight course by means of a stretched wire. The experiments were made with the models both totally immersed and only half immersed. The execution of the experiments was superintended by Mr. Scott Russell, as being the only member of the committee resident in or near London. The actual performance of the experiments was entrusted by Mr. Russell to Mr. J. Quant, who had performed the duty with great skill and assiduity. A lake in Blackheath Park was kindly granted for the experiments by Dr. Joseph Kidd. Twenty-eight experiments had been made on the first model, with the following results:— 1. The resistance, when immersed so as to be just covered with water and no more, was more than double its resistance when half immersed, at the same speed. 2. When the after body of the model was turned so as to convert the water-line into buttock-line, its resistance was increased, and that whether the model was half immersed or just covered. The report deferred the detailing the description of the experiments until they should be completed. Professor Rankine concluded with moving a vote of thanks to Mr. Scott Russell for the presentation to the Association of several magnificent pictorial volumes, published by him, on "The modern system of naval architecture."—The vote was cordially awarded.

THE STRENGTH OF MATERIAL CONSIDERED IN RELATION TO THE CONSTRUCTION OF IRON SHIPS.

Dr. W. Fairbairn read a paper (the joint production of himself and Mr. T. Tate, Hastings) "On the strength of material in relation to the construction of iron ships." The paper first dealt with the qualities of iron best adapted for iron ships, and especially ships of war. The quality of iron estimated by work expended on the ultimate elongation of a bar one foot long and one square inch in section was first considered. This work, or dynamic effect, gives a comparative measure of the powers of resistance of different kinds of material to a strain of the nature of impact. The value of this modulus or co-efficient of dynamic resistance, determined by Dr. Fairbairn's experiments for different plates or bars of iron, show that the resistance of thick plates to rupture is about 2½ times that of thin plates; that the resistance of thick steel plates is about one-tenth greater than that of the Low Moor iron plate A; and that the resistance of these latter plates is one-half greater than that of the rolled plates D. Similarly the work expended in the deflection of a bar, supported at its extremities by a force applied at its centre, may be taken as the modulus of dynamic resistance of different kinds of material to a force of impact, tending to produce transverse rupture. The next section of the paper gives the maximum transverse strain produced on a ship when the load is unequally distributed. The point of maximum strain is not always at the centre of the ship, as many practical men assume. Section 3 gives a value at the moment of inertia for different elementary sections of material. Section 4 gives certain simple, general, analytical expressions for the moment of inertia of complex sections of girders, such as that of an iron ship. The distribution of the material, so that the beam may have the greatest strength, is then investigated, and the formulæ applied to the section of one of our most approved iron ships show that the upper portion of the ship should be one-half stronger than it is, in order to have a proper distribution of the material. Section 5 treats of the penetration of iron armour-plates by flat-faced tempered steel shot. The following formula, derived from Dr. Fairbairn's experiments on punching, is given. The work requisite to penetrate a plate varies as the square of its thickness multiplied by the radius of the shot, or $U = C\, r\, t^2$. The constant of this formula, deduced from the experiments with ordnance, may be taken as 24.000. It is shown from this formula that a 100lb steel shot, 5in. diameter, with the velocity of 1,200 feet per second, would completely perforate an armour-plate exceeding 5 inches in thickness.

The foregoing abstract was read by Dr. Fairbairn, after which Mr. Tate illustrated the principles laid down, in a series of problems worked out on the black board. A discussion of a technical nature followed, in which Professor Rankine, Dr. Fairbairn, Mr. Tate, Mr. E. A. Cowper, and others took part. The great obstacle in the way of deciding upon a perfect form for iron ships was generally conceded to be the difficulty of estimating the action to which the several parts of a vessel were subject in the commotions of the sea.

* Dr. Fairbairn's "Useful Information for Engineers." Second Series.

ON THE EFFECT OF BLAST OF HIGH TEMPERATURE.

Mr. E. A. Cowper read the following paper "On the effect of blowing blast furnaces with blast of very high temperature." It is not proposed to detain the meeting with a history of the numerous attempts which have been made to raise the blast furnaces to a very high temperature, nor will the author occupy much time in the description of the means by which the desired result has been obtained, as a full account of the apparatus was given at the meeting of this Association held at Oxford (though the paper on the subject was not printed in the Transactions). In 1861, experimental stoves only on the new plan had been erected, and worked for heating the blast for one tuyere, out of the fire used for one blast furnace. Such satisfactory results were, however, obtained, that it was clear that the difficulty of procuring blast of very high temperature had been overcome, and Messrs. Cochrane and Co., of Woodside Ironworks, Dudley, and Ormesley Ironworks, near Middlesbro'-on-Tees, forthwith erected large stoves on the new plan for a complete blast furnace; and it is now proposed, with your permission, to lay before the section the results obtained during upwards of six years' practical working with these stoves. The effect of heating air on the new plan was that a temperature of blast of 1,150 deg. Fahr. was obtained, instead of only 600 or 700 deg., as with cast-iron pipes in the common stoves. There was no loss of blast from leakage, owing to cracked or damaged cast-iron pipes; the iron produced was of rather better quality; 20 per cent. more iron was made from the same furnace; and fully 5 cwt. of coke was saved in the blast furnace per ton of iron made. The details of the construction of the new stoves will be easily understood by reference to the drawings. First, there are two stoves, which are heated alternately, and used alternately in heating the cold air: these are filled with brickwork, "set open" (or small spaces between the bricks), and from "regenerators" on the principle of Mr. Siemens's regenerator furnaces as now so largely and successfully used in glass houses, gas works, iron works, &c., both for obtaining great heat and economising fuel. The outsides of the stoves are of thin wrought iron plate, lined with fire brick, the iron skin being necessary to retain the blast under pressure, whilst the firebrick resists the heat. Second, there are provided for the purpose of heating the stoves, valves for the admission of gas and of air into a central flue, where combustion takes place when a stove is being heated, the products of combustion passing up the flue and down through the mass of firebricks forming the regenerator, and escaping at the bottom to the chimney, after the whole of the heat has been abstracted by the firebricks, the temperature of the chimney being from 212° to 250°, or thereabouts, during the time a stove is being heated, viz., for a period of four hours. Then when a stove is hot, the gas and air are turned off, the chimney-valve shut, and the cold blast is turned on at the bottom of the regenerator, and passes up through the bottom courses of brickwork in the regenerator, this very quickly becoming heated, and passing in this heated state up through the remaining courses of hot brickwork, and down the central flue through the hot blast valve to the blast furnace, the process of absorption of heat by the air being so perfect that as long as a few of the top courses of brickwork remain hot, the blast is well heated, the variation in the temperature of the blast being only about 100 degrees Fahrenheit, with four hours' changes. Thirdly, the gas for heating the stoves was supplied from gas producers, similar to those commonly used by Mr. Siemens for his regenerator furnaces, and which have already been described before this Association. They consist of a simple brick enclosure or fireplace, with bars near the bottom, for the admission of a very small quantity of air. The gas is formed by the slow combustion of a very thick fire, supplied with poor coal or slack, down a slope or hopper, the gas passing off from above the fuel through pipes to the hot blast stoves. Gas may, however, be taken from the top of the blast furnace for heating the stoves, provided proper arrangements are made to separate it from the dust which comes over from the blast furnace with it: and judging from recent practical experiments, it is certain that there are several ways in which this may be done with perfect success. The late Mr. James Beaumont Neilson, who did so very much for the iron manufacture by his original invention of the hot blast in 1829, was sufficiently long-sighted to predict the advantages that would flow from the use of blast of very high temperature, though, as it happened, he was limited to what could be obtained from passing the air through iron pipes exposed to a fire, as in common stoves. Mr. Neilson said, "In the new regenerator ovens that had just been described, the great capacity of firebrick for heat had been well taken advantage of, and a very important step in advance had been made by giving the means of raising the temperature of blast much above the extreme limit practicable with the old ovens: and he considered this would be productive of the greatest benefit in the working of the blast furnace—he had no doubt the "make" of iron would be considerably increased by the higher temperature of blast given by the regenerative ovens. These anticipations have been fully borne out in practice during upwards of four years' regular working of the stoves. The high temperature of the blast produces such an improved effect iu the furuace, that the "burden" is increased so as to save fully 5 cwt. of coke per ton of iron made; and as there is less fuel supplied, so there are less impurities taken in, and the quality of the iron is improved, the tuyere breasts do not work hot or burn, or give more trouble thau usual, as the burden is increased as just stated. The same furnace is of course enabled to do more work, the "make" being increased fully one-fifth, so that a given plant produces 20 per cent. more iron per annum, besides saving nearly three shilling per ton for coke. There is less friction or loss of pressure of blast in these stoves than in common ones; and there is no loss of leakage through cracked or burnt cast-iron pipes or joints. More stoves are now being erected on the same plan."—Mr. Siemens said that the application of regenerators which Mr. Cowper had brought before the meetiug was one of the most interesting which could have been made. He had provided the means of heating blast really up to the temperature at which bricks would melt. Mr. Siemens defined the chemical process effected by Mr. Cowper's arrangement, and affirmed that there was no deterioration of the quality of the iron produced by that process.—After other remarks, Mr. Cowper was thanked for his paper.

ON RAILWAYS IN WAR.

The President *pro tem.* (Mr. C. Vignolles), announced that in consequence of the pressure of other papers, the one by Sir J. Burgoyne, "On Railways in War," would be taken as read, and the discussion deferrsd till the next meeting of the Association, the more especially as several engineers were busy preparing reports on several of the matters treated of in Sir John's paper. The paper opened by stating that railways would have an important effect on war, and that it was a matter of interest to ascertain the means of obtaining the greatest advantage from them, and what would be their precise capabilities. A vague idea existed that armies could be transported from place to place, and to a seat of war with the same facility and speed as ordinary travellers, whereas there were many circumstances connected with the conveyance of the former which would show any such comparison to be quite fallacious. With regard to a small body of infantry, there was no reason why this should not be the case; but with large forces and with cavalry and artillery, and all the accessories of an army, its baggage, camp equipage, spare amunition, its wagons, &c., enormous means would be required, and difficulties would arise which called for study and consideration to reduce them them to a minimum. How to adopt the ordinary railway passengers and horse carriages and trucks in the best manner to the transport of troops of all kinds, and how to get the troops most rapidly in and out of them would be easily ascertained, if it had not been so already; the great great disideratum was to define how large forces could be moved in greatest strength, with the most rapidity, on single railways or by a limited number of lines, for it was on these calculations, having under consideration the several lines which could be brought to bear on the operations, that the generals in command must arrange their plaus. The basis for consideration would be, What could be done by any one line of railway with its ordinary means, or aided by additional means from other lines of the same gauge with which it was connected, on the same level, and which might not have the same pressure on them. To afford an idea of what might be required, it might be assumed that the officers and soliders would occupy the space of ordinary travellers, and consequently it would become a question how many passenger carriages, in how many trains, each drawn by one locomotive,would be required to convey 1,000 men with their officers; and how many officers of cavalry, and for staff of infantry regiments, one truck would carry. The guns and equipments of each battery of field pieces, with number of trucks necessary to carry them, should be defined as well as the number of horses per battery of horse or foot artillery. To give an idea of the amount of conveyance required for such forces on one occasion, to transport a battery of field pieces, with its horses and carriages, and about 500 cavalry, merely to a review, no less than six trains were required, consisting each of thirty railway carriages. Viewing the very large means necessary for moving any but a very moderate force, and the embarassments which would attend the undertaking in the rapid succession required to be effective, it became a matter of much interest for railway engineers to consider and define how arrangements could be made in providing, stationing, and working the trains that would tend to facilitate the service, and what, with the adoption of these measures, would be the capabilities of conveyance of troops of given strength to given distances in given times on emergent occasions on any one railway; whether, for instance, as the great traffic is in one direction, both lines of rails might not be used for it for certain distances, under the best arrangements that can be made for the return of carriages, &c. These researches are required not only to ascertain the best modes of accelerating the movements, but also to come to a clear understanding as to what, even when duly organised, can be obtained from railways in rapidity of transports for large bodies. It is manifest that as they approach the scene of action, the railways would have less influence ou the immediate theatre of warfare itself, it would be something dangerous to trust to them at all under the chance of the enemy interrupting the communication between the divisions and resources of the army. For short distances there would rarely be much advantage, as regards time, in moving troops by them, on account of the time required for getting to and away from the railway, and into and out of the carriages. Their great advantage would be for concentrating troops and means, by converging lines, from the interior to some appropriate point forming a basis of operations; for gradually bringing up reinforcements and other resources to the rear of the army; and for the speedy removal of sick, wounded, prisoners, and other incumbrauces. They will also be particularly favourable to retreating forces, by expediting their movements; while, by the destruction of the lines behind them, the enemy would be deprived of any use of them. The partial destruction and the repairs to railways will hereafter be an engineering duty for which the service should be prepared. Every railway, even in the vicinity of the operations in a campaign, will be of much value, so long as it can be used without danger of interruption, and therefore it becomes a subject of interest to possess a knowledge of the best means for their destruction, and how to apply them in cases where the lines are likely to fall into the hands of the enemy, and for re-establishing any that may have been more or less injured. It is clear that a portion of a railway might be for hours in temporary possession of a part of an army, who might, from ignorance, or want of some trifling means, be unable to take advantage of the occasion, and thus would leave it to be re-possessed by its enemy in perfect order, when, by due instruction and a little preparation, an influential amount of damage might have been done to it. The military engineers of an army have attached to them in the field a selected assortment of the most useful implements for the different services most freequently required of them, the proportions of which they vary according to the prospect of the nature of the approaching engineering operations, such as for seiges, entrenchments, destruction or repairs of roads and bridges, mining, &c.; and they are practised in the best modes of applying whatever means may be at hand for their purpose. To these must now be added what is applicable to the destruction and re-establishment of railways. In damaging a railway to impede the progress and available means of an enemy's army, the object will of course be to do as little injury to a great convenience of the country as is consistent with the primary consideration of crippling the military resources of the enemy for the time. Should the exigencies of the period justify extensive damage, it will be done by blowing in tunnels, bridges, viaducts, or embankments, by mines and processes as practised by military engineers, with regard to the old routes, to the extent that circumstances will allow, and may admit. The object for consideration, however, here is, how the peculiarities of a railway can be dealt with to most effect, in a summary manner, with little time and small means?

Taking it, then, as a question rather of dismantling than of destroying, the first measure would be taking up and destroying all the rails. This would be easy enough to a party of railway navvies provided with their apparatus; but what we require is some instruction and practice given to soldiers how to do as much as possible with the smallest means. Thus, instead of being, as at present, from ignorance, perfectly helpless, they might be taught under previous instruction, that even a few stray articles for implements, such as might be found in an adjoining house, as might be described, could, on an emergency, be made available to some extent. Possibly it could be shown that, after a first rail was removed, the very article itself, with the sleepers, &c., might be used to extend the damage. Another question would be, having in view the possibility of obtaining a temporary power over a railway which is of service to the enemy, what very small and most portable assortment of implements might be carried with in a detachment being accompanied, if possible, by a few sappers that would aid such a proceeding, and what would be the most effective process, and if the implements could be such as enter into the assortment forming part of the engineer field equipment, required for other purposes, all the better. The rails being raised, the best disposition of them would be clearly to carry them away altogether; but it is very improbable that there would be available means of conveyance to render that practicable. The next most easy resource would be to scatter, hide, or bury them; but if it could be shown how they could be broken or rendered unserviceable, the effect would be still greater. The destruction of the sleepers would be much more easy, but the effect would be less, and the removal of the chairs from their portability would be easy, and also valuable for the object. With regard to the reinstatement of a damaged line, it would be instructing to know whether any temporary expedients can be adopted for the passage of locomotives, and carriages, or even of the carriages only, across the places where the rails may have been removed, till new rails can be procured; and if so, what those expedients may be and how to be applied. One resource might be available in double lines, namely, to dismantle one of the double rows, from the nearest part untouched, to make a good through communication for at least one single line. It will be very desirable to obtain from railway engineers a consideration of all those matters, and special instructions drawn up on all expedments that can be suggested, in which the troops, but more particularly the engineer soldiers, might be subsequently practised; nothing of the kind, it is believed, having yet been undertaken.

DISTRICT PRIVATE TELEGRAPHS.

Mr. N. J. Holmes, of London, read a paper on "District Private Telegraphs." Having outlined the history and uses of the telegraph, and its great importance as a vehicle of communications in towns, he pointed out that the popular use of the telegraph depended upon the adoption of a more easy system of signs than was used by the ordinary telegraph companies. This desideratum was secured by Professor Wheatstone's invention of the alphabetical telegraph in 1858. The communicator or transmitter, by which the operator with his finger spells out words, letter by letter, consisted of a box, fitted with a dial, round the face of which the letters of the alphabet were arranged. Opposite to each letter was a button or finger key. In the interior of the box was a magnetic arrangement, the generations of the currents being consequent upon the revolutions of an armature, kept in continuous motion, when passed through its arrangements. A company was formed four years ago, for the promotion of this form of the telegraph, the use of which, in newspaper offices, was yearly increasing. Several papers had an indepeudent system of their own between the Reporter's Gallery in the House of Commons and their offices. The *Daily Telegraph*, in addition to this, have wires to the residences of their managers. Its use was increasing among commercial houses generally. Though the company had been incorporated little more than four years, its system already extended throughout the United Kingdom, at all points where commerce and manufacturing industry existed. Upwards of 2,000 miles of private wires had been erected by the company, employing upwards of 863 sets of instruments. The principle upon which the wires and instruments are supplied is that of rental. Comparatively few lines supplied were purchased by the parties using them, and when purchased were those chiefly over private properties. The paper set forth a mass of information as to the details by which the system was worked, and the advantages arising from it. The paper was illustrated by working models. At its close, Mr. Holmes received the cordial thanks of the section.

ATMOSPHERIC HAMMERS.

Mr. George Burt, of Birmingham, read a paper on a pneumatic hammer, of which he submitted a model for inspection. He said it was one which had been found extremely useful in trades which were largely carried on in Birmingham —the size of the anvil or the thickness of the metal under operation being of no consequence, and the variation in force of the blows being effected instantly by a movement of one handle within easy reach of the hammerman. The paper described the construction of of the hammer by the aid of diagrams. It was not pretended that the hammer at all approached the power of a steam hammer of the same total weight, or that it would take the place of the steam hammer for general smiths' work. The advantages claimed for it were that it was very simple, especially in its single acting form, as shown by the model; that there were no valves in constant motion and wear; that the momentum of the driving parts connected with the crank shaft was very small on account of their small extent of motion (a throw of 1in. only being given to the 10in. piston) that the wear on these parts was consequently very slight, also owing to the elastic nature of the medium between the driving and driven piston: that there was an absence of all dropping of condensed steam, such as would invariably be caused by the use of a steam hammer, and which would be fatal to a surface under the operation of being planished.

Mr. D. W. Grimshaw, read a paper "On Grimshaw's Improved Atmospheric Hammers." Having described the invention, which is more complete in structure than the one introduced by Mr. Burt, the paper set forth that it was claimed for these atmospheric hammers that they showed, in working, a considerable economy as compared with steam hammers of equal force of blow. In the majority of cases, where hammers worked by power were used at all, they were from the exigencies of the trade placed at distances from the boiler or engine that were unfavourable to the economical conveyance of steam to them. For every 100 lbs. of steam generated, not not more than 60 or 65lb. reached the hammer, whereas Grimshaw's hammers, which are worked by shafting and belting, can be driven at a loss of five per cent. of the steam used in propelling the engine employed to drive it. Conversation ensued, after which, the writers were respectively thanked for their papers.

PATENT STEAM PILE DRIVER.

Mr. W. SISSONS (of the firm of Sissons and White, Hull), read a description of the Patent Steam Pile Driver, manufactured by the firm. By the machine the ram falls twelve times in a minute, with a 5ft. lift. The size of the bottom frame is only 7ft. 6in. square, and it occupies a smaller space than an ordinary hand machine; and can be used in any situation, on land or afloat, where the other can. It supplies a deficiency long felt, viz., something more powerful and expeditious than hand machines hitherto brought out. During the past six years fifty-four of them have been made; seven are in use on the Thames Embankment, and Mr. Brassey has five in operation in Gallacia. The writer of the paper received the thanks of the Section.

ON WARMING, AND LIGHTING, AND VENTILATING THE BIRMINGHAM TOWN HALL.

A paper on this subject was read by Mr. BROOKE SMITH, of Birmingham. He said that three years prior to 1862 the town hall had been notorious for cold draughts. He also said it was badly lighted; in particulars which he enumerated. The town council took up the question. Professional opinions were taken, and plans and estimates varying from £500 to upwards of £1,000 were obtained; and a committee was appointed to take the whole subject into consideration. It was found that the downward currents in the side galleries did not come from the ceiling, as had been asserted, but simply from the windows, even when closed. The paper proceded to remedy the defective lighting and warming of the hall, which principally consisted in substituting pendants for the sunlights in the roof with which the hall had previously been lighted. The present mode of lighting the hall was generally considered satisfactory, whilst the warming power of the pendants was so great, that with the assistance of the window lights and the warming apparatus, without any alteration having been made in it, the hall could now, in the coldest weather, be made comfortably warm. The ventilation had been improved, but further steps in this direction were still under consideration. It was not pretended that perfection had been attained, but very great improvement had been effected, at a comparatively small cost, the alterations being such only as would have been required had any of the warming systems been adopted irrespective of an altered mode of lighting, thus showing that lighting, warming, and ventillation were most intimately connected, and required to be treated as parts of one subject. The series of experiments instituted brought out very remarkably the fact that in all warm rooms cold downwards currents must, in cold weather, continue to descend from closed windows, unless some provision, such as warming the windows or double glazing be adopted. And it would be obvious, that whilst there would be a continuous downward stream inside warm rooms, there must be a continuous upward flow of air outside, as its particles become rarified by contact with the comparatively warm surface of the window. The facts adduced also strikingly illustrated the law of radiation of light and heat, as to the increase and decrease of their power by distance.—The reading of the paper was followed by remarks from Mr. Bramwell and Mr. Isaac Smith, after which Mr. Brooke Smith received the cordial thanks of the section.

GOLD-BEARING ROCKS IN SOUTH AMERICA.

Mr. D. Forbes delivered an address "On the existence of gold-bearing eruptive rocks in South America, which have made their appearance at two very distinct geological epochs." He said he was not aware that the gold-fields and the deposits of South America had been stated to determine the age at which gold itself made its appearance. His remarks would merely show the results of his own observations during several years' travel in South America. Native gold, wherever it occurred in South America, could invariably be traced to some igneous rock. There were two classes of deposits. The largest deposits of gold were found in pernetic rocks, which, he believed, were generally auriferous in other parts of the world. The gold quartz would go into the permitic period, and would invariably be found to come from granite. He believed quartz had been ejected from granite, carrying the gold along with it. These granite rocks were found at a depth of 200ft. in cutting for a line of railway. He believed this auriferous character of rock would be found to have extended to Europe. The metallic riches of South America might be said to arise from the eruptions of these rocks. These eruptions had made their appearance at two very different epochs in the chronological geology of South America, both distinct in age and character.

The President said this communication showed him, as an old geologist who had attempted to generalise upon the subject of gold, how careful they ought to be before they attempted generalisation. Having examined Russia and the Ural Mountains, having found that the gold produced there was produced exclusively from Silurian rocks, he had come to the conclusion that it was exclusively in Silurian rocks, and that in secondary or tertiary rocks people need not look for gold. His friend (Mr. Forbes) had entirely demolished that generalising.

A Gentleman in the body of the room said he heard with satisfaction the confession of a geologist that he had generalised too much. He hoped some of the younger geologists would take an example from the President.

Professor Jukes did not know any one who was so ready to acknowledge past errors and was so constantly correcting past errors as geologists. He expressed his gratification with the paper of Mr. Forbes, and commented upon several points. Mr. Forbes had, he said, made a valuable addition to their knowledge, and he had stated what was new and very interesting.

After some remarks by Mr. Sorby, of Sheffield,

The President said his generalising had never been corrected as regarded Russia, Scandinavia, France, Spain, and the British Isles. Therefore, it was not bad generalising as far as it went.

FOSSILIFEROUS SLATES IN NORTH WALES.

A paper by Mr. George Maw, F.S.A., F.G.S., F.L.S., of Broseley, entitled "On some fossiliferous slates occurring between the bunter sandstone and mountain limestone of the Vale of Clwydd, North Wales," was read by Mr. Thompson. The following is an abstract:—The ordnance geological survey map places the Bunter sandstone, occupying the vale of Clydd throughout its boundary, either adjacent to the mountain limestone, or the Dwigshire pits. In several places along its eastern side strata intervene consisting of mottled sandstones, variegated shaly marls, containing plant remains and dark micaceous sandstones. The marly shales abound with plant remains, which Mr. Etheridge, palæontologist to the survey, considers of a Permian type. These beds are for the most part apparently conformable to the mountain limestone, dipping unconformably under the red brick bunter sandstone towards the Vale of Clwydd. In a lithological aspect they strongly resemble Permian strata. The principal localities where they are exposed are at Pentre Celyn, near Llaufair, in the wood above Llandibr Farm, and in a lane between Llandibr Farm and Llangynhafae. Red and variegated marls and marly shales, containing some soft coal, and resting on the mountain limestone, occur also at Rhiwbibill, near Llangwynfen, opposite Denbigh. Although apparently conformable to the carboniferous limestone, it is probable that they rest on its eroded surface, as although the millstone grit is largely developed close at hand, it does not intervene at Rhiwibill, and if a break really intervenes the marls and shales resting on the limestone could not be of carboniferous age.

A number of fossils were shown, and a brief conversation followed on the paper, in which the President and Professor Jukes took part.

THE THEORY OF REPULSION.

A paper by Mr. G. E. Roberts, entitled "Notes on the theory of repulsion as illustrative of physical geography," was next read by Mr. Pengelly. It was as follows:—Although the theory of a repulsive force co-existent with the external power of gravitation in the physical economy of our terrestial surface was made known, and, the author believed, first applied to geological physics in 1853, by Dr. Winslow, of Boston (U.S.), it has not, so far as I know, been brought before the notice of English geologists. The author said he therefore ventured to introduce it, not as an idea to which he was inclined to give an entire acquiescence, but as one well worthy the attention of those who study cosmical phenomena. In the last pamphlet written by Dr. Winslow on the theory (1865), he thus plainly states his propositions:—"The irregularities of the earth's surface, *i. e.*, our physical geography, on the results of sudden depressions and engulphments, by which the globe has from time to time been absolutely reduced in size and violently careened in different directions towards the sun; these events and consequent cataclysms have occurred many times since vegetable and animal life appeared in its primæval seas, rendering it probable that the earth, when first giving birth to life, was from 200 to 300 miles larger than now in all its diameters. Upheavals, where they really do exist, are exceptional and limited, as in the case of volcanoes, dikes, and igneous material, earthquakes, and slight oscillations of coast, all which are attempts of the repulsive force to upheave and revolve matter back to its elementary diffusion, counteracted and rendered abortive by gravitation." These sentences contain the thesis as propounded by Dr. Winslow. He supports his doctrine of repulsion by reasoning that just as violent subterranean thunderings have always been heard preceding local sinking of the surface, and generally in connection with periods of volcanic or seismological activity, so the vast depressions in our ocean areas are due to the falling-in of the roofs of vast caverns existing beneath the earth's crust, causing at divers epochs in the world's history "the waters to be gathered together in one place, and the dry land to appear." He remarks that Liebnitz, in 1683, and De Luc, in 1779, propounded similar theories, which may be regarded as precursors of his own. As a necessary consequence of such sudden disturbances of the earth's equilibrium, "its major axis turning always towards the sun," Dr. Winslow considers that the shorter axis of the globe, which at present are our poles, are not the result of flattening by rotation, but by a sudden falling in of strata somewhere, breaking the symmetry of the sphere, and producing an irregular spheroid. It appears, then, from this interesting contribution to cosmical science, that every stage of the history of our globe from its primal nebulous condition, as taught by La Place (and which may yet be regarded as the nearest approach to a comprehension of its earliest state yet attained to) to that of its present physical state, may be regarded as connected terms of a series of events, and that the primal consolidation through centrifugal and centripetal forces of nebulous matter into a more dense cosmical substance ushered in a scheme whose latest phase of activity is characterised by the still greater though more mechanical power of a substratal cataclysm, depressing the areas beneath which such power is localised, engulphing the land, and adding to the areas of the seas; or deepening ocean areas, and adding to the breadth and height of the surrounding continents. The author stated that his reason for bringing the paper before the section was, that it bore in a remarkable manner upon the recent resuscitations of the Laplacian doctrine made by Mr. Sorley and some few of our German geologists.

CORRESPONDENCE.

We cannot hold ourselves responsible for the opinions of our Correspondents.

THE SUGAR MILL AND THE SUGAR-MAKING PROBLEM.

To the Editor of The Artizan.

Dear Sir,—You will, no doubt, be somewhat surprised at finding me returning to England, after a ten years' absence. * * * * * * * * * *

At the onset of my career in this country I was often consulted on some remedy for the planter's difficulties. They told me, as they might have told others, of their unsatisfactory mills, and of their imperfect sugar product, &c. My leisure afforded me opportunities for studying these things.

Experience was not wanting for a guide. I have seen the planter* returned to his old stone mill as to a refuge from the casualties, the disappointments, and the expenses of his iron mill, to the discouragement of the other planters in that sugar-growing province. I feel that I may not encumber this with particulars, but sacrifice, becomingly, in generalities to you business gentlemen who desire brevity.

Mills, then, as you are aware, have been repeatedly strengthened by makers in a variety of ways, and with considerable ingenuity, to bend or break in the next weakest part. Unfortunately the cause remains to be removed, and the consequence lays at the mercy of accident. In short, mills come daily to a stand-still, and that more or less suddenly, when in full work, stagnating the operations. Occasionally this happens once too often for the entirety of the mill.

I can have no doubt that if one of those talented engineers, who designed some of the more modern mills, had similar opportunities of seeing them in practice, those gentlemen could not shut their eyes to such facts, but rather have discovered the cause of failure, and the remedy would have suggested itself to their experience also.

In a word, I am prepared to increase the efficiency of the sugar mill, without exceeding the present cost, possibly under.

The operations on various plantations were freely laid open to me, and repeatedly submitted to my control, with a view to the practical solution of the other difficulty also.

These experiments, extending over several years, afforded me so many fine, practical opportunities for cautiously and legitimately approaching "the complicated sugar problem." Its intricacy interested me; its difficulties excited me to renewed exertion. Chemistry helped me to comprehend its delicate details, and to trace out the cause of the mischief complained of. Chemistry had prescribed remedies to my predecessors in this task, and now suggested the necessity for avoiding the cause, and when to do it. The result of numberless experiments to this end is, that we may now place the means of its accomplishment at the disposal of the engineer, in preference. We have now a more immediate, practicable mode, more or less perfect, of avoiding the cause of loss of sugar, without the necessity for skilled labour. Nor do we require any chemical nostrum to create suspicion in the minds of the consumer.

It is due to those eminent chemists who have preceded me, and also to our argument, to give the proper value to their efforts, and admit them to be, what they really are, just so many elegant and strictly correct laboratory experiments. Their non-success in practice must be equally clear to one having experience in such things. I may not now enter on an exposition—it would be obviously too elaborate. It may be sufficient to note that our views are in accord, and only differ in the means of accomplishing the desired object.

I now find that I only import into this subject discoveries made so recently in another field of science, that, in point of time, they follow after the elaborate investigations of my talented predecessors in this task. What may be sufficient for our present purpose is, that, agreeing as I do with these chemists, so far as they agree with themselves, as to the cause, we can repeat the practical demonstration of its avoidance at pleasure, and confirm my position, in the absence of the normal cane juice.

You will no doubt allow me to remind you of the fact, that the sugar product does not average one pound per gallon of juice; exceptions here again prove the rule, whereas it contained, and proper treatment would realise two pounds of sugar, as has been repeatedly determined in laboratory experience; say it contains 18 to 20 per cent., and the average product, in common practice, is about 9 per cent. of sugar.

There is something so extravagantly absurd about the difference in these figures that, but for the oft-repeated and recorded facts, of which the figures are the mere indices, we might be disposed to meet them with ridicule, possibly with contempt. But they are too formidable for either, and our pride suffers when recognising such facts. The slimy treacle is also a humiliating fact, and rum is another: the sum of their nett money product, only reduces the otherwise more formidable loss, involving a larger capital for additional expensive plant, wages, &c.

The difference, in these figures is sufficiently absurd to betray the existence of some gross radical error in the system which evoked it. Then we develope other facts when explaining that the planters are not engineers, nor are the latter the former, and neither the one nor the other offers any individual claim on chemistry, when that severely analytic science may be, and is of vital importance to the whole process, and possibly indicates the only clue out of the labyrinth. Again, we may have seen by the light of history, the independent efforts of the planter, the engineer, and also of the excruciating chemist; yet neither succeeds out of his laboratory, where everything occurs *secundem artem*, nor is their *esprit du corps* gratified beyond the extravagance complained of in practice, where things most decidedly are *not secundem artem*, yet possibly can become so. It may be only prudent to break down the seeming antagonism of independent action, and unite the essentials which each can afford, even at the expense of some "old opinions." Of course we respect "old opinions," but to follow them strictly with eyes shut, and the smile of self-complacency, might be trenching on the privilege arrogated by the demented, and remains unchallenged by the sane majority.

I have had ample experience of the intelligent efforts of the engineers; I am well aware that they are anxiously waiting to be satisfied as to which can be the right direction, so that they may move in it with perfect confidence to themselves, and to the entire satisfaction of the planters.

I may be permitted to separate myself at once from the appearance of extravagant pretensions, contenting myself with "a certificated gain of 25 per cent.," without permitting myself even to allude further to a larger sugar product.

The uninitiated can understand the anxiety of the planters for, and appreciate the avidity with which they seize on an improvement that can approach the realisation of their wants, with the prospect of increasing their profits. It is this anxiety which has so repeatedly appealed to the chemist, challenged his resources, and practically tried their merits throughout the catalogue, from the innocent simple to the positive poison. The sulphates of iron and zinc and the acetate of lead found places in the list of *panaceas*—of course subject to the control of skilled labour. The last proposition, as might have been expected, left the unwelcome odour of rotten eggs in the sugar by the sulphuretted hydrogen liberated in the use of the sulphuret of sodium. The resultant increase of sugar product varied from 12 to 15 per cent. Here we elicit another important fact, for the same "remedy" in the hands of the chemist would have produced greater results, for, when chemically considered, it was a step in the right direction, and surrounded with impediments too formidable for its success in practice.

Theirs may be so many scientific remedies, prescribed by chemistry and liable to misapplication in practice, when failure is the inevitable consequence. My proposition will be found to be a more or less perfect avoidance of the cause of the loss complained of, by an arrangement which is perfectly consistent with the discovery of chemistry, and cannot lay open to casualty in practice, until sacrificed by determined neglect.

The planter then is sensible of his loss, and is prepared to avail himself of a practicable means to its avoidance; the more so when he finds his expense is limited to the engineer's first and only charge for a mill in its completeness, exceeding the present price of mills by a mere trifle, and as the margin for profit may determine.

Without troubling you, at present, with more than this abrupt, because brief and necessarily imperfect outline, will you kindly inform me if I am right in the following suppositions.

I apprehend that a new form of mill, which can command a decided preference among planters, must command also the trade for the maker of it. Possibly an authenticated fact can satisfy you better than any seeming egotism of mine, which must also be my apology for introducing any allusion to it.

As soon as it was known in Cuba, where the present system is carried out, as near to perfection as it is capable of, that I had practically obtained, by my, then immature process, and adventitious appliances, an increase of 25 per cent. of sugar product; the planters, merchants, &c., were not only prepared to accept the fact, but so anxious are they to realise the benefit, that they at once subscribed 35,000 dollars to defray the expense of a local chemist, Don Alvaro Reinoso, who had been informed of my success by a Spanish friend of mine, and by the *Diario de Manila* of the day, to enable him, who now announced the fact to the Cubanos as *his* discovery, to make such practical trials as they hoped should lead to a practical reality of their long cherished expectations. His success at guessing out this complicated problem, does not appear as evident

* El Senor Don Pedro Blanco, del pueblo de Quingua, en el Provincia de Bulacan, Isla de Luzon.

in nearly two years of disappointment, as the anxiety and the enterprising spirit of the planters, which retains their original freshness.

Other particulars, the amount subscribed by each gentleman, about 60, can be seen in the Spanish newspapers, and in the *Diario de Manila* 28de Agosto, 1864.

The spontaneous 35,000 dollars become a significant hint to those who profess to consult the planters requirements when promoting their own interests.

As soon as I became satisfied with my ultimate results I left Manila to return to England, at the suggestion, and with the assistance of my friends, for the purpose of consulting you, which on my arrival in London I will do.

Yours respectfully,

Manilla, April 25, 1865. W. E. Gill.

[The foregoing letter came to us by the last mail. We give it publicity, just as it is, under the impression that it refers to important colonial questions which deserve to be better known. Although Mr. Gill has been absent abroad for many years, he is not unknown at home as a thoroughly practical man. He appears to prefer the test of experience, and to hold the unexplainable in contempt. We apprehend that he contemplates no more now than is consisteut with plain common sense. We see by the Spanish newspapers, which contain the Cuba subscription list of the 35,000 dollars alluded to by Mr. Gill, that in all probability Senor Reinoso is not working out his ideas into practical utility in Cuba, but probably is waiting for something "to turn up." We shall be happy to receive any communications for Mr. Gill, from colonial and other correspondents, who may be desirous of acting with Mr. Gill in the demonstration of these important scientific and commercial improvements. They may be addressed to him to the care of the editor.—Ed. Artizan.]

REVIEWS AND NOTICES OF NEW BOOKS.

Quartz Operators' Handbook. Wheeler and Randall, San Francisco. Mining and Scientific Press Job Printing Office, 1865. 12mo. 130 pp.

Messrs. Wheeler and Randall have, in a most compact form, supplied in their "Handbook," a very complete and thoroughly practical guide for the use of quartz operators. Commencing with the use of the blow pipe, blow pipe tests, and chemical tests, the authors then treat of roasting and reverberatory furnaces and of the purification of mercury intended to be used for amalgamation. Then is described the extraction of gold and silver and their separation from their accompanying metals. Mechanics, the steam engine, strength of materials, water supply, mensuration, and mathematics are discussed as far as the circumstances of the work require, after which is given an account of the tractory and differently formed grinding plates, the work concluding with a table of the properties of bodies and miscellaneous notes.

Altogether Messrs. Wheeler and Randall have executed their task most creditably, producing a handbook touching upon all the processes, chemical, metallurgical, and mechanical connected with quartz operations.

A Treatise on the Screw Propeller, Screw Vessels, and Screw Engines. Illustrated. By John Bourne, C.E. New Edition. Part I. London: Longmans, Green, Reader, and Dyer. 1865.

As far as we can judge from this, the first part of the new edition of Mr. Bourne's excellent work on the screw propeller, it will, in its complete form, prove most interesting and useful. It strikes us as evidencing that a considerable amount of scientific research has been devoted to its preparation, the results being classified and analysed with the author's usual ability. As a matter of course there is much that is old in the treatise and much that has been already published, but great advantage is derived from having all the various descriptions of that class of machinery to which the work is devoted, brought together into a form at once comprehensive and compact. The engravings and woodcuts are excellent. The plates illustrative of the *Great Eastern* steamship have been copied from those given in The Artizan, and which were at the time got up at great cost, exclusively for this journal.

Electrical Communication in Railway Trains. By Andrew Edmund Brae. London: Effingham Wilson. 1865.

This pamphlet treats of the various systems proposed for satisfactorily solving the problem of electrical communication in railway trains, the causes being considered which have hitherto militated against their successful application. The author, himself an inventor, after devoting a few pages to general considerations, proceeds to give a list of patents for communicating, by means of electricity and electro-magnetism, signals or alarms from one part of a railway train to another, which cannot fail to be very valuable to all who are interested in the subject, and, at least, of some interest to all engineers. The author then gives a classification of the various inventions in connection with the subject of the work under notice, and adds some comments thereupon. Two appendices are added containing specifications of Mr. Brae's patents, illustrated with engravings, which inventions, however, we do not think advance the subject to a point of successful solution.

Report of the United States' Commissioner of Patents, for the year 1862. 2 vols. Washington: Government Printing Office. 1864.

The first volume contains the text of the specifications, and the second the illustrations of the American patents for 1862.

We have received these volumes from the American Library and Literary Agency of Messrs. Stevens Brothers, Henrietta-street, Covent Garden, who have been appointed the official channel for the transmission of the United States' Patent Office publications, as well as those of other public institutions in America. Messrs. Stevens' Agency possesses peculiar facilities for the transmission of exchanges from this country to the United States.

Tables of Tangential Angles and Multiples for setting out Curves from 5 to 200 Radius. By Alexander Beazeley, M.I.C.E. London: Lockwood & Co. 1865.

These tables, intended for use in the field when setting out curves with the theodolite according to Professor Rankine's system, cannot fail to prove extremely useful to surveyors and engineers. They are in an exceedingly compact form, being printed on a number of cards three inches by one and a-half, the entire series being contained in a case one inch thick. In setting out any particular curve the card applying to it is fixed to the theodolite, thus leaving both the surveyor's hands free for adjustments and signalling.

NOTICES TO CORRESPONDENTS.

R. S.—You cannot represent the equivalent effect of the blow from a sledge hammer by pressure, it is in fact work, that is to say, force acting through space; the effect of a sledge hammer will be measured by the work accumulated in it. Thus, if your hammer weighs 20lb. and is lifted 5ft., and suffered to fall without impulse other than its own weight, 80ft. lbs work will be done by it. You may estimate the mean pressure upon the metal acted upon, if you know how much it is compressed by the stroke of the hammer, by dividing the accumulated work by the distance through which the hammer passes after contact with the metal. Thus, if the metal were compressed $\frac{1}{500}$ of a foot in the above case, the mean pressure of the blow would be 40,000lbs., or about 18 tons.

T.M.—Malleable cast iron is chiefly distinguishable by its ductile properties; its composition varies; we refer you to the Artizan of May, 1864; and, for any further information you may require, as to the processes of manufacture employed here and on the Continent; be good enough to apply here to the office.

Mechanic (Newcastle).—To prepare iron cement, to 100 parts of powdered and sifted iron borings add 1 part of sal ammoniac, work the mixture into a paste with water for use. For lead cement for steam pipes, take red or white lead in oil 4 parts, iron borings 2 to 3 parts.

Chemist (Worcester).—In analysis of ferruginous minerals to separate sulphur from iron, dissolve the minerals slowly in hydro-chloric acid, pass the evolved gas through acetate of lead, in a solution acidified with acetic acid; sulphate of lead is precipitated; this is converted into sulphate of lead by digestion in fuming nitric acid: from the weight of the sulphur the amount of sulphur is calculated.

PRICES CURRENT OF THE LONDON METAL MARKET.

	Sept. 30.	Oct. 7.	Oct. 14.	Oct. 21.	Oct. 28.
COPPER.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Best, selected, per ton ...	89 0 0	89 0 0	89 0 0	94 0 0	99 0 0
Tough cake, do.	86 0 0	86 0 0	86 0 0	91 0 0	96 0 0
Copper wire, per lb.	0 0 11½	0 0 11½	0 0 11½	0 1 0	0 1 0½
„ tubes, do.	0 1 0¼	0 1 0¼	0 1 0¼	0 1 0¼	0 1 1
Sheathing, per ton	91 0 0	91 0 0	91 0 0	96 0 0	101 0 0
Bottoms, do.	96 0 0	96 0 0	96 0 0	101 0 0	106 0 0
IRON.					
Bars, Welsh, in London, per ton	7 12 6	7 12 6	7 12 6	7 12 6	7 12 6
Nail rods, do.	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0
„ Stafford in London, do.	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0
Bars, do.	8 12 6	8 12 6	8 12 6	8 12 6	8 12 6
Hoops, do.	9 15 0	9 15 0	9 15 0	9 15 0	9 15 0
Sheets, single, do.	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0
Pig, No. 1, in Wales, do. ...	4 10 0	4 10 0	4 10 0	4 10 0	4 10 0
„ in Clyde, do. ...	2 18 6	2 18 6	2 17 6	2 17 9	2 18 6
LEAD.					
English pig, ord. soft, per ton	20 10 0	20 10 0	20 5 0	20 5 0	21 0 0
„ sheet, do. ...	20 0 0	20 10 0	20 10 0	20 10 0	20 10 0
„ red lead, do. ...	22 0 0	22 0 0	22 0 0	22 0 0	22 0 0
„ white, do. ...	26 0 0	26 0 0	26 0 0	26 0 0	26 0 0
Spanish, do.	18 15 0	19 0 0	19 0 0	19 0 0	19 0 0
BRASS.					
Sheets, per lb.	0 0 8½	0 0 8½	0 0 8½	0 0 9½	0 0 10
Wire, do.	0 0 8¾	0 0 8¾	0 0 8¾	0 0 9¾	0 0 9¾
Tubes, do.	0 0 9½	0 0 9½	0 0 9½	0 0 11¼	0 0 10¼
FOREIGN STEEL.					
Swedish, in kegs (rolled) ...	13 0 0	13 0 0	13 0 0	13 0 0	13 0 0
„ (hammered)	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0
English, Spring	18 0 0	18 0 0	18 0 0	18 0 0	18 0 0
Quicksilver, per bottle ...	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0
TIN PLATES.					
IC Charcoal, 1st qu., per box	1 10 0	1 10 0	1 10 6	1 10 6	1 12 0
IX „ „ „	1 16 0	1 16 0	1 16 6	1 16 6	1 18 0
IC „ 2nd qua., „	1 7 0	1 7 0	1 7 6	1 7 6	1 9 6
IC Coke, per box	1 4 0	1 4 0	1 4 6	1 4 6	1 6 0
IX „ „	1 10 0	1 10 0	1 10 6	1 10 6	1 12 0

RECENT LEGAL DECISIONS

AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

UNDER this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least —less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

LIABILITY FOR SMELTING WORKS NUISANCE.—In the case of Tipping *v.* the St. Helen's Smelting Gompany (Limited), which was an action for injury done to the plaintiff's land, including his trees, shrubs, &c., by the company's smelting works, it was held by the House of Lords, at one of its last judicial sittings (affirming the judgment of the Court of Exchequer Chamber), that the plaintiff had the right of action, and that it was no defence for the defendants (the smelting company) to show that the locality abounded in similar manufactures, or that the company's business was carried on in a proper manner.

INSPECTORSHIP DEEDS.—In the case of Hernalewicz *v.* Jay, by a deed under 192 of the Bankruptcy Act, 1861, it was provided that "if any dividend shall be declared before all the creditors have executed or assented to the deed, or before the dividend payable on all their respective debts shall have been ascertained, the inspectors shall retain sufficient sums to pay a like rateable dividend to any creditor who shall not have executed or assented to the same, or the amount of dividend payable on whose debt shall not have been ascertained, and shall afterwards pay such dividend to such creditor on his request in writing, or on the amount of dividend payable on his debt being ascertained. It was held by the Court of Queen's Bench that this did not impose on non-assenting creditors such an unreasonable condition as to make the deed invalid as against them; since the object of requiring a written request was merely to enable the inspectors to perform their duties rightly towards both classes of creditors, and not to force non-assenting creditors to execute the deed.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding' as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevent ion Chemistry as applied to the Industrial. Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

THE MONT CENIS TUNNEL.—A letter from an Italian engineer announced that the workmen employed in piercing Mont Cenis have come upon a bed of extremely hard quartz, which turns the edge of the best-tempered steel, and that it is feared this obstacle may retard the opening of the tunnel for four years. Foreign engineers have expressed an opinion that the tunnel will take longer to complete than the sanguine Italian managers anticipate. The summit railway, however, is likely to be made before the end of next year, and will shorten to four hours the passage of the mountain.

CLEARING UPPER THAMES OF SEWAGE.—Mr. Menzies, acting under the deputy ranger of Windsor Great Park, recently attended at the Windsor Board of Health, and stated that he appeared on behalf of the Board of Works, for the purpose of obtaining the consent of the Windsor board to the surveyor in giving the necessary statistics and other information with a view to the disposing and utilising the sewage of Windsor, instead of permitting it, as at present, to be discharged into the River Thames. From Mr. Menzies' statement, it appears that the Commissioners of the Thames Navigation have been making a general survey of the river, from Oxford, with a view of ascertaining the general effect of the discharge of sewage into the Thames from the various towns and villages between Oxford and London. Mr. Menzies, who, under the Board of Works, has the control of that portion of the drainage which passes through the private part of her Majesty's grounds in the Home Park, proved the present great nuisance, especially at low water, not only at Windsor, but at all other towns on the banks of the Thames. He also stated that he had a scheme by which the sewage may be utilised and the discharge into the Thames avoided. The board passed a resolution agreeing to afford Mr. Menzies all facilities in their power, with a view to carrying out the object contemplated.

HOT-AIR ENGINE.—MM. Burdin and Bourget have presented for the opinion of the Academy of Science of France a plan of hot-air engine, from which they believe an economy of at least one-half the fuel may be obtained, and which they desire to construct and experiment upon at the expense of the Government. The plan has simplicity at least. "Let there be an ordinary furnace, such as is used for steam engine boilers, the products of combustion of which escape into the chimney, after descending along an inclined plane. Let the atmospheric air be first compressed to two atmospheres in small parallel tubes lodged in the flue, the air entering at the lowest point, and consequently rising." Then follows a very rational calculation of the length and diameter of the tubes necessary, and a more complicated account of the engine. The theory is excellent; if it should succeed in practice we will return to it.

COAL EXPORT AND IMPORTS.—The exports of coal during the month of August, 1865, from the northern ports of this country amounted to 452,982 tons; from the Yorkshire ports, 49,288; from Liverpool, 48,902; from London, 3,547; from Severn ports, 200,435; and from the Scotch ports, 86,693, being a total of 841,847 tons, an increase of 57,671 tons as compared with August, 1864. The total exports from the various ports named from January to August, 1865, inclusive, were 5,709,575 tons, an increase of 446,172 tons compared with the same period of 1864. The total exports coastwise from Liverpool during August, 1865, were (according to Messrs. Higginson and Co.'s Circular) 11,177 tons. The total imports of South Wales and other coals coastwise into the port of Liverpool during August, 1865, were 5,578 tons, being a decrease of 201 tons compared with August, 1864. The total of these imports from January to August, 1865, inclusive, shows a decrease in 1865 of 23,084 tons. With regard to London, it appears that the imports of sea-borne coal, culm, and cinders during August, 1865, amounted to 263,739 tons, showing an increase over August, 1864, of 1,739 tons. The figures from January to August show an increase of 9,497 tons. The coals arriving in London by railway and canal during August, 1865, amounted to 232,729 tons, being an increase over August, 1864, of 50,876 tons. The actual increase of imports into London from both sources during August, 1865, was 52,615 tons, and from January to August, inclusive, 253,316 tons. The statistics for 1865 are not sufficiently advanced to form an estimate for the whole year, but those of 1864 show a great improvement in the coal trade of the country as compared with 1863, particularly as regards Liverpool and Birkenhead. The progress of Birkenhead is forcibly illustrated by the fact that the business done in coal there by rail in 1860 was 236,667 tons, and in 1863 it was 427,931 tons, an increase in three years of 80 per cent.

RAISING THE PRICE OF COAL.—The Wigan coal companies recently held a meeting at Liverpool, when it was resolved that there should be an advance in pit prices of 1*s.* per ton on best coals, and 6*d.* per ton on common coal and slack. The Rochdale and Heywood coal proprietors also met, to consider whether it would be advisable to advance the price of coal, and comply with the application of their workpeople for an advance of wages, when it was resolved to make a general advance of 1*s.* a ton in the price of coal.

THE THAMES EMBANKMENT.—The cofferdam fronting Somerset House, and extending to the west end of No. 2 contract, near Waterloo-bridge, has been completed and made water-tight. The dam at the eastern end is also fast approaching completion; and thus, by the completion of both dams, the entire line of works will shortly be inclosed from the effects of the tide.

EXHIBITION IN MANCHESTER.—A prospectus has been issued by the committee of the Manchester District Art Workmen's Association, announcing that it is their intention to hold an exhibition of arts and manufactures early next year.

THE MAGNESIUM LIGHT.—Experiments have been made at Birmingham to try the effect of the magnesium light when attached to a balloon in the air. The experiments were striking in effect, the light thrown forth being very brilliant, and illuminating the streets, houses, and crowds of people with a distinctness resembling day.

OPENING OF THE PORTUGUESE EXHIBITION.—The Portuguese International Exhibition has been opened at Oporto with great rejoicings, by the King and Queen, Dom Ferdinand, and Dom Augusto, who entered the crystal palace, with a brilliant suite, and were conducted through the central nave to the throne prepared for their majesties. Here an address was delivered by the president of the company by whom the palace has been constructed. England is best represented for manufactures among foreign nations in the Exhibition.

NEW PATENT IRON DOORS.—Among the patents just sealed is one for iron doors, invented by Mr. Joseph T. Harris. These doors are intended as a substitute for wood, and can be produced at almost the same cost. When fixed and painted it will be difficult to distinguish them from any kind of wooden doors, as they will be precisely the same in appearance, and will open and shut with equal facility. They are especially adapted for dwelling-houses, offices, and public buildings, and, indeed, for every purpose for which wooden doors are now used, their great merit being their extra security, lightness, and durability, in addition to which they can be made perfectly fireproof, and are not liable to shrink, as is the case with wood.

PORTABLE CENTRIFUGAL PUMPS.—A pump so arranged that a rigid suction-pipe may be conveniently used has been patented by Mr. C. T. Burgess, of Brentwood, the required inclination of the suction-pipe to suit the distance of the water below the pump being obtained by the movement of the disc or wheel case together with the suction pipe, instead of by turning the suction pipe separately on its joint or swivel.

MOTIVE-POWER.—A curious invention has been provisionally specified by Mr. E. S. Jones, shipowner, of Liverpool, according to which he proposes to compress air into suitabe chambers, conveniently stored in various parts of the ship. The compression is effected whilst the ship is in port, or at any other suitable time, in order that it may be available for use when required in cases of emergency.

CITY IMPROVEMENTS.—The City Sewers Commission have agreed to the following resolution:—"That a special committee, to consist of five members, be appointed to consider and report relative to improvements now in hand or contemplated, also generally, or any needed in the judgment of such committee, and upon the powers of the commission to provide means for improvements, and any recommendations such committee may see fit to make thereon." This may be valuable.

ANOTHER NEW GUNPOWDER.—Near Potsdam, in Prussia, gunpowder is being manufactured from wood on something like the gun-cotton principle. It is now some years since we first heard of the conversion of sawdust into an explosive by means of acids on the gun-cotton principle; but Captain Schulze, of Potsdam, appears to have carried out the invention into a practical manufacture. By machinery he cross-cuts beech and other timber into very thin veneers, which are easily crumbled into a coarse-grained powder or sawdust, which is then exposed to the action of acids, probably in much the same way that cotton is to form gun-cotton. The grains are thus reduced in size, and rendered explosive when dried, without yielding either smoke or smell in the combustion, but giving a brilliant light suitable for pyrotechnic displays.

FLEXIBLE AIR TUBING.—Mr. Ellis Lever, of Manchester, so well known as the inventor of Air Tubes for Mine Ventilation, has just adopted a novel and very useful improvement in the manufacture of his tubing. Instead of the flat or bevelled hoop hitherto used for expanding the tubes, Mr. Lever substitutes a five-eight round iron ring, not welded, but joined, so as to yield when subject to pressure, but immediately springing back to a perfect circle when released from such pressure. The tubing made with the new rings is said to be stronger, lighter, and less costly than the old kind, and we are glad to know that it is being used to great advantage in some of the most explosive coal mines in the kingdom, as well as in the ventilation of iron and lead mines.

GALE'S PROTECTED GUNPOWDER IN AMERICA.—Mr. Handel Cossham, who left England a short time since with Sir Morton Peto and other English capitalists for a visit to the United States, has there introduced Gale's process for protecting gunpowder with the same success as has attended the experiments in England. The New York papers publish the particulars of an interesting series of experiments tried at the Jersey City Locomotive Works, for testing the process, which were very satisfactory.

Drilling Rocks.—A machine has been invented by Mr. Robert Hood, of Dayton, Ohio, U.S., which consists in the employment of a spiral lifter, in combination with a tappit extending from a sleeve fitted in the drill or drill rod, and with an arm extending from said sleeve in the cam slot, in such a manner that, by the action of the cam slot or arm, the tappit is held in contact with the thread of the feeder until it arrives at the end of the stroke, when the same, by a curve in the cam slot, is thrown out of contact with the feed screw, and the drill is allowed to drop, and, while being thrown out of gear with the feed screw, it is turned, causing it to strike a different spot on each stroke. By this arrangement two or more drills can be operated by means of the same lifter and by the same driving power.

Improved Puddling Furnace.—Mr. J. Williams, Montreal, Canada East, claims—1 The novel arrangement in a puddling furnace of a blind grate with the ordinary grate, together with the combination of slide doors, trap doors, tewed holes, and air chamber, whereby for all the fuel consumed in the blind grate the benefit is received into the body of the furnace on the iron, with much less of the fuel passing up the chimney than in the ordinary furnaces. 2. In the different grates he claims the introduction of the trap doors for letting the ashes, cinders, &c., fall into the external ash pit, and thus save the handling out of ashes when the furnace is in operation, thereby effecting a saving of time. 3. He claims the peculiar arrangement of water boshes, whereby water may be employed witout the danger of an explosion from the generation of steam.

Bessemer Steel.—Recently a cubic block of steel, of the enormous weight of 100 tons, was successfully cast at the new works of Messrs. Bessemer and Sons, at East Greenwich. At Bolton, Lancashire, a block of similar steel, weighing 250 tons, was cast by the aid of Messrs. Ireland and Sons' patent upper-tuyere cupola furnace.

The Clyde.—It appears that the revenue of the River Clyde Trust for the year ending the 30th of June, 1865, amounted to £121,588, as compared with £121,381 in the year ending the 30th of June, 1864, showing an increase of £207. The ordinary annual expenditure of the year ending the 30th of June was £41,565; the interest on the bonded debt of the trust amounted to £54,547, and the ground annuals and feu duties to £5,515, making a total of £101,627. On deducting this amount from the income, the surplus revenue of last year was £19,960, which was applied to extraordinary repairs, new works, and improvements. After this application of surplus revenue, however, the expenditure of the year on new works and extraordinary repairs left a deficit of £87,942 to be provided for by loan. In the special expenditure of the year the Windmill Croft Dock figured for £27,434; a considerable sum was also expended for two new hopper barges, a new dredger, new workshops, &c. The total borrowing powers of the trust are £2,000,000, and they had been exercised, June 30th, 1865, to the extent of £1,422,379. The goods imported and exported during the year ending June 30th, 1865, amounted to 1,450,846 tons a decrease of 31,860 tons, as compared with the year ending June 30th, 1864. While the revenue of the trust remained nearly stationary in 1864-5, the ordinary expenditure showed an increase of £4,919 as compared with the previous year. The expenditure on the dredging account showed a reduction in 1864-5 of £4,944. The extraordinary expenditure made in 1864-5 showed an increase of £49,987, as compared with 1863-4. It has been already noted that the imports and exports into and from the Clyde showed a decrease of 31,860 tons in 1864-5, as compared with 1863-4; to this decrease the foreign trade contributed 25,562 tons, and the coast-wise trade 6,298 tons. The decrease in the foreign imports occurred principally in grain, flour, tallow, and lard; the most marked increase in the foreign exports was in the article of railway chairs, being to the extent of 19,377 tons, but this was nearly neutralised by the falling off in box and bale goods and bar and pig iron. The number of sailing vessels which entered the Clyde during the year June 30th, was 4,499, of the aggregate burden of 457,774 tons, as compared with 4,569 vessels, of the aggregate burden of 483,305 tons, in the previous year, showing a decrease of 70 vessels and 25,531 tons. On the other hand, in the course of 1864-5 there arrived 11,856 steam vessels, representing 1,261,284 tons, giving an increase, as compared with 1863-4, of 1,894 arrivals and 216,350 tons.

Wallachia and Servia.—The Queen has been graciously pleased to give orders for the appointment of John Green, Esq., her Majesty's Agent and Consul-General in Wallachia, and John Augustus Longworth, Esq., her Majesty's Consul-General in Servia, to be Ordinary Members of the Civil Division of the Third Class, or Companions of the Most Honourable Order of the Bath,

Movement of Gold.—The value of the gold imported into the United Kingdom in August was computed at £1,079,638, as compared with £1,114,045 in August, 1864, and £1,725,222 in August, 1863. The receipts from Australia revived in August, having been £504,915 in that month, against £102,844 in August, 1864, and £189,087 in August, 1863. On the other hand, they declined from Mexico, South America, and the United States. In the eight months ending August 31, this year the imports were £8,876,597, against £11,411,120 in 1864, and £13,150,777 in 1863 (corresponding periods). The receipts from Australia to August 31 were £1,916,676, against £2,016,109 in 1864, and £4,081,131 in 1863 (corresponding periods). From Mexico, South America (except Brazil), and the West Indies the imports were £1,868,709, against £3,727,798 in 1864, and £2,784,865 in 1863 (corresponding periods). The United States sent gold to August 31 to the value of £3,041,623 against £4,932,005 in 1864, and £4,651,420 in 1863 (corresponding periods). The exports of gold in August were £593,655, against £556,342 in August, 1864, and £727,425 in August, 1863. The quarter to which the principal movement of gold took place in August was Spain. In the eight months ending August 31 the total exports of gold were £4,873,867, as compared with £9,668,235 in 1864, and £10,141,588 in 1863 (corresponding periods). The exports of gold to France in the first eight months of this year were £2,210,424, as compared with £5,111,044 in 1864, and £2,278,960 in 1863 (corresponding periods). To Egypt the exports of gold to August 31 this year were £230,380, as compared with £1,554,955 in 1864, and £1,079,957 in 1863 (corresponding periods). To Brazil we only sent gold to the value of £367,609 to August 31 this year, while in the corresponding periods of 1864 we sent £891,413, and in the corresponding period of 1863 £1,110,303 in the same direction.

Pharaoh's Serpents.—Mr. C. H. Wood writes to the *Pharmaceutical Journal*:—"A very curious toy is now being sold in Paris under the name of Pharaoh's Serpent. As this toy really constitutes an interesting chemical experiment, perhaps an account may prove interesting to your readers. It consists of a little cone of tinfoil containing a white powder, about an inch in height, and resembling a pastile. This cone is to be lighted at its apex, when there immediately begins issuing from it a thick serpent-like coil, which continues twisting and increasing in length to an almost incredible extent. The quantity of matter thus produced is truly marvellous, especially as the coil which so exudes is solid, and may be handled, although, of course, it is extremely light, and somewhat fragile. Having a little of the white powder with which the cones are filled placed at my disposal by a friend, I submitted it to analysis, and found to consist of sulphocyanide of mercury. The salt when heated to a temperature below redness undergoes decomposition, swelling or growing in size in a most remarkable manner, and producing a mixture of mellon (a compound of carbon and nitrogen) with a little sulphide of mercury. The resulting mass often assumes a most fantastic shape, and is sufficiently coherent to retain its form. It presents a yellow colour on its exterior, but is black within. The 'serpent' shape of course results from the salt being burnt in a cone of tinfoil. Both the mercurious and mercuric sulphocyanides decompose in the same manner; but the mercuric salt, containing more sulphocyanogen, seems capable of furnishing a larger quantity of mellon, and is the one used in the French serpents. A solution of pernitrate of mercuric sulphocyanide may be easily so prepared. It is best touse the mercurial solution as strong as possible, and to keep it in excess throughout the precipitation. Solution of perchloride of mercury is not so easily precipitated as the pernitrate, probably owing to the solubility of the mercuric sulphocyanide in the chlorides. Perhaps I may be excused for adding that sulphocyanide of ammonium, suitable for the above purpose, may be very easily and economically prepared as follows:—One volume of bisulphide of carbon, four volumes of liq. ammon. fort., and four volumes of methylated spirit are put into a large bottle, and the mixture frequently shaken. In the course of one or two hours the sulphide of carbon will have entirely dissolved in the ammoniacal liquid, forming a deep red solution. When this result is attained, the liquid is boiled until the red colour disappears and is replaced by light yellow. The solution is then evaporated at a very gentle heat (about 80 or 90 degrees F.) until it crystallises, or just to dryness. The product is sulphocyanide of ammonium, sufficiently pure for the above purpose. One recrystallisation from alcohol will render it quite white. One ounce of bisulphide of carbon yields, by this process, exactly one ounce of sulphocyanide of ammonium."

Metropolitan Board of Works—Salaries of the Engineers.—It has been resolved, by a large majority of votes, to raise the salary of the chief engineer, Mr. Bazalgette, from £1,500 to £2,000 a year, with £200 a year for incidental and travelling expenses as heretofore; and the salaries of the other engineers, Messrs. Lovick, Grant, and Cooper, from £500 to £800 a year each, with £200 a year for expenses as heretofore.

NAVAL ENGINEERING.

The Squadron of Iron Mortar Boats, built during the Russian war, and since laid up at the eastern end of Chatham dockyard, where they have been lying for some years high and dry, and under cover, are gradually being brought into use for harbour duty, several of the number having already been appropriated for various purposes. An order from the Admiralty directs another of the mortar boats to be converted into a dredging vessel for deepening the river at the entrance to Chatham harbour, and preventing the accumulation of shoals.

The Floating Battery "Thunderbolt," 16, 200-horse power, which ever since the close of the Russian war has been lying in the Medway, attached to the Chatham Steam Reserve squadron, has been removed into the steam basin preparatory to being taken into the steam basin preparatory to being taken into dock for the purpose of being paid over with a coating or the Hay composition, which is also to be applied to the bottom of the iron paddle wheel steamer *Recruit*, 6, 160-horse power.

The 22-Gun Screw Steam-Frigate Endymion, of 2,478 tons, to be fitted with 500 horse-power engines, will be launched shortly at Deptford, and will be completed for sea at Sheerness. The whole of her engine gear, boilers, and machinery have been forwarded from Woolwich to Sheerness in the *Dee* and a couple of dockyard lighters, which left Woolwich yesterday morning in tow of the *Monkey*, Second Master Smithers.

The 6-Gun Paddle-Sloop Spiteful, lying in ordinary at Woolwich, has been in readiness some weeks to hoist the pennant for sea, but on account of a couple of leakages having been discovered in the hull it is expected that she will be redocked and repaired before she is commissioned. It is stated to be highly probable that some spots of dry rot will be met with on a further examination, and that in consequence she may be detained some considerable time at Woolwich.

The Iron Paddle-Wheel Vessel Oberon has been undocked at Woolwich in readiness for commission, and has been replaced in dock by the iron paddle-vessel *Antelope* to make good defects.

The Floating Battery Ætna, 16, 200 horse-power, until recently attached to the third division of the Chatham Steam Reserve, is now in the engineers' hands for the purpose of having her boilers, engines, and machinery removed, preparatory to being fitted up as a floating residence for the members of the dockyard police doing duty afloat; the *Nymph*, the frigate at present used as a police residence, being required for other purposes.

The "Helicon" and the "Salamis" returned from their Channel competitive trial cruise on the 17th ult. to Spithead. Both vessels are of 835 tons, propelled by paddle engines of 250 nominal horse power (the engines of both being made by one firm from the same set of patterns), and are alike in every respect, excepting that the *Helicon* has the long plough coulter-shaped bow, introduced into Her Majesty's navy by Mr. E. J. Reed, and the *Salamis* possesses the old Admiralty hatched-shaped form. The programme laid down for the trial was for the two vessels to steam 10 knots on the first day at sea, and 12 knots on the second day, measurement being taken, as far as might be possible under the circumstances, of the amount of fuel burnt. The third and concluding trial was to be simply a run back to Spithead, each vessel to do its best. The trial at 10 and 12 knots speed were duly made, but no safe inferences can be drawn from the results until the indicator diagrams now at the Admiralty have been marked out, and the indicated power of each ship's engine compared with consumption of fuel, &c. With regard to the ship's behaviour when steaming at 10 and 12 knots, there was never at any time a sufficiently heavy sea to bring out decisively the respective qualities of each vessel in meeting the waves at full speed. The 10 and 12 knot runs having been concluded, the two vessels were put under easy steam until a position, 335 miles west of St. Catharine's, Isle of Wight, was reached. Then the preparatory flag was hoisted on board the *Helicon*, to start on the race back, the winning-post being the Warner light-ship at the eastern entrance to Spithead, and the distance 350 miles. All was soon ready, but the start was delayed for about half an hour, during which time the Salamis's pressure of steam fell, her boilers filled with water, and her fires necessarily grew dull. All this could not be avoided, but it nevertheless gave the *Helicon* a decided advantage, as it enabled her commanding officer to start her at his own time—1 p.m.—under a full head of steam, with clear fires, and her head set straight on her course; while the *Salamis* had to get her head round from the westward, and start with steam down to 10lb., and with dead fires. At the end of two hours from the time of starting the *Helicon* had obtained a head of from two and a-half to three miles, but the *Salamis's* fires and steam were now all right, and her engines were doing their best. By 4 p.m. the distance between the vessels was but trifling, and by 1 a.m. on the following morning they were fairly abreast of each other, the green light of the *Helicon* being distinguishable from the fore-deck of the *Salamis*. At daylight on Sunday the coal received at Portsmouth in the bunkers of the *Salamis* was nearly all gone, and a very inferior kind of coal, which had been 12 months in the bunkers, having been taken on board at Copenhagen and Hull, when the *Salamis* was in attendance upon the Prince and Princess of Wales upon the occasion of their visit to Denmark, had now to be burnt in the furnaces. The effect in this change of fuel was soon apparent in the gradual creeping away of the *Helicon*, under the greater power of her Welsh coal, but recently received on board at Portsmouth. The actual distance between the two vessels at the finish will be best understood by reference to one of the Admiralty charts of Spithead. At the moment the *Helicon* was passing the Warner light-vessel, the goal of the race, the *Salamis* was passing inside the buoy of Bembridge Ledge, the inner channel having been taken by both vessels by the east end of the Wight to the Warner, and not the outer channel round by the Nab light-vessel. In this contest the *Helicon* has proved herself to be undeniably slightly the faster vessel of the two.

The Two-Turreted Ship "Wyvern," Captain Hugh T. Burgoyne, V.C., made her Steam Factory and Commission trials of speed at Portsmouth on the 5th ult. All her seagoing weights were on board, the absence of her guns and ammunition, which have nor yet been supplied to her, being compensated for by 180 tons of iron ballast, placed in her turrets. Under these conditions—the only conditions that can give a fair estimate of a vessel's seagoing rate of speed—the *Wyvern's* draught of water was 14ft. 8in. forward and 16ft. 1in. aft, or a mean draught of 15ft. 4½in.; immersion of the upper edge of the upper screw blade, 2ft. 10½in. The forecastle deck was then, at the supernumerary stem head, 15ft. 9in. above the water line, the poop deck at the stern being 12ft. 6in., and the bulwarks amidships being 9ft. 10in. The poop and forecastle being built up as superstructures on the hull proper of the ship, stand 8ft. above the level of the upper deck, and the depth of the midship bulwarks is 5ft. The results of the trials, at full and half boiler power, turuing circles, &c., were as follows:—

Full Boiler Power Runs.

No. of Run.	Time. M. sec.	Speed. Knots.	Rev. of Engines.	Steam. Lb.	Vacuum. Inches.
1	5 27	11·009	67	19	24
2	6 45	8·889	67	20	23
3	5 25	11·077	65	18	24
4	6 38	9·043	66½	21	23
5	5 12	11·588	68	21	23
6	7 20	8·182	66	21	23

Mean speed of the ship at full boiler power, 10·060 knots.

Half Boiler Power Runs.

No. of Run.	Time. M. sec.	Speed. Knots.	Rev. of Engines.	Steam. Lb.	Vacuum. Inches.
1	5 25	11·077	55	20	23
2	9 54	6·061	55½	16	23½
3	5 38	10·651	54½	18	23
4	8 34	7·004	54	19	23

Mean speed of the ship at half boiler power, 8·523 knots.

The indicated horse-power of the engines was 1,440, with excellent indicator card diagrams. The engines were worked well slackened up, but to criticise them further here would be out of place. They were built to a special order, but not to the order of our Admiralty; notwithstanding which, however, they really worked, on the whole, better than had been anticipated.

Circles	Port Helm. Full power.	Port Helm. Half power.	Starboard Helm. Half power.	Starboard Helm. Full power.
Time in getting helm up	50″	30″	32″	58″
Turns of wheel	4	4	4	4
Men at wheel	8	8	8	8
Half circle made	2′ 25″	2′ 33″	2′ 35″	2′ 34″
Full circle made	4′ 49″	5′ 32″	5′ 47″	5′ 5″
Angle of rudder	41°	41°	39°	41°
Revolutions of engines at half circle	61	49	53	61

(The ship's screw has a right-handed thread.)

After making the circles the engines were tested in their quickness of movement, in obedience to order given, and they were stopped dead in 11 sec. from going at full speed ahead, turned astern from rest to full speed in 4 sec., stopped and sent on ahead again at full speed in 11 sec.

The "Basilisk," 6, paddle-wheel sloop, 1,031 tons, 400-horse power, having had her boilers and engines thoroughly overhauled and repaired in Sheerness dockyard, after a long term of foreign service, was on the 5th ult. taken to the measured mile, off Maplin Sands, in charge of Captain Randolph, for the official trial of her engines. The vessel, with all her weights and stores on board, made six runs on the measured mile, with the following results:—First run, 6 min. 33 sec.; revolutions of engines, 17·25 per minute; speed due to time, 9·160. Second run, 7 min. 22 sec.; revolutions of engines, 19; speed due to time, 8·145. Third run, 6 min. 2 sec.; revolutions of engines, 17·5; speed due to time, 9·944. Fourth run, 7 min. 51 sec.; revolutions of engines, 19; speed due to time, 7·643. Fifth run, 5 min. 53 sec.; revolutions of engines, 17; speed due to time, 10·198. Sixth run, 7 min. 58 sec.; revolutions of engines, 18·5; speed due to time, 7·531. The result gave a true mean speed of 8·879 knots per hour. The circle, the diameter of which was 356 yards, was turned at full power in 5 min. 53 sec.; at half power in 6 min. 33 sec. The draught of water forward was 16ft. 9in.; aft, 16ft. 11in.; and the load on the safety valve, 12lb. The engines worked in a very satisfactory manner, and the boilers generated a good supply of steam.

Naval Appointments.—The following appointments have taken place since our last:—H. H. Mothersole, J. Hird, W. White, and W. H. Wivil, engineers, additional, to the *Bristol*; H. Sedwick, engineer, additional, to the *Dædalus*; J. Lanksbury, engineer, additional, to the *Royal George*; W. J. J. Spry, engineer, additional, to the *Royal Adelaide*; T. W. Sanders, engineer, to the *Duke of Wellington*; F. C. Kelson, acting engineer, to the *Donegal*; W. Skelton, G. Weight, J. Etherington, and J. Legate, first-class assist.-engineers, additional, to the *Bristol*; J. Imrie, first-class assist.-engineer, additional, to the *Victory*; H. H. Small, first-class assist.-engineer, additional, to the *Trafalgar*; H. C. Stansmore, acting second-class assist.-engineer, to the *Duke of Wellington*; J. Coade, chief engineer, to the *Bristol*; C. W. G. Chambers and A. Long, engineers, to the *Bristol*; W. Miller, engineer, to the *Dauntless*; D. Storrar, first-class assist.-engineer, to the *Bristol*; N. H. Rowe, second-class assist.-engineer, to the *Bristol*; W. H. Brinsfield, promoted to be acting engineer to the *Wye*.

STEAM SHIPPING.

Ship-building in Preston.—The Preston Iron Ship-building Company launched, on the 9th ult., a fine barque, of about 650 tons gross register, intended for the California trade, and named the *Maravilla*. She is of the following dimensions—160ft. on the load water-line, 28ft. 2in. beam, and 18½ft. depth of hold. This makes the third vessel launched this year by the above company, which has been at work eighteen months; and they have now on hand a paddle steamer of 1,020 tons, for the General Steam Navigation Company (intended for the cattle trade), a barque of about 750 tons (for the East India trade), a steel paddle-steamer for the Pacha of Egypt, and a schooner of 190 tons, making in all about 4,500 tons of shipping launched and begun this year.

Steam Shipbuilding on the Clyde.—Messrs. W. Simmons and Co., of the London Works, Renfrew, have launched a paddle named the *Conqueror*, built for the Clyde Shipping Company. The *Conqueror* is fitted with a pair of beam engines, two boilers, and feathering paddles. Messrs. Simons are constructing two powerful iron dredgers, intended for cutting a deep sea channel to an inland city, with the view of making it a seaport. Messrs. Steven and Sons, of Kelvinhaugh, have launched an iron screw of 650 tons, built for Messrs. Handyside and Henderson, and intended to be employed on their Mediterranean line. The engines are being supplied by the Finnieston Steamship Works Company. Messrs. J. and R. Swan, of Kelvin dock, have launched an iron screw of 100 tons, named the *Albert*. The same firm has also laid down the keel of another steamer of similar size. Messrs. T. Wingate and Co., of Whiteinch, have launched an iron steam dredging machine of considerable dimensions, and fitted with engines of 30-horse power for the Aberdeen Harbour Commissioners. Messrs. A. and J. Inglis, of Point House, have launched a large sailing vessel, fitted also with a screw propeller, for the Australian and China trade. The vessel is named the *Erl King*, and is intended to be the nucleus of a line of ships under the management of Messrs. Robertson and Co., of London. The engine for driving the propeller is of 250 horse-power nominal. Messrs. T. Wingate and Co., of Whiteinch, have launched a screw named the *Mariei*, of 275 tons builders' measurement, 130ft. long, 20ft. broad, and 12ft. deep, with engines of 60-horse power. The *Mariei* has been built to the order of Messrs. W. Cruicksbank and Co., of Glasgow, for the Spanish coasting trade. The London and Glasgow Engineering and Shipbuilding Company (limited) have launched a screw named the *Milo*, and intended by the owners, Messrs. T. Wilson, Sons & Co., for the Baltic trade. Her dimensions are 210ft. by 29ft. and 16ft.; burden, 860 tons builders' measurement. She will be propelled by a pair of direct-acting engines of 100-horse power, now completed in the engine works of the same company and ready to go on board. A screw named the *Oneglia* has been launched by Messrs. Macnab and Co. The *Oneglia*, which is 130ft. in length by 18ft. in breadth, and 10ft. in depth, will be propelled by a pair of direct acting engines of 40 horse-power, constructed by the same builders. She has been built for the San Remo Steam Navigation Company, and is intended with the *San Remo*, a sister vessel, built some time since, for the coasting trade on the Sardinian coast. The *Zeta*, built by Messrs. A. Stephen and Son, and Messrs. H. Bath and Son, of Swansea, and intended to be employed in the passenger and copper ore trade between England and Valparaiso, has "run the lights" between Cloch and Cumbrae on favourable conditions. Thus the *Zeta*, which was engined by Messrs. A. and J. Inglis, attained a speed of 9¾ knots, the steam being merely auxiliary. The *Limena* has made the run out from Liverpool to Valparaiso, a distance of [illegible] miles, in 30 days 23 hours, with a coal consumption of 880 tons for the whole voyage. The *Limena* was one of four steamers built on the Clyde last year by Messrs. Randolph, Elder and Co., for the Pacific Steam Navigation Company. The *Java*, recently built by Messrs. G. and J. Thomson, and the latest addition to the Cunard fleet, has left the Clyde for Liverpool. In running the lights between Cloch and Cumbrae she attained a speed of rather more than 16½ miles per hour. Messrs Macnab and Co., of Greenock, have launched from their yard at Albert-quay, a handsome screw steamer of about 300 tons burden. Her engines were on board when she was launched. Messrs. Blackwood and Gordon have launched the *Taranaki*, a screw, built for the New Zealand passenger trade, and owned by the New Zealand Steam Navigation Company. The dimensions of the *Taranaki* are as follows:—Length of keel and fore-rake, 185ft.; breadth of beam, 24ft. 6in.; depth of hold, 14ft.; burden, 550 tons, builders' measurement. She is to be propelled by a pair of direct acting inverted engines of 90-horse power, and is expected to attain a high rate of speed. She is a sister steamer to the *Wellington*, built by the same firm about two years since, and has been constructed under the superintendence of Mr. W. M'Millan, of Glasgow. A screw of 650 tons, named the *Venezia*, has been launched by Messrs. A. Stephen and Sons, of Kelvinhaugh. She is a sister ship to the steamers *Roma* and *Valetta*, built by Messrs. Stephen for the same owners—Messrs. Handyside and Henderson, and she is to be employed by them in their line of steamers trading to the Mediterranean. Messrs. J. and G. Thomson have launched the *Malta*, the latest addition to the fine fleet of Messrs. Burns and MacIver. Her dimensions are as follows:—Length of keel and fore-rake, 300ft.; breadth of beam, 39ft.; depth, 26ft. 6in. She is to be supplied with oscillating geared engines of 350 horse-power nominal, with surface condensers and all recent improvements. Her burden is 2,350 tons. The *Erl King*, a screw recently built by Messrs. A. and J. Inglis, of Point House, for the Australian and China trade, attained on her trial trip an average speed of 14 miles per hour. She has left the Clyde to load in the Thames. A new Turkish ram, the *Abdul Aziz*, has tested her engines in the Clyde, and is completing her fittings at the Tail of the Bank. Mr. R. Little has contracted with Messrs. R. Duncan and Co., of Port Glasgow, for the construction of a screw of 750 tons for the Mediterranean trade. Her engines will be supplied by Messrs. Rankin and Blackmore. Messrs. Caird, of Greenock, have received orders from Messrs. Burns to build a paddle for the Royal Mail service between Scotland and Ireland, similar in all respects to the *Buffalo*, *Wolf*, and *Llama*, to be named the *Camel*. Messrs. Randolph, Elder, and Co. have launched a screw of 1,300 tons for the African Steamship Company. She has been named the *Mandingo*.

Iron Shipbuilding on the Usk.—For the last three or four years the advantages presented by the South Wales ports for iron shipbuilding, owing to their contiguity to the iron and coal districts, and other circumstances, has attracted the attention of capitalists, and the result has been that at Newport, Cardiff, and Llanelly, several iron shipbuilding yards have been opened, and the trade is gradually becoming one of considerable importance. Recently an iron bark was successfully launched from the yard of Mr. Thomas Spittle, on the east side of the Usk, at Newport, and she was christened the *Iron Queen* by the daughter of the builder and owner. The bark is intended for the River Plate trade, and her tonnage and dimensions are as follow:—Registered tonnage 255 tons, builder's tonnage 288 tons, length 115ft., beam 23ft. 4in, and depth of hold 14ft. This is the second iron ship launched at Newport, the first having been built by Messrs. Batchelor. The keel of another iron vessel of much larger tonnage has been laid at Mr. Spittle's yard.

Channel Steamers.—The already fine fleet of steamers belonging to the London and South Western Railway Company has been increased by the addition of a new screw vessel called the *St. Malo*, of 300 tons burden, and fitted with horizontal engines of 100 horse-power. She was built for the company by Messrs. Aitkin and Mansell, of Glasgow, and is intended to run between Southampton, the Channel Islands, and St. Malo. The *St. Malo*, on her trial trip, realised a speed of about 14 statute miles per hour. The apartments for passengers are very handsomely fitted up, and the vessel is provided with every improvement to render her suitable to the service in which she is to be employed.

LAUNCHES.

Launch of a West India and Pacific Steamer.—Messrs. Jones, Quiggin, and Co. launched from their yard on the 9th ult., a fine screw steamer, which was named the *European*, for the West India and Pacific Steamship Company (Limited). The dimensions of the vessel are 270ft. long, 32ft. beam, and 28ft. deep to the spar deck. She will register about 1,600 tons.

The Steam Launch, No. 13, six horse-power, for the *Bellerophon*, was, on the 6th ult., taken to the measured mile at Saltpan Reach, in the Medway for the official trial of her engines, which have been erected by Messrs. Penn and Son, of Greenwich. Six runs were made, giving a true mean speed of 6·888 knots per hour. The maximum number of revolutions of engines per minute was 301, and the mean 294. The draught of water was 2ft. 6in. forward, and 3ft. aft. The load on the safety valve was 80lb., and the pressure of steam in the boilers 72lb. The launch is driven by a four-bladed propeller, the diameter of which is 2ft. 6in., and the pitch 3ft. 11in. The engines worked in the most satisfactory manner, and there were no hot bearings. The boilers generated a good supply of steam, and there was an entire absence of priming.

TELEGRAPHIC ENGINEERING.

The Russian American Telegraph.—A New York paper states that Minister Clay has transmitted to the State Department an official copy of the conditions stipulated between the Russian Telegraph Department and Hiram Sibley for the establishment of telegraph communications between Russia and America, by which the exclusive right is granted to the latter plenipotentiary of the American Western Union Telegraph Company for 33 years from the day the line shall be opened; the Russian Government to grant a further term as it may judge convenient. In order to encourage the undertaking, the Government grants to the company an allowance of 40 per cent. on the net produce of despatches transmitted by it over the lines to and from America; and, in order to contribute as much as possible to the success of the present undertaking, the Minister of Public Utility will adopt the measures necessary for securing the company's telegraph from being maliciously injured by the local population; but at the same time the Government refuses to take upon itself any responsibility for such injuries of any nature whatever. The company is allowed to import materials free of duty.

RAILWAYS.

RAILWAY MATTERS.—It is proposed to bring an independent railway into Hull and the East Riding of Yorkshire, and a new project for crossing the Humber by a great bridge will be introduced into Parliament as the Hull, Lancashire, and Midland Counties Railway. A Scottish nobleman, who is connected by property with the islands of Orkney, has offered to subscribe £60,000 for the construction of railways "in that district,"—which, we presume, means on the main island, Pomona, where Kirkwall stands.

THE PNEUMATIC DESPATCH RAILWAY has been completed, and a train of trucks containing a quantity of goods driven through the tube, from the central station at the Bull and Gate, Holborn, to the terminus at the London and North-Western Station at Euston. The time occupied in running between the two stations, about a couple of miles, was some five minutes. The driving power is at Holborn, and consists of two 24 horse-power steam-engines. These set in motion a disc, the diameter of which is about 22ft., and this immense circular fan revolves with great rapidity in an air-chamber, creating an almost irresistible atmospheric power, which by the use of valves can be used either for blowing the trains through the tubes or literally sucking them back again. The height and width of the completed iron tube are respectively 4ft. 6in., the width between the rails being 3ft. 8½in. The Duke of Buckingham, the chairman, and several of the directors of the Pneumatic Despatch Company were blown in a train of three carriages, under the superintendence of Mr. Rammell, the engineer, from the Holborn station, to Euston.

THE PANAMA RAILWAY is the most successful undertaking of the kind in the world. It has paid with regularity a dividend of 20 per cent. per annum, with occasional distributions in addition; but these returns have now been thrown into the shade, for, as we gather from the New York papers, the company has just declared a dividend in shares of 40 per cent., and a quarterly cash dividend of 6 per cent., so that the total distribution for the last year appears to be at the rate of 64 per cent. Results of this nature are, of course, only obtained through the virtual monopoly which the railway enjoys, but they indicate at the same time that the company is making too much out of the travelling community, and this view is confirmed by the complaints which are frequently heard, that commercial interests are suffering for want of additional means of transit across the Isthmus. It appears, however, that the establishment of a competing route, by means of a line of railway and steamers, is seriously contemplated. The railway is to be 140 miles to the northward of Panama, between the fine harbours of Chiriqui and Golfito. It is added that a large portion of the shares are being privately subscribed for.

RAILWAY SIGNALS.—The manufacture of railway signals, with their machinery, has now become an extensive business, employed hundreds of skilled workmen. The signals on a railway forty or fifty miles long cost as much as £3,000, and the complicated ones at a chief station on a great railway will cost £2,000. These signals are of the semaphore kind. Immense levers move railway points and signals at the same time. We believe the principal firm engaged in this manufacture is that of Messrs. Saxby and Farmer, at Kilburn, about 400 hands being employed by them.

NEW RAILWAY ROUTE FROM ENGLAND TO SCOTLAND.—A survey is now being made by the Midland Railway Company for the extension of their line from Settle to Carlisle, there to communicate with the North British Company's system. Upon a former occasion when the Midland Company took measures for opening out for themselves a new and independent route to the north, they were induced to abandon their scheme and content themselves with entering into working arrangements with the London and North Western Company. The plan having, however, proved unsatisfactory to them, the Midland Company are preparing to go to Parliament next session for an independent line of their own. Starting at Settle, the proposed new line will pass along the vale of the Eden to Kirby Stephen, in Westmoreland, where communication may be had with the Stockton and Darlington, by the Eden Valley line. Pursuing the vale of the Eden, the line will enter Cumberland near Culgaith, and having crossed the Eden, will pursue closely the course of that river to the village of Armathwaite, passing through some of the most picturesque woodland and river scenery in Cumberland, which has hitherto been a *terra incognita* to the generality of tourists. From Armathwaite the line will pass to Scotby on the Newcastle and Carlisle section of the North Eastern system, and running almost parallel with that line for a couple of miles will find entrance into Carlisle Citadel Station and join the North British line there.

RAILWAY TAXATION.—It appears that in the year ending March 31, 1864, the amount received by English railway companies for the conveyance of passengers chargeable with duty was £7,433,462, and by Scotch railway companies £641,630, making a total of £8,085,092. In the year ending March 31, 1865, the corresponding amounts were £8,213,227 and £682,518 respectively, making a total of £8,895,745. The amount of duty charged in the year ending March 31, 1864, was £372,173 on English railways; and on Scotch railways, £32,081, making a total of £404,254. In the year ending March 31, 1864, the corresponding amounts were £410,661 and £34,126 respectively, making a total of £444,787. In the year ending March 31, 1863, railway taxation produced in Great Britain, £383,057; in the year ending March 31, 1862, £366,288; in the year ending March 31, 1860, £359,212; in the year ending March 31, 1859, £339,569; in the year ending March 31, 1858, £348,611; in the year ending March 31, 1857, £334,063; and in the year ending March 31, 1856, £323,790. The revenue derived from this source is thus steadily increasing.

RAILWAY ACCIDENTS.

COLLISION ON THE LONDON AND NORTH-WESTERN RAILWAY.—A collision occurred early on the morning of the 1st ult. on the London and North-Western Railway. A long excursion train, consisting of nearly 40 carriages, from Leamington, Warwick, and Coventry to Birmingham, was returning from the latter place between 1 and 2 a.m., when as it approached near to Coventry the driver of the engine discovered something on the line at a short distance ahead. He immediately turned off the steam and vigorously applied the break, but he was unable to bring the train to a standstill in time to prevent a collision, although he succeeded in considerably abating its force. The engine charged the obstacle, which proved to be a truck and guard's van, and was immediately thrown off the line, the whole train receiving a shock, the passengers being more or less hurt, though none dangerously.

ACCIDENT ON THE BRISTOL AND EXETER LINE.—On the evening of the 1st ult., shortly after 6 o'clock, there was a collision at the Nailsea Station, which although unattended by loss of life or any serious personal injuries was yet of such a nature as to impede the traffic for some hours. A heavy goods train was being shunted from the down to the up rails when it was run into by the passenger train which leaves Bristol for Exeter at 5.50. Such was the force of the concussion that three trucks of the goods train were thrown off the rails, and the engine of the passenger train was wedged by the trucks which it had displaced, and its progress stopped.

A RAILWAY COLLISION TOOK PLACE ON THE BOLTON AND CLITHEROE BRANCH of the Lancashire and Yorkshire Railway on the evening of the 5th ult., within four miles of Blackburn. The half-past four o'clock passenger train from Clitheroe to Blackburn, Bolton, and Manchester, left the former station at its appointed hour, and all went safely until the train came to the tunnel adjoining the Ribchester station, which is not more than 100 yards in length. At this point the line is on the incline in the opposite direction, consequently the train was going up the gradient as it entered the tunnel. After it had passed about 30 yards into the interior it ran into a goods train, which was so heavily laden that it could not get along; the consequence being that several of the passengers were seriously shaken.

DOCKS, HARBOURS, BRIDGES.

NEW PIER FOR CAPE CLEAR.—Miss Burdett Coutts has signified her intention of subscribing £2,000 towards the erection of a pier at Cape Clear, or in its neighbourhood, for the accommodation of the local fishermen, and of the seafaring interest in general.

SOUTHWARK BRIDGE.—The Court of Common Council have resolved, on the motion of Alderman Salomons, that Southwark Bridge shall be kept open for other twelve months with the option of purchasing the bridge altogether. The motion was strenuously opposed, not from any doubt as to the convenience afforded by the bridge being free, for that was admitted on all hands, but because the motion pointed to the chance of the Corporation purchasing it altogether, for which it was said that there were no funds forthcoming.

MINES, METALLURGY, &c.

GOVERNMENT INSPECTION OF METALLIFEROUS MINES.—With reference to Lord Kinnaird's last draft of a Metalliferous Mines Bill, which it is anticipated will be introduced early in the ensuing sesssion, Mr. Frederick Hill, of Helston, proposes to avoid the inconvenience of impracticable Acts of Parliament by the bringing forward of an inspection bill by the miners themselves. It would not be uninteresting to see a draft of Mr. Hill's proposed measure, and perhaps Lord Kinnaird would do well to seek his co-operation. Mr. Hill remarks that Lord Kinnaird's Metalliferous Mines No. 2 bill provides for the appointment of paid commissioners, in number not less than three nor more than seven, appointed by the Secretary of State, who also nominates the chairman. This board is to have a secretary and office in London or Westminster, at salaries to be hereafter fixed, with power to prescribe to any mine such rules—laid down in the bill—as the board may direct. Many of these rules are identical with those in the original bill, and there are the same objectionable arbitration clauses, the control and supervision being substantially transferred from the manager to a London commission, which has power to appoint inspectors. The second bill is nearly as mischievous as the former and quite as impracticable, and proves that Lord Kinnaird has not yet seen the injustice of applying the same rules to all description of mines. There is clearly a determination to force legislation, and it remains with those interested in mining, and possessing adequate information on the subject, to originate some measure which may fairly meet the recommendations in the recent report of the commissioners.

OUR TRADE WITH THE UNITED STATES.—During the seven months ending July, 1865 compared with the same period of 1864, there was a falling off in the exports of iron and steel to America of £1,705 4s. 11*d*.; lead, £154,927; tin plates, £91,622; and coal, £13,383. But trade with the United States appears to be now generally reviving, and it is confidently anticipated future returns will be of a more satisfactory character.

STEEL AND CAST IRON.—A process for the production of steel directly from the ore has been proposed by Mr. G. Hand Smith, of Philadelphia, in the Franklin Institute. Pure oxide of iron, such as the magnetic oxide, for example, is crushed, washed, and packed in layers alternating with charcoal, in the ordinary cementing furnaces: after heating, a porous mass is obtained which may then be rolled into plates. Mr. Fleury also described, at the Institute, a process of manufacturing steel analogous to that of Bessemer, in which the decarbonisation of the cast-iron was effected by introducing into it while melted pulverised oxide, whose oxygen served to combine with and remove the excess of carbon. He also gave an account of a process for increasing the strength of cast-iron by the addition of an alloy of zinc, lead, and tin, in the proportion of about seven per cent. This process has been patented in the United States.

NEW COAL FIELD.—It is stated that the search for coal at Thirkleby, near Thirsk, has proved successful, and that measures are about to be taken for bringing the mineral into working.

WATER SUPPLY.

WATER SUPPLY OF PARIS.—Previous to the annexation of the suburbs Paris received 147,000,000 litres of water daily from the Canal de l'Ourcq, the steam pumps at Chaillot and the bridge of Austerlitz, the aqueduct of Arcueil, the artesian well of Grenelle, and the northern springs at Belville and Près St. Gervais. Since then Paris, enjoying the hydraulic establishments which supplied the annexed suburbs, has had its provision increased by 25,000,000 litres daily derived from the waterworks at the bridge of Ivry, Auteuil, Neuilly, Clichy, St. Ouen, and the Port-a-l'Anglais, all which represent a total of 172,000,000 litres daily. Formerly there was an eighth waterwork at Clichy, but that was removed on the construction of the main sewer. The Dhuys will bring an addition of 40,000,000 litres, at least, to those 172,000,000 litres, and the water drawn from St. Maur will produce exactly the same quantity, so that Paris is about to possess a supply of 252,000,000 litres of water for the daily use of the inhabitants. Should any necessity arise for it, recourse can be had to another supply from a spring which exists in the valleys of the Somme and the Sonde, in Champagne. It is not intended, as has been erroneously asserted, to bring water from the rivers Somme and Sonde to Paris, but only to draw it from the springs, which it is expected will produce 60,000,000 litres daily. These waters will be drawn from a distance of 150 miles, and will enter Paris by the quarries of Pantin, and be received in a reservoir to be constructed at the hills of St. Chaumont, above the circular railway.

APPLIED CHEMISTRY.

SCHULTZE'S WHITE GUNPOWDER.—This is tri-nitro-cellulose, prepared from sawdust by the following process. The sawdust is first boiled for three or four hours with a weak soda solution, and then boiled a second time with a fresh lot of the same solution. It is then washed in running water, afterwards steamed for fifteen minutes, and then again washed in running water for twenty-four hours. It is now bleached with chlorine or chloride of lime, boiled in water, once more washed in a stream, and now dried. The sawdust is now ready to be treated with nitric acid. For this purpose a mixture of forty parts strong nitric acid (1·48 to 1·50) are mixed with 100 parts of sulphuric acid (1·84); and the mixture is allowed to stand two hours to cool. One hundred parts of this mixture are then placed in an iron vessel, around which a stream of cold water circulates, and six parts of the sawdust are gradually added, stirring all the time. The sawdust is allowed to remain in the acid two or three hours, the stirring being continued. After this time the whole is transferred to a centrifugal machine, and the acid separated. The wood is then washed for two or three days in cold water, afterwards boiled in a weak soda solution, again well washed in cold water, and then dried. It is now ready for the final operation, which consists in soaking it for ten or fifteen minutes in a solution of 26 parts of nitrate of potash in 220 parts of water. After this, it is carefully dried at a temperature not exceeding 44° C.; the very fine dust is then separated by means of a drum sieve and the remainder is ready for market

LIST OF APPLICATIONS FOR LETTERS PATENT.

We have adopted a new arrangement of the Provisional Protections applied for by Inventors at the Great Seal Patent, Office. If any difficulty should arise with reference to the names, addresses, or titles given in the list, the requisite information will be furnished, free of expense, from the office, by addressing a letter, prepaid, to the Editor of "The Artizan."

Dated September 23rd, 1865.

2442 J. H. Simpson—Locking and unlocking railway carriage doors
2443 M. Schaffuer—Obtaining sulphur from soda waste
2444 J. Player—Iron or steel
2445 J. Dreisorner—Hydraulic pressure engines
2446 R. W. Barnes—Ascertaining the state of tonnels and sewers
2447 W. Routledge and F. F. Ommanney—Presses worked by steam

Dated September 25th, 1865.

2448 W. Unwin—Iron
2449 J. W. Coburn—Waterproof soles for boots and shoes
2450 G. F. Smeeton—Wringing clothes
2451 E. Brooke—Ventilation of sewers
2452 A. Prince—Breech-loading fire-arms
2453 W. E. Newton—Engine for pumping
2454 A. V. Newton—Presses for hay

Dated September 25th, 1865.

2455 R. T. N. Howley—Securing tubes in tube plates
2456 N. Korshunoff—Steel
2457 C. Parigot and A. Grivel—Safes
2458 J. S. Staines—Submarine lamps
2459 J. Hargreaves—Sanitary coffins
2460 W. Ambler—Knickerbockers
2461 T. F. Cashin and J. F. Allender—Iron
2462 W. H. Brown—Springs to resist concussion
2463 C. M. Kernot and N. Symons—Construction of railway plant
2464 R. A. Brooman—Moulding crucibles
2465 A. V. Newton—Decarbonising retorts
2466 W. E. Newton—Fire-arms
2467 J. Hillar—Preventing down draught in flues
2468 G. T. Bousfield—Paper files
2469 G. T. Bousfield—Preparing peat
2470 A. Farr—Receptacle for tooth powder

Dated September 27th, 1865.

2471 J. Taylor—Washing machines
2472 G. Everleigh—Vegetable fibrous substances
2473 L. H. Gillet—Preserving food
2474 A. Moore—Signalling on railways
2475 J. Broun—Cartridges
2476 W. Tatham—Spinning cotton
2477 W. Morgans—Charcoal ovens
2478 R. A. Brooman—Washing machines
2479 J. R. Arnoldi—Steam engines
2480 J. Boffey and C. W. Smith—Coating metollic surfaces
2481 J. J. McComb—Paddle wheel
2482 C. H. L. Wintzner—Separating phosphoruss from iron
2483 R. Reece—Applying sulphurous acid
2484 C. Price—Locks and latches

Dated September 28th, 1865.

2485 B. Wren—Grinding grain
2486 M. Nopitsch—Pencil cases having a movable lead
2487 J. Maublanc—Lamps for burning potroleum
2488 W. E. Metford—Rifling fire-arms
2489 A. Rigg—Pumps
2490 A. M. Bennett—Ascertaining specific gravities
2491 E. T. Hughes—Tighening chucks for drilling machines
2492 C. E. Davis—Chambers for the steeping of grain
2493 D. Spink—Propelling ships
2494 I. Smith and W. F. Batho—Evaporating and cooling liquids
2495 S. Donn—Coffins
2496 W. E. Newton—Shoeing horses
2497 C. Giuliano—Chains
2498 R. A. Brooman—Sewing machines
2499 E. Cottam—Fittings for stables

Dated September 29th, 1865.

2500 J. H. Pinckvoss—Casks
2501 W. Schofield and J. Smith—Washing fibrous materials
2502 W. E. Gedge—Steam engines
2503 C. F. Cotterill—Connections for and in stopping pipes used for conveying water
2504 G. Davies—Reclining chair
2505 J. Duke—Cement
2506 J. de Weweirne and A. Verschaffelt—Dyeing
2507 J. Addenbrooke G. Addenbrooke, and P. A. Millward—Collecting or drawing off the gases from blast furnaces
2508 G. Gillett—Impressing designs upon biscuits made by machinery
2509 J. A. Mee—Telegraphic cables

Dated September 30th, 1865.

2510 J. W. Hurst—Life rafts
2511 J. E. Townshend—Ventilating spring mattress
2512 E. Linder—Breech-loading guns
2513 A. Hill—Candlesticks
2514 R. Wallacy—Supplying food for cattle
2515 J. H. Johnson—Lighting and heating suitable for sick rooms
2516 J. W. M. Miller—Preparing skins
2517 W. E. Newton—Feeding fibrous substances
2518 S. Faulkner—Grinding cards
2519 W. Longbottom—Weft winding machines

Dated October 2nd, 1865.

2520 T. Willisms—Lessening the momentam of heavy bodies
2521 T. Allan—Preparing metals for electroplating
2522 J. W. Tyler—Fixing sheet metal for roofing
2523 C. D. Abel—New fabric for making paper pasteboard
2524 D. Greig and R. Burton—Travelling cranes
2525 P. Jenner—Fastenings
2526 H. G. James—Railway signals
2527 S. C. Salisbury—Producing and combining gases for heating purposes
2528 S. C. Salisbury—Blast furnaces

Dated October 3rd, 1865.

2529 H. A. Bonneville—Steel cylinders for boilers
2530 H. A. Bonneville—Submarine cables
2531 C. P. Button—Revolving cover
2532 W. R. Lake—Sewing machines
2533 C. Walker and W. Preston—Carding wool and other fibrous substances
2534 C. J. Tinker—Manufacture of lozenges
2535 R. A. Brooman—Decomposing and superheating liquids
2536 R. A. Brooman—Preparing red and violet colouring matters
2537 W. E. Newton—Pneumatic ways for the transmission of letters
2538 W. E. Newton—Spinning and twisting yarns or threads
2539 J. Heydon—Bench stops or abutments used in planing wood
2540 E. Farr, W. Tarr, and I. Gregory—Pianofortes

Dated October 4th, 1865.

2541 F. Tolhausen—Musical reed instruments
2542 J. Jones and F. J. Jones—Cartridges for breech-loading fire-arms
2543 J. Wadsworth, T. Hall, and S. Bonser—Looms for weaving
2544 A. Craig—Extracting oil from coal
2545 L. Hewitt—Lamps for burning paraffin
2546 E. W. de Rusett and R. F. Date—Ships' water-closets
2547 W. B. Stocks, J. Whitwham, & W. Blakey—Cutting the nap of pile fabrics
2548 J. Dodge—File-cutting machines
2549 J. J. Webster—Gas meters
2550 R. Tonge—Folding fabrics and inserting card board between the folds

Dated October 5th, 1865.

2551 M. Henry—Sewing machines
2552 H. Hughes—Shaping metal and other substances
2553 J. Millar and B. Burton—Breech-loading fire-arms
2554 J. C. Stovin—Cleaning cotton seeds
2555 W. R. Barker—Administering injections to the human body
2556 E. Marsland and P. Williams—Punching or perforating leather
2557 E. Marsland & P. Williams—Cleaning cotton
2558 R. Morson—Treating meat
2559 W. H. Phillips—Extinguishing fires
2560 H. A. Dufrene—Raising weights
2561 A. R. Shaw—Breaks for carriages and other vehicles
2562 B. Johnson—Pianofortes
2563 R. W. Fraser—Propelling and steering steamships

Dated October 6th, 1865.

2564 J. Holliday—Preparing certain colouring matters
2565 L. R. Whitehead—Date and other indicator
2566 C. Fitzgerald—Fasteners for doors
2567 R. A. Brooman—Rotary engines and pumps
2568 H. F. Smith—Waterproofing
2569 G. W. Rendel Gun carriages
2570 F. W. Gardiner—Laying telegraphic cables in deep waters
2571 V. J. B. Germaix—Bricks and other analogous materials
2572 L. A. I. Daumesnil—Mechanical propelling screw toy
2573 R. M. Cameron and D. Cameron—Pens used in writing
2574 W. Clark—Treating paper pulp
2575 W. A. Martin—Signalling
2576 W. D. Grimshaw—Capstans
2677 T. Machin—Wooden spills
2578 J. Cunninghsm—Fire-proof gates

Dated October 7th, 1865.

2579 C. O. Crosby—Ruffle or frills composed of strips of fabrics
2580 T. V. Lee—Candles from peat
2581 H. G. Craig—Carriages
2582 J. Roddy—Cleaning solution
2583 J. Priestly, W. Whitworth, and J. Sutcliffe—Grinding corn
2584 C. H. Mellor—Indicating danger
2585 H. A. Bonneville—Preparing skins for tanning and for currying
2586 J. Hancock—Railway signals
2587 J. Howard—Compound cylinder engines
2588 J. Kirby—Winding flax
2589 T. M. Gisborne—Cleansing the bottoms of ships vessels
2590 T. Campbell—Evaporating and distilling liquids
2591 W. Harris—Tanning hides
2592 J. B. Thompson—Coating iron and steel with gold
2593 J. Homan—Wrought iron girders
2594 J. Homan—Fireproof floors and ceilings

Dated October 9th, 1865.

2595 G. Voight—Stopping railway carriages
2596 P. Todd and J. Holding—Looms for weaving
2597 R. Walmsley—Mangling and callendering
2598 J. Robertson—Colour slide for artists' palettes and case
2599 T. Miles—Scent bottles
2600 W. E. Gedge—Obtaining motive power by expansion of air
2601 W. Clark—Propelling vessels

Dated October 10th, 1865.

2602 W. Cooke—Cure of smoky chimneys
2603 W. Cooke—Sanitary window fittings
2604 J. Sturgeon—Generating steam
2605 F. T. Hubert—Submarine cables
2606 J. A. Leon—Sugar
2607 G. G. Rich—Action of upright pianofortes
2608 W. E. Gedge—Billiard tables
2609 J. G. Woodward—Ventilating apparatus for use in steam boats
2610 J. H. Johnson—Steam generators
2611 M. Walker—Flyers used in doubling machines
2612 J. F. Wiles—Submarine telegraphy
2613 A. Nicholls—Rules for measuring
2614 R. Abell—Ventilating sewers
2615 J. J. Parkes—Railway station and other gas lamps
2616 D. Gallafent—Paraffine lamps

Dated October 11th, 1865.

2617 T. Worburton—Breaks for carts, and other vehicles
2618 F. P. Warren—Bolts
2619 J. Crutchett—Straps for harness for driving machinery
2620 J. Crutchett—Gas
2621 M. Henry—Railway carriages
2622 W. E. Gedge—Double or single action pumps
2623 T. Du Boulay—Carrioges propelled by manual power
2624 D. C. Pierce—Permanent way of railways
2625 W. Bull—Rendering wood for building noncombustible
2626 J. Liuton—Utilisation of town sewage
2627 V. A. Messinger and V. J. Messinger—Shirt collars

Dated October 18th, 1865.

2628 J. H. Selwyn—Cartridges for certain kinds of breech-loading fire-arms
2629 R. Loudon—Hurdles for fencing or dividing land
2630 A. A. Lerenard—Composition of india rubber
2631 J. B. Edge and E. Hird—Twisting or doubling cotton or other yarns
2632 J. U. Bastier—Raising liquids
2633 H. H. William—Sabots for projectiles
2634 W. C. Cambridge—Clod crushers and chain harrows
2635 G. Deslandes and A. Deslandes—Working windlasses
2636 W. Mather—Heating calendar bowls and other cylinders
2637 H. H. Craigie—Overflow for basins, sinks, and baths
2638 W. Barwick—Composition for coating or colouring walls
2639 W. E. Newtou—Centrifugal pumps

Dated October 13th, 1865.

2640 M. Cartwright—Elastic fronts, sides, and backs for boots and shoes
2641 G. Rosselet—Applying water as a motive power
2642 W. May—Construction and mode of fixing skates
2643 W. H. G. Jones—Crushing and washing gold quartz
2644 G. Marshall—Preparing casks to make them suitable for containing liquids
2645 H. H. Williams—Breech-loading fire-arms
2646 R. A. Brooman—Liquid compound for purifying water
2647 W. Robertson and J. G. Orchar—Finishing textile fabrics
2648 J. De W. Brinckerhoff—Preparing paper and the surfaces of other materials for photographic purposes
2649 G. B. Woodruff—Sewing machines
2650 W. E. Newton—Tompions for ordnauce and small arms

Dated October 14th, 1865.

2651 G. A. Ermen—Preparing cotton and other fibrous substances
2652 J. Tangye—Cutting screws
2653 W. J. C. MacMillan, J. Mason, and J. V. Scarborough—Preserving and keeping clean the bottoms of ships
2654 W. J. Artitage, F. Wooler, and J. Hodgson—Tyres for railway wheels
2655 J. L. Hancock—Apparatus for polishing and brushing
2656 J. L. Hancock—Couches and other articles for reclining on
2657 J. C. Ridley—Applying carbonic and other gases to metals in a molten state
2658 C. A. Elliott—Blinkers for horses and other animals
2659 R. Stephen—Improved harrow for use by contractors and builders

Dated October 16th, 1865.

2660 A. J. Mott—Production and uses of carbonic acid gas
2661 F. Wise, E. Field, and E. H. Aydon—Steam boilers
2662 W. Clark—Treatment of copper ores in the manufacture of copper
2663 C. H. Murray—Skips for raising ballast and other matters of bulk
2664 J. Orrin and T. Geer—Fastening for books and similar articles
2665 J. Rending, S. A. Reading, and F. F. Reading—Sleeve links
2666 J. B. Robertson—Sewing machines
2667 J. L. Hancock—Apparatus for separating ashes from cinders
2668 J. L. Hancock—Wheels for common road carriages
2669 H. Skinner—Working railway switches, points and signals
2670 R. E. Kaulbach—Establishing submarine telemarine communication between distant continents and islands
2681 T. McGrah—Securing the handles of knives and forks

Dated October 17th, 1865.

2672 E. Lord—Looms for weaving
2673 A. Fenton—Machinery for the manufacture of fish hooks
2674 C. G. Lenk—Process for purifying and preserving water
2675 R. A. Brooman—Hot air engines
2676 F. G. Sicardo—Making available as fuel all or part of the steam actually evolving from engines into the atmosphere
2677 A. H. Hassall—Preparation of meat for food
2678 G. Davies—Folding chair
2679 E. Beanes—Improvement in treating animal charcoal
2680 R. Burley—Chucks for turning lathes
2681 H. E. Newton—Weaving the covering of blind-cord
2682 W. Beardmore—Furnaces
2683 I. Gregory, E. Farr, and W. Farr—Pianofortes and organs

Dated October 18th, 1865.

2684 T. H. P. Dennis—Greenhouses
2685 W. Schofield and J. Smith—Hanging fabrics in chambers
2686 W. Schofield and J. Smith—Rollers for washing yarns and other fabrics
2687 J. Rock—Common road carriages, and in breaks for the same
2688 T. Jones, E. K. Mason—Saddles
2689 C. H. Cope—Sifting cinders, slack, and other like purposes
2690 J. W. Truman and H. Lovi—Block matches, and in machinery for the same
2691 T. Catchpole—Weaving cocoa-nut, jute, and other fibre
2692 W. H. Parker—Mounting or hanging mill stones
2693 J. Taylor—Tiles for roofing
2694 T. King—Manufacture of chemical toys known as Pharaob's serpents

Dated October 19th, 1865.

2695 J. Penton—Forging and swaging steel and iron wheel tyres
2696 J. Everard—Rollers for roller blinds, and in roller blind furniture
2697 G. R. Ghiselin—Forming the mouths of boiler and other tubes
2698 T. Routledge, D. Bentley, and J. B. Jackson—Hydraulic presses
2699 J. Ballard—Window blinds
2700 T. Adams and G. J. Parson—Slide valves, pistons, and glands
2701 W. Clark—Impressing and dyeing fabrics and tissues
2702 W. Clark—Chromates of ammonia

Dated October 20th, 1865.

2703 A. L. McGavin—Desiccating the leaves and flowers of plants
2704 W. Johns—Double-acting safety stirrup-bar
2705 E. E. Middleton—Laying submarine telegraph cables or wires
2706 C. D. Abel—Rotary pumps
2707 F. Thompson—Gussets of leather satchels, bags, and purses
2708 S. R. Rowe—Wheels for carriages and other
2709 J. Needham & G. H. Needham—Breech-loading fire-arms
2710 R. Fell and D. Hammond—Regulating the supply of water.
2711 W. B. Haigh and W. Bissell—Moulding or cutting moulds
2712 J. White—Furnaces for heating the feed water for steam furnaces
2713 W. Sumner—Preparing, spinning, and winding cotton
2714 T. Cooke—Improvements in aneiroid barometers
2715 G. Mussell—Self-adjusting apparatus for railway signals
2716 M. L. J. Lavater and J. Kershaw—Covers applicable to drawing or printing rollers

Dated October 21st, 1865.

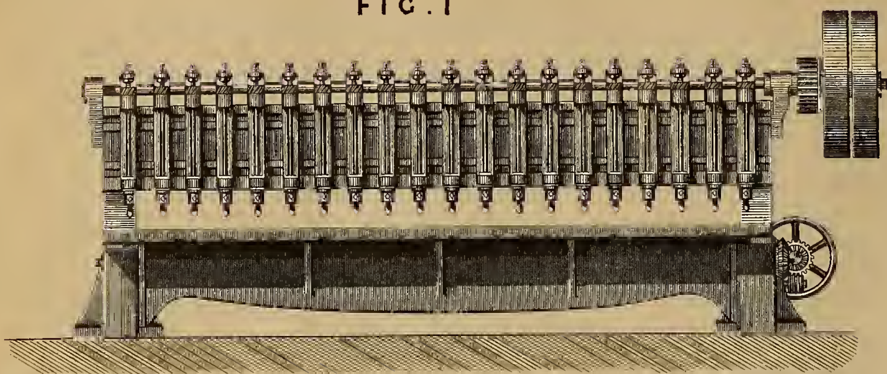
2717 R. Biessy—Apparatus for splitting and preparing cane
2718 T. Webb—Improvements in certain knitted fabrics
2719 I. Baggs—Inflammable gases, and in their application to useful purposes
2720 A. Bankart—Apparatus for calcining copper ore
2721 W. H. Kitchen—Apparatus for producing artificial respiration
2722 C. Boyd—Cotton press
2723 W. E. Gedge—Process for bending or arching wood
2724 J. D. Frazer—Railway chairs
2725 J. H. Dickson—Process of and machinery for preparing flax
2726 J. Wright—Utilising the liquors used in the manufacture of straw
2727 J. W. Lea—Apparatus to be fitted to windows when cleaning
2728 I. Roberts—Moulding clays and earths into bricks
2729 L. D. Girard—Obtaining sliding surfaces
2730 H. A. Dufrene—Lozenges
2731 W. Parsons—Mortising machines
2732 S. P. Matthews—Blind rollers
2733 A. Parkes—Telegraphic conductors

Dated October 23rd, 1865.

2734 H. Newman—Supporting window sashes
2735 J. Orris—Holders for holding knives
2736 M. Julien—Hydraulic transmission
2737 W. E. Gedge—Supplying oil to the journals of railway vehicles

Patent Multiple Drilling Machine.

FIG. 1



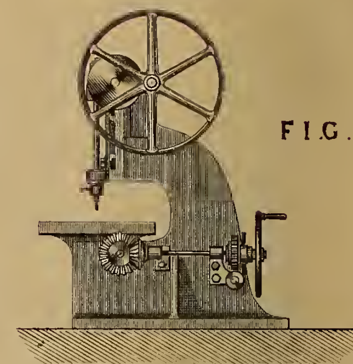
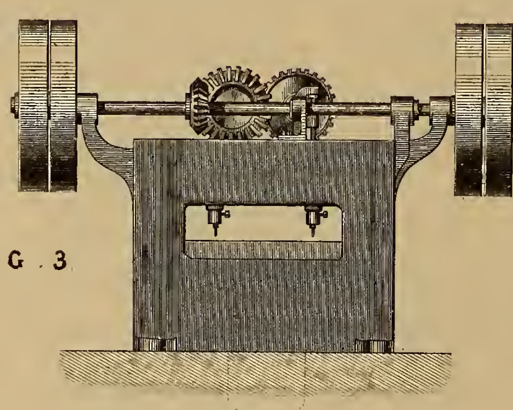


FIG. 2

Scale to Figs 1 & 2

FIG. 3



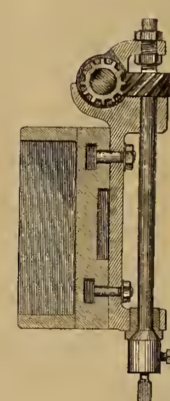
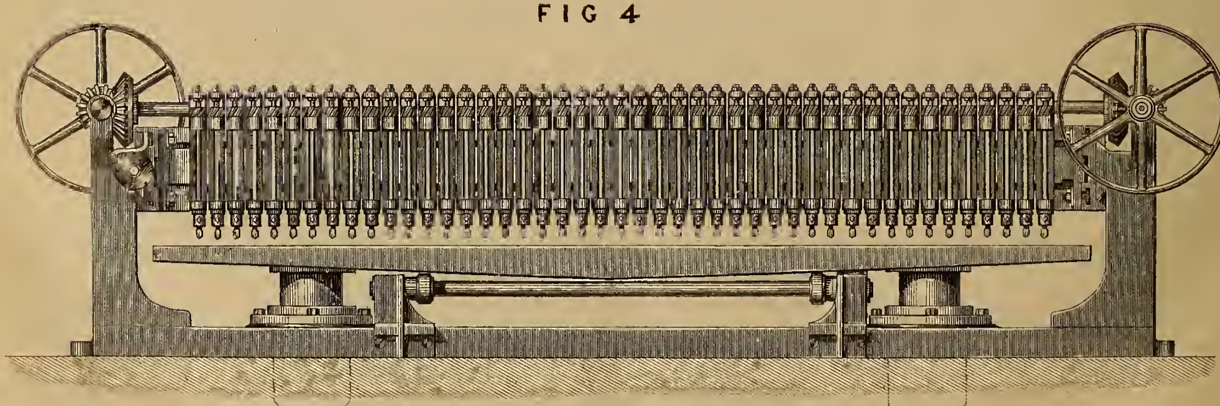


FIG. 5

FIG 4



Scale to Figs 3 & 4

W. Smith C.E. direx.

THE ARTIZAN.

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DECEMBER 1st, 1865.

WORKSHOP MACHINERY.

Patent Multiple Drilling Machine.

(*Illustrated by Plate* 290.)

In continuation of our articles on workshop machinery, we now proceed to give a description, illustrated by Plate 290, of Messrs. Collier and Co.'s patent multiple drilling machines.

Soon after the general introduction of wrought iron for such structures as bridges and girders, the defects of the system of punching the plates to receive the rivets, by which the various parts were to be united, became so apparent as to cause engineers and contractors to direct especial attention to the means of obviating them. Drilling by the ordinary method would be too tedious; hence, if drilling were to be resorted to, some improved adaptation of machinery would become necessary. In the manufacture of the Charing Cross bridge, such machinery was employed by Messrs. Cochrane, who used a frame carrying 80 drills, and driven by a ten horse-power steam engine, to perforate the plates which formed the flanges of the main girders. It has since been found desirable to make the principle involved in the construction of machines of this class more universal in its application, which is accomplished in the multiple drilling machine which we now illustrate.

As shown in the figures 3, 4, and 5, in the accompanying Plate 290, the machine is carried on a strong base plate running the entire length of the machine, which is about 18ft.; in this base plate are circular openings, placed at intervals along the centre line of the machine to receive the cylinders of the hydraulic presses, by which which the table is raised and pressed against the drills. Upon this table the plates to be drilled are carried, the requisite pressure against the drills being obtained by the upward action of the hydraulic presses. End frames are bolted to the base plate, to which are attached guides adjusted to the corners of the table, in order to ensure its correct vertical movement. Upon the end frames are fixed girders, which carry the drill frames; the ends of these girders are fitted in planed grooves, and they are made in halves in order to admit of their being set wider apart, without altering the gearing; they can also be turned with the drill frames inward, if desired, so that rows of holes can be drilled 4in. apart and upwards.

Each drill is held in a separate frame, bolted on the horizontal girders by means of bolts, the heads of which are in a T groove; a slight recess is planed in the girders, in which a corresponding projection of the drill frame fits, thus the drill frames are all held at the same height. To the top of each drill spindle is fitted a pair of inclined plane wheels. These wheels may be described as each consisting of a short section of a 3¼in. diameter twelve threaded screw, of which the threads are about 12in. pitch. A long steel shaft, 2¼in. in diameter, having a groove throughout its length, passes through each drill frame and its vertical wheel, giving motion to all the drills. A pair of strong bevel wheels communicate motion to the shaft from the pulley shaft which is driven with pulleys 3ft. 6in. in diameter, with a velocity of about ninety revolutions per minute; the bevel wheels reduce this velocity in the ratio of one to one and a half. A strong parallel motion gear is fixed under the working table to prevent it from lifting at one end more than the other, when the pressure upon it is unequal. Each drill spindle is fitted with an adjustable tail-pin and lock-nut, which receives the upper pressure on the drill spindle, the lower end resting in a conical bearing.

Figs. 1 and 2 represent a form of multiple drilling machine, furnished with only one row of drills, as shown. The necessary "feed" is given by raising the table upon which the work is fixed, by means of the hand gear shown, attached to the vertical standard at the end of the base plate.

The drills are all turned parallel for a short distance at the ends, and fit in parallel sockets, so as to admit of short drills being adjusted to the same length as others; each drill is fastened by a set screw. A pair of 1¼in. pumps, worked by eccentrics on a shaft, throw water into an accumulator of the ordinary form, but fitted with self-acting apparatus to throw the pumps out of gear; when full, the hydraulic presses communicate with the accumulator by a two-way cock. The working pressure is about 3 cwt. per square inch, producing a pressure of about 6 cwt. per drill. The chief novelty in this machine consists in the inclined plane wheels, which allow the drills to be conveniently shifted about, so that they may be adjusted to drill rivet holes of various pitches.

THE GAS EXPLOSION AT NINE ELMS.

It has long been received as an axiom by gas engineers that a gas-holder cannot explode, and in accordance with that belief, numerous arguments have been promulgated to account for the disastrous calamity at Nine Elms, without the necessity of acknowledging that the explosion was really and primarily in the gasholder which was blown to pieces.

The facts of the case appear to be as follows:—Gasholder No. 1,—150 feet in diameter, and 60 feet in height was exploded, and some fragment projected by the shock penetrated gasholder No. 2, and the escaping gas from that holder took fire. Each of the gasholders being at the time of the accident charged with about 1,000,000 cubic feet of gas. The retort houses wherein is made the gas supplied to these holders, consist of three buildings 60 feet wide, and 194 feet in length, containing 480 retorts, and being capable of generating in the aggregate about 4,300,000 cubic feet of gas per diem. The meter and governor house containing also various offices and testing rooms was entirely demolished, notwithstanding that it was a very substantial building, but the meter although much damaged remained standing.

Upon the visit of the directors and some of the shareholders to the calamity, the opinion put forward as to the cause of the disaster, was that an explosion first occurred in the meter house, the force of which burst the side of gasholder No. 1., igniting its contents, the flames from which, then burst through the top of the gasholder.

We are of opinion that this is utterly inaccurate, and believe that a very brief consideration of the facts which were evident at the time of the accident, and of the condition of the *débris* afterwards, will prove that the explanation thus given of the matter assumes the existence of a state of affairs almost impossible, and in fact, it is difficult to conceive what can have prompted such a view of the case, except the foregone conclusion that a gasholder cannot be exploded under circumstances capable of occurring in ordinary practice.

Let us in the first place show why it is highly improbable that the explosion could have occurred as stated above.

If the explosion had originated, as is suggested, in the meter house, it must have destroyed the meter itself, since its violence was so great that the shock produced by it was felt across the river in Pimlico. In the next place, the mere burning of the gas in No. 1 gasholder could not have blown out the roof, leaving the structure in the condition in which it was afterwards found, for it would have burned quietly away at the orifices already made in the side of the gasholder. That this would be the actual effect is shown by the burning of the gas in holder No. 2.

We will now examine the theory that gasholders cannot explode, and see upon what it is based, and how far it may he modified by the practical conditions under which gas is generated and stored.

Hydrogen gas, and also carburetted hydrogen, is not capable of producing an explosion under any circumstances when pure, that is to say, when unmixed with any considerable amount of some other gas, such as oxygen, capable of readily combining with it. The difference between quiet combustion of the gas and its violent explosion may be thus stated: in the former case, the combustible gas and that which supports its combustion are not mixed together, but merely come into contact at some particular point or points, and, on the application of fire at that junction, ignition ensues over the plane of contact, and proceeds quietly so long as the supply of the two gases is continued. The resulting products will be carbonic acid gas and steam; of course, with ordinary coal gas, other products will also be generated, such as sulphurous acid gas, &c., in small quantities, but, for our present purpose, it is not necessary to take those into consideration. When two bodies of the gases have become thoroughly intermixed in about the combining proportions, if a light be then applied to them, instantaneous combination throughout the mass will take place, great heat being thus generated, causing an enormous temporary expansion of the resulting gaseous products, and producing an explosion of a very violent character.

If it be assumed that the gas in No. 1 holder was not mixed with atmospheric air, then the flames could not pass to its interior, and blow out the roof, as was suggested, for there would be no oxygen to support combustion, except at the fracture, and, therefore, at that point only could ignition continue.

It is, however, certain from the effects produced that there was an explosion of gas, and that a very violent one, and, moreover, it must have occurred *within* the gasholder, for otherwise the crown plates would not have been blown *outward*. This at once upsets the cherished maxim that gasholders cannot by any possibility blow up, for, unfortunately for those who have been wont therewith to comfort such as reside near large gasworks, and perhaps themselves, this is not one of those cases where "the exception proves the rule."

It now remains to ascertain how air could have been introduced into gasholder No. 1, for it is clear that it must have been there, otherwise the calamity would not have occurred. In the retorts, gas is generated from coal by the action of external heat; this, after depositing by condensation its accompanying tar, ammoniacal liquor, &c., in the hydraulic main condenser, scrubbers and other contrivances passes into the gasholders, and, in those cases where it does so merely by its own pressure, of course no air can pass through along with it, for should a leak occur in the retort, or any of the communications between it and the holder, gas will escape therefrom by reason of its pressure. But in extensive works it is found that the amount of pressure necessary to force the gas through the various vessels between the retorts and its point of distribution from the works is so great as to be injurious, and, therefore, the retorts are relieved from that pressure by pumping out the gas from them into the holders by means of an "exhauster," and it is to this apparatus that we feel inclined to attribute these gas explosions when they do occur. If a leak should occur on the suction side of the exhauster, and the supply of gas should fall short, a quantity of air would be drawn in and forced into the gasholder, and, being thus intermixed with the gas, would give rise to the explosive compound to which we have referred, after which, ignition would only be required to produce such an accident as that which lately shook the neighbourhoods of Vauxhall and Pimlico, and caused a disastrous sacrifice of life.

In conclusion, it appears to us that henceforth engineers must modify the axiom of the non-liability of gasholders to explosion, at least in those works where exhausters are in use.

HISTORICAL AND DESCRIPTIVE SKETCH OF THE MERSEY DOCKS AND HARBOUR.

By J. J. Birckel.

(*Illustrated by Plate* 291.)

We now bring this subject to a close by laying before our readers, in the accompanying plate (No. 291), illustrations of the landing stage which has been placed into the low water basin at Birkenhead, and also of the general features of the sheds, with a detail of their roofs, which have been erected upon the quays of the majority of these docks, to provide a temporary shelter for the goods which are being shipped or discharged, and in general to facilitate the despatch of business in its various forms and stages upon the dock quays.

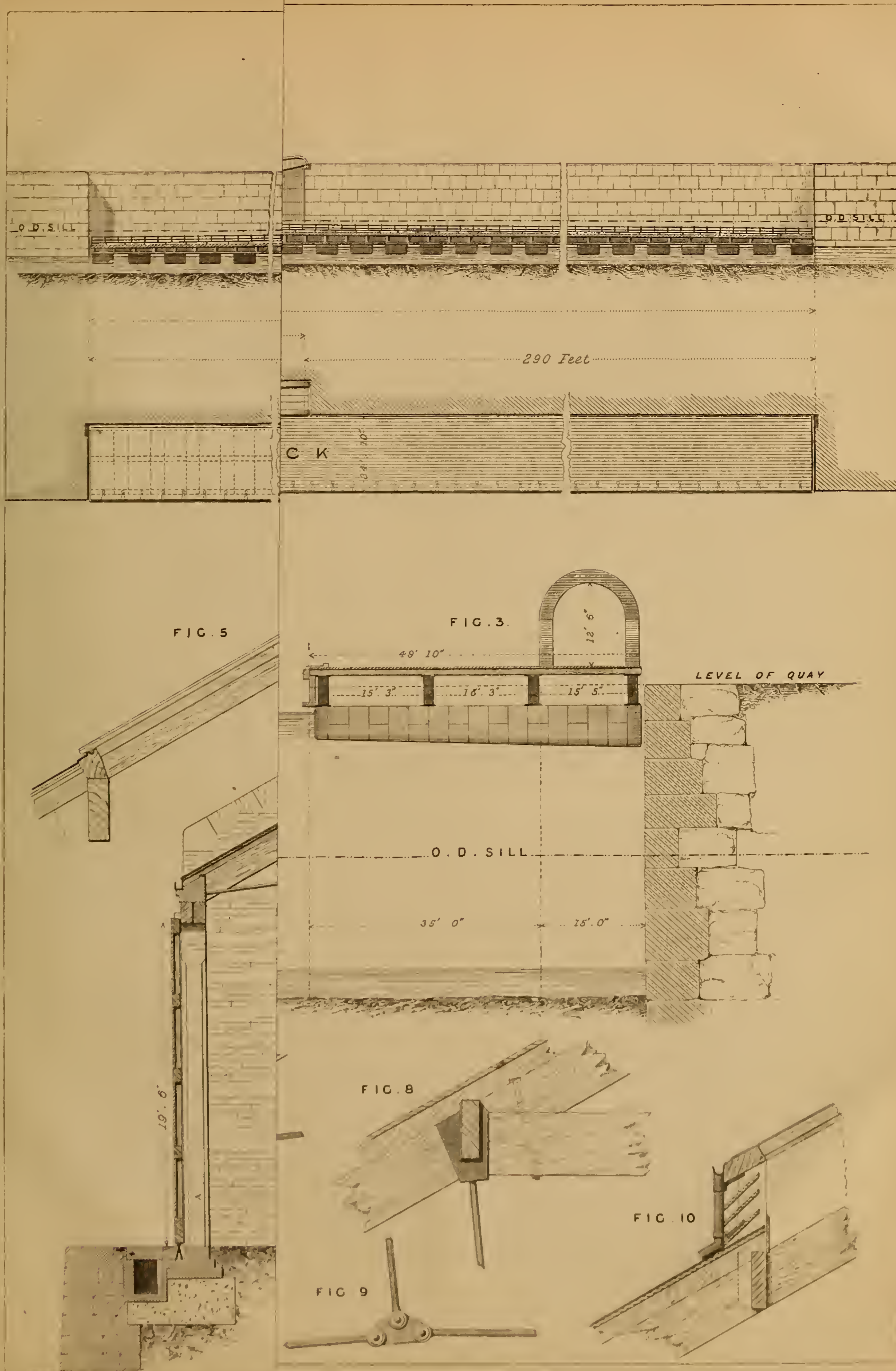
The landing stage which did not originally form part of the scheme of the low water basin, but which has superseded Mr. Rendel's inclined slip, may be said to be the practical or rather the tangible result of the parliamentary inquiry of 1856, and is in a great measure the embodiment of a suggestion offered by Messrs. Rendel and Cubitt, as a remedy to the very cogent objection raised by the opponents of the Birkenhead scheme, that in consequence of the continuous and great variation in the level of the water as compared with the level of the quays, owing to the tidal phenomena, the basin would be practically useless to shipping for the purposes of taking in or of discharging cargo; and had the basin not otherwise failed to give the accommodation, or to fulfil the expectations which the promoters of that scheme anticipated of it, there can be no doubt but that the introduction of the landing stage would have effectually met the objection raised.

At the period of the inquiry referred to, stages or floating wharfs of this description were, of course, no novel or untried structures to the engineer, for our readers will recollect that, in the number for February last, we have illustrated a similar stage, which was constructed from the designs of Mr. Cubitt, and floated off the George's pier head early in 1848; this suggestion, therefore, claims no other merit for Mr. Rendel than that he watched carefully all the objections which were raised against his scheme, and that he endeavoured to dispose of them to the best of his own intuitive abilities, or to the best of his knowledge, as gathered from established experience, and in the case under consideration not without success.

The stage now illustrated is 1,039ft. 6in. long, by 35ft. wide, over a length of 370ft. at each end, the central portion of about 300ft. being 50ft. wide. It is supported upon sixty-five wrought iron pontoons, forty-six of which (that is, twenty-three at each end), are 33ft. 6in. long × 10ft. wide and 5ft. deep, the central ones being 48ft. 6in. long × 10ft. wide, with a depth of 5ft. at the outer edge of the stage, and of 6ft. at that contiguous to the wall, this extra depth of 1ft. being given for the purpose of obtaining the requisite extra displacement to balance the part weight of the bridges which rests upon the stage. The pontoons are maintained in their respective places relatively to each other by means of three longitudinal kelsons running over the entire length of the stage, and by a fourth kelson stretching over the extent of the long caissons only, or the wide portion of the stage; the outer kelson, that is the one farthest removed from the wall, is 4ft. 6in. deep, and the following ones are gradually increased in height to such extent as to give the deck a sufficient incline from the wall towards the outer edge, to allow the rain water or the spray to run off freely from the stage.

The kelsons and the pontoons are constructed in every respect like those of the Prince's landing stage illustrated in a previous number, with this exception only, that the pontoons have rounded bilges—in our opinion a useless cause of expense to the builder.

The stage proper consists of two layers of pine planking, the upper one 2in. thick, running transversely to the stage, and the lower one 4in. thick,



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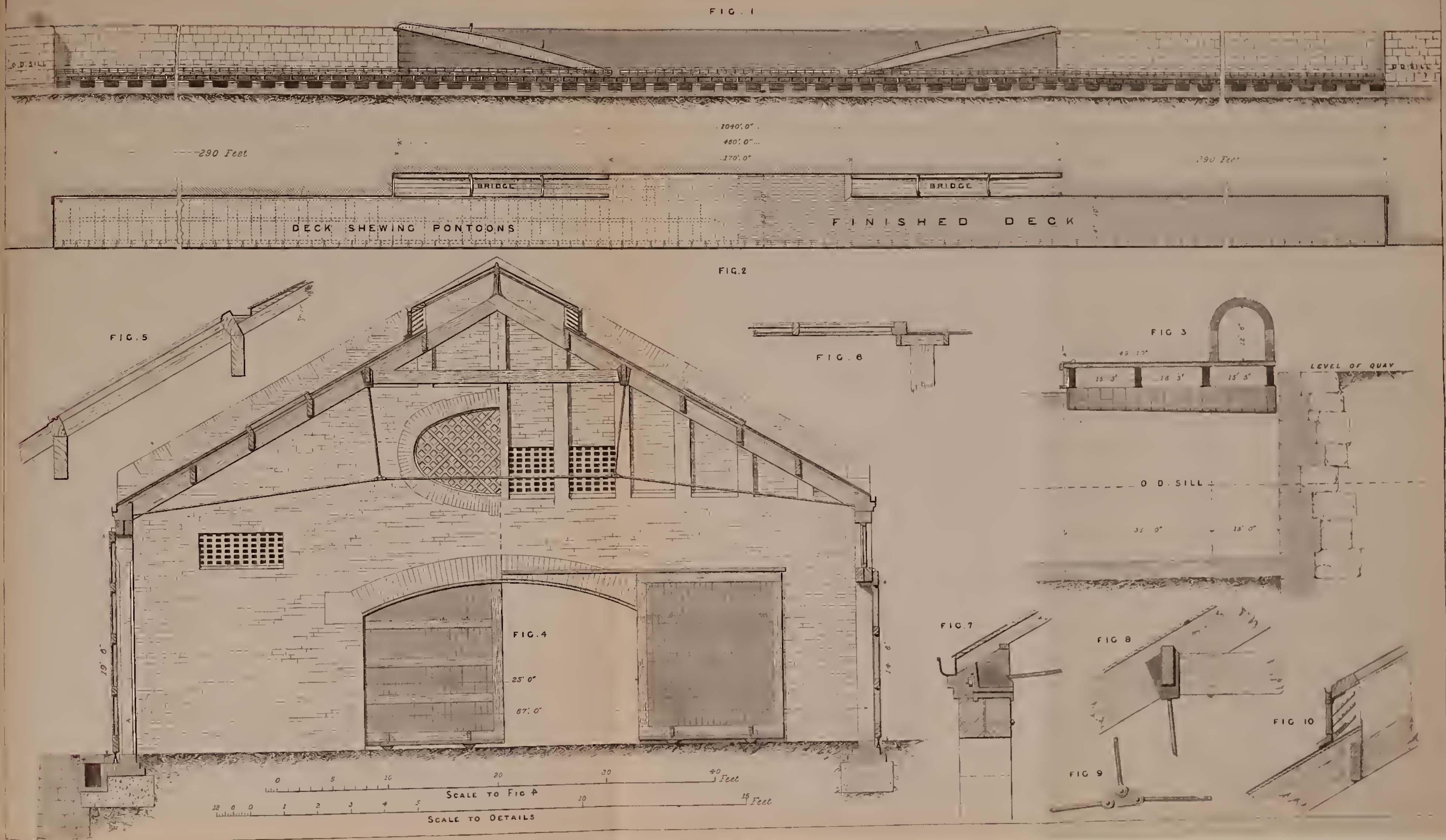
MERSEY DOCKS AND HARBOUR.



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running lengthwise, these being supported by a series of deck beams, 14in. × 12in., placed at intervals of 3ft.

The characteristic difference between this stage and those previously illustrated, resides in the fact that the bridges, instead of having their planes of vibration at right angles with the stage, have them in a direction parallel to the length of the stage, an ingenious device (however obvious it may seem), adopted by Mr. Hartley to meet the want of the particular locality in which it had to be erected of keeping the whole width of the basin clear of all permanent obstructions throughout its length. To that effect a recess has been built into the south wall of the basin, of just sufficient depth to receive the stage.

The bridges have a span of 150ft., like those of the George's stage, and, like them, consist chiefly of two hollow main girders, constructed on the cellular principle; their land fastenings are similar to those of the Prince's stage, but it will be seen that for very obvious reasons the ends which rest upon the stage are allowed freely to slide backward and forward as their horizontal length alters during the flux and reflux of the tide. We did so minutely detail the calculations of displacement and of the carrying capabilities of the stages which we have previously illustrated, that we shall not weary our readers with a repetition of the same process, but we shall simply state that this one displaces about 2,400 tons of water under its own weight, with an immersion of the pontoons of about 3ft., thus leaving 2ft. of the depth of the pontoons for immersion under external load; and as it is evident that the carrying capability of the stage is proportional to the available depth of immersion of the pontoons, it necessarily follows that it will take an external load of 1,600 tons, in order entirely to submerge them; this, for an area of about 41,000 square feet, gives an extreme carrying capability of about 1½ cwt. per square foot.

The transverse strength of the bridges, as in the case of those of the Prince's stage, is considerably greater than that of the bridges of the George's stage which, as will be remembered, were designed by Mr. Fairbairn, who in that instance was true to his maxim not to waste any material; but it was Mr. Hartley's invariable fault to err on the safe side, even to excess, in all his constructions, and as he had not to pay out of his own pocket for this great prudence, our readers will readily excuse him for it.

In other respects the stage is finished like the former ones, being provided with apron planking, rubbing beams and mooring posts, all which are arranged like those in the Prince's stage; at the ends it is provided with guide brackets which are made to fit into special recesses provided in the wall, and, moreover, after it had been put into its place, Mr. Lyster found it necessary to provide strong retaining brackets at its mid length, because it had such a great tendency to swing or bulge sideways that it would soon have wrenched the bridges from their fastenings without this safeguard.

The practical use of this stage up to this date may be said to have been *nil*, because the land adjoining, known as the North Reserve, which is in the possession of the railway company, has not yet been put into proper condition for the purposes of traffic, and if the Dock Board should succeed in getting the sanction of Parliament to convert the basin into an internal dock, as they intend to do, this structure will add another £35,000 at least to the large sum of money expended upon Mr. Rendel's scheme without the prospect, as it now seems, of any practical result. Should Parliament, however, insist upon the maintenance of the low water basin, which possibly might be kept open by dredging, to the great hindrance of traffic, though, it is difficult to conceive how the stage will escape taking the ground; for the dredger could never reach underneath it, nor has there been any provision made in the shape of cutwaters to remove the silt by scouring.

In the accompanying plate 291, fig. 1 shows a front elevation of the stage at low water, fig. 2 a plan, and fig. 3 a cross section at high water through the wide portion of the stage.

The sheds which were erected on the quays of the earlier docks—as, for instance, the George's, the Queen's, and one or two more—are of the simplest possible description, consisting merely of a roof, supported upon iron columns all round, which provides but a scanty shelter against the inclemencies of the weather, and offers no other protection of any kind to the goods or merchandise deposited there; and it devolved upon Mr. Hartley to stamp this portion of the engineering works of the Dock Estate with that mark of solidity and special usefulness or adaptation for the purposes of the traffic carried on alongside the docks, which, as we have seen already, is so characteristic of his handiwork. There is in these sheds no attempt whatever at artistic design, and perhaps there is some ground for regret that no touch of architectural beauty has been introduced to relieve the eye of their monotonous symmetry, especially when it is remembered that the moneys expended upon these works are not drawn from any individual purse, but are levied upon the trading community at large; but they offer an appearance of strength and durability such as must convince the blindest of mortals that Mr. Hartley had no sympathies whatever with the aspirations of the Latterday Saints, nor faith in Dr. Cumming's interpretations of prophecy, but that, on the contrary, he both wished and expected them to outlive many generations after him.

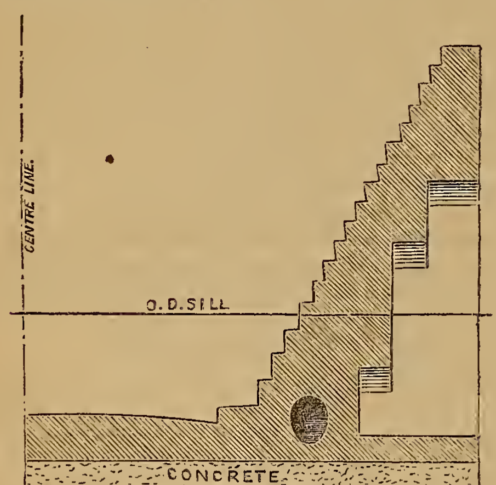
The walls are generally built with common brick, excepting here and there a corner exposed to frequent chafing by carts, which are built of granite up to a sufficient height for the purposes of safety, and their thickness is generally from two to two-and-a-half bricks; their footings rest upon a tolerably broad bed of concrete to give them a continuous monolythic bearing. As in the case of the dock walls, no portion of the mason's or bricklayer's work in the sheds is let out on contract, but the whole of it is made by the Dock Board's own men, under the superintendence of the dock engineer's own staff, and it must be said of their brickwork that it would be difficult to conceive of any better work, and we believe impossible to find any like it—indeed, perfection of workmanship is carried to such an extent, that on one occasion, being desirous to ascertain what amount of work of that description a man might do per day, we put that question to an intelligent looking set of bricklayers, who replied that they did not know; and upon our suggesting to them to take special note of it for our personal information, their emphatic rejoinder was, "Oh, sir, it would not be worth our while to do that, for when we leave here we shall never have to do any work like that again." On various occasions also we have noticed that it was almost as difficult to break into these walls, as into the solid rock; but this no doubt is to a great extent accounted for by the good quality of the mortar used in the construction of them.

The roofs with which these sheds are covered bear such marked individual characteristics that their design has received the local name of "the Hartleyroof," and they are especially remarkable for this, that they have been made to span a clear space of 80ft., we believe, with no other trussing but the collar beam and the two braces which bring back upon the rafters the vertical component strain due to the rise of the tie rod. Another peculiarity of these roofs is, that the principals are placed at distances of from 18ft. to 24ft. apart, necessitating the use of trussed purlins, and although the general practice of placing the principals considerably closer in roofs of ordinary spans seems to point to the conclusion that Mr. Hartley's practice leads to greater expense, yet are we inclined to think that his long experience had taught him quite the reverse, at any rate in the case of roofs of large spans, such as those which he had to construct. The purlins, instead of resting upon the rafters, are hung on to them by means of T headed bolts let into the ends of the purlins, and hung by their nuts into a saddle which rests upon the rafters; the junction of the collar beam with the rafters is made by means of cast iron shoes into which they are both made to engage. The upper portion of the principal, namely, that above the collar beam, may be considered as an independent small principal resting upon the main one, and as it has to resist only the strains due to the portion of the load which it carries, the two part rafters of which it is composed may be considerably less than those of the main principal which have to resist the strains arising from their own immediate load and those thrown upon them by the upper rafters; the manner in which they are respectively proportioned leaves no room for doubt but that Mr. Hartley was thoroughly conversant with the theory of this system of trussing.*

The feet of the rafters rest in strong cast iron shoes fixed to the walls both by means of bolts and by being let into the stone upon which they are bedded, (a practice which we should not recommend), and the tie rod as well as the braces are made of round iron. A continuous covering of ⅞in. boarding is placed upon the laths, and upon this the slate is finally fixed; the roofs are provided with ventilators and skylights, and the rain water is received by moderate-sized eaves gutters, and discharged through square down spouts sunk into recesses specially provided in the walls.

In our plate illustration fig. 4 is a cross section of one of the sheds, showing also the general design of the gates with which they are usually fitted, in such numbers as may be deemed necessary for the special purposes to which the shed is to be devoted; it may be observed that the gates which are made of heavy timber work are not hung upon hinges, but rest upon cast iron rails, upon which they are made to roll for the purpose of opening or closing them. Figs. 5, 6, 7, and 8 are details to enlarged scale of portions of one of the principals; and figs. 9 and 10 show detailed sections through one of the skylights.

The roof here illustrated has a clear span of 65ft. 6in., and the dimensions of the main parts are as follows:—Rafters, 16in. × 9in. at the foot, tapering down to 15in. × 9in. collar beam, 15in. × 9in.; tie rod and braces, 2in. diameter; the purlins are placed at horizontal distances of about 6ft., and their scantling is 15in. × 5in.



In the accompanying woodcut we have also given a cross section of one of the 50ft. graving docks, which may be considered a fair type of graving dock construction upon these works; the length of these docks varies from about 100ft. to 250ft., but for a detailed statement of these particulars, we refer our readers to the article published in the number of THE ARTIZAN for October, 1864.

Before dismissing the subject, we wish publicly to record our thanks to those gentlemen who have favoured us with their assistance by furnishing us with maps, drawings, and other necessary information for the compilation of this work; and among them we should mention our friend Dr. Wm. Fairbairn, of Manchester, Mr. Joseph Boult, Mr. J. Vernon, Messrs. B. Hick and Sons, Mr. Francis Giles, C.E., of London, Mr. Graham H. Hill, Assistant Marine Surveyor, and Mr. Fereday Smith, of Manchester, Secretary to the Bridgewater trust.

* For an investigation of the strains on the various component parts of roofs, we refer our readers to the papers "On the Construction of Iron Roofs," published in THE ARTIZAN of August, September, and October, 1862.

ON THE DETAILS OF WATERWORKS.

(*Continued from page* 226.)

Having considered the construction of collecting reservoirs, let us now pass on to the mode of distributing the water from them, either into filter beds or conduits leading to the places of consumption.

The first point which requires our attention is how to obtain the greatest economy of fuel without expending more capital than is necessary, and in each individual case it will be necessary to compare the advantage gained by increased economy with the loss due to increased cost.

In the mere point of raising so much water for so much coals consumed, the Cornish engine has always stood pre-eminent, but at the same time it is enormously expensive in prime cost, more especially the older forms introduced in London, though of late years much has been done by some engineers, amongst whom we may particularly mention Mr. Morris, of the Kent Waterworks, to simplify them, and at the same time obtain the greatest amount of work out of them for the fuel consumed.

The Cornish engine, doubtless, owes a great proportion of its superiority to the ease with which it works, and its comparative freedom from vibrations, such as must occur in rotative engines, where the motion of the machinery and of the column of water is reversed instantaneously; for be it remembered, that in the Cornish engine each stroke is complete in itself—there is no momentum at either commencement or end of either stroke, both the machinery and the column of water being at rest, and that for a sufficient time to allow the valves to close quietly, by falling *through* the water, and not *with* it; when the latter action takes place, not only is a great blow (destructive in the case of heavy valves) produced, but a portion of the water which has been raised is also lost, by passing through the suction valve as it closes.

Of course the valves must be of such a form that they will close expeditiously, otherwise they may remain open, or partly open, until the return stroke is commenced, and then the evils just referred to will occur. Formerly it was attempted to obviate these disadvantages by admitting air under the valves; but then the loss of water was enormous, amounting often to as much as ten or twelve per cent. of the total quantity raised; but now, by means of valves of various forms, which we shall presently define, this inconvenience is avoided.

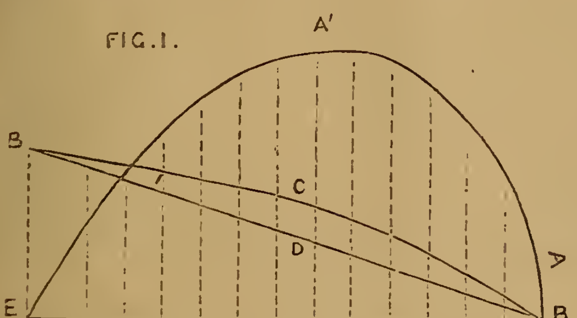
Single-acting pumping engines are of two classe, *i.e.*, those which raise the water during the indoor or steam stroke, and those which raise the water during the outdoor or preponderating weight stroke, for the steam in the latter case raises a weight which, in falling, forces the water wherever it may be required; but the steam stroke in this case certainly raises the water from the pump well into the pump barrel, though the work thus absorbed is usually insignificant in comparison with that required to expel the water from the pump; and, indeed, in some cases the pump is *below* the level of the water in the pump well, in which case the water will flow in, and, in fact, assist in raising the preponderating weight.

Now let us see to what we may attribute the superior working of the second class of engines, viz., those with which the water is raised by the preponderating weight. At the commencement of the stroke the weight is at rest, but the steam pressure on the piston is much greater than what would be required merely to balance this weight; hence it rises with a certain (at first increasing) velocity, corresponding to so much accumulated work. After the supply of steam to the cylinder has been cut off, the pressure of that remaining gradually decreases, sinking below what would be only equivalent to the preponderating weight, and at this period of the stroke the deficiency is made up by the momentum or accumulate work in that weight, by virtue of which the stroke is completed, and it wil then be found that the average resistance and average gross pressure for the whole stroke (excepting friction) have been eqnal.

When the out-door stroke commences, the preponderating weight is superior to the head of water upon which it is operating, but at the termination of the stroke inferior to it, for in the meantime it has descended a distance equal to the length of the stroke of the pump. Thus, for instance, suppose the stroke of the pump to be 10ft., and the height of the lift 100ft. from the bottom of the pump, then, at the commencement of the out-door stroke, the preponderating weight would be acting against a head of 90ft. of water, and at the end of the stroke against a head of 100ft. of water, the average pressure being during the stroke 95ft. of water, to which, with some addition for frictional and other useless resistances, the preponderating weight must be made equal.

On the accompanying fig. 1 are shown analytical curves exhibiting the action of the steam, velocity of the piston, and work absorbed throughout the indoor stroke. These curves have been calculated from a series of experiments made upon a Cornish engine, having a cylinder 34in. in diameter, with a maximum stroke of 8ft., and making about eleven strokes per minute.

FIG. 1.



The engine was not particularly economical in its action at the time of the experiments, as it did not hold its vacuum well, having been at work about nine years, and having made about 22,000,000 strokes in that time; however, the experiments were quite accurate in themselves, as showing the relation between the work done and that absorbed at each part of the stroke; the duty attained was about 48,000,000 foot pounds per 112lbs. of coals.

In fig. 1, the curve A A′ A is the velocity curve, showing the speed of the piston at each part of the stroke; during the experiments the stroke was evenly maintained at 6ft. 9in.; it is shown by the line B′ E, to a scale of $\frac{4}{10}$in. to a foot. The ordinates (some of which are shown by dotted lines) normal to B′ E, and terminated by the curve A A′ A, show the velocity of the piston at each part of the stroke to the scale of 1in. to a speed of 3ft. per second. The line B′ C B shows the amount of work done by the steam upon the piston at each part of the stroke, the total work done at any point being given by the length of the corresponding ordinate normal to B′ E, and terminated by the line B′ C B; these ordinates are drawn to a scale of 1in. to 120,000 foot pounds of work. The straight line B′ B B shows the work absorbed, its ordinates being to the same scale as those of B′ C B. It is a matter of observation that the two lines B′ C B, B′ D B, have coincident loci at B′ and B—starting from zero at B′, and having equal ordinates at B—showing that at the end of the stroke all the work done upon the piston has been absorbed, and the moving masses brought to a state of rest. In the intermediate positions, it will be observed that the total work done up to any given point is always in excess of that absorbed; this excess is stored in the moving masses as momentum or accumulated work up to the point A′, from whence it gradually is given off again, as shown by the increase of velocity up to that point, and its subsequent diminution, and also by the similar variation of the differences between the ordinates of B′ C B and B′ D B, which differences show the excess of work done over that absorbed at any point of the stroke.

Having thus shown the distribution of the work developed in the cylinder, or rather of that portion of it which is taken up by the preponderating weight, it is now necessary to speak of that lost in friction and working the pumps during the indoor stroke of the engine; and in this inquiry we shall take as the basis of our calculations the table of quantities, determined by Mr. Wicksteed in his experiments on the Cornish engine at the East London Waterworks.

The area of the piston of the Cornish engine, minus the area of the piston rod, is equal to 5,019 square inches; the water is raised 108ft. from the surface in the well; the stroke of the pump is 9ft., that of the piston 10ft.; the diameter of the pump plunger is 41in.; area, 9·168 square feet. The total useful effect will be 61,884 foot pounds for each stroke, which work would be done by a pressure averaging 11·09lbs. per square inch of piston. The preponderating weight amounts to 55,401lbs. pressure on the piston, which acts through a distance of 10ft., so that the work absorbed thus amounts to 554,010. Work absorbed by raising water into pump, 41,250; by cold water pump, 1,860; hot water pump, 60; air pump, 5,910; imperfect vacuum, 36,640; friction, 10,090. The sum of these quantities amounts to 649,820 foot pounds of work, being equal to about 12·94 pounds per square inch average pressure on piston. Thus far the absorption of all the work developed in the cylinder during the indoor stroke is accounted for, and of the accuracy of these experiments there can be no doubt; but it is to be observed that some of the calculations, resulting from them have been questioned; wherefore it is very desirable to closely examine the conditions under which they were performed in order to arrive at the truth of the matter. In table 7 of the "Experimental Inquiry," we are furnished with the details of the experiments, and from that we may probably deduce the information necessary to test the accuracy of the elements which, together, amount to the total work done as above stated. We have here the results of five experiments tried with different grades of expansion, with the view to prove the advantages of a high degree of expansion, but at present we shall not touch upon that point, but merely deal with the data which have reference to the steam pressure in the cylinder, in order to ascertain if the average has been rightly stated as 12·94lbs. per square inch; if not, the item friction will be found erroneous, being the only one that does not admit of calculation independently, and therefore being necessarily determined by deducting those qualities which can be calculated from the total amount of work done. A portion of the work taken up by the preponderating weight will also be absorbed as friction during the outdoor stroke, and as such it should be stated.

(To be continued.)

SUPPLY OF GAS TO THE CITY.

When the works at Soho first presented the brilliant appearance of a gas illumination, the originators of that mode of lighting can scarcely have anticipated the degree of importance to which in half a century or little more it would attain, not only as one of the most important and universally applicable inventions of this or any other age, but also as a commercial investment, yielding profits scarcely paralleled in any other class of permanent speculation.

From time to time improvements and modifications have been devised, and numerous materials proposed, for the manufacture of gas, but nevertheless the system of preparing it from coal only has not merely held its position, but steadily advanced, monopolizing practically the entire sphere open to this branch of industry. Up to the present time there can scarcely be found any other projects yielding such large interest upon capital as that derived from gas works, and doubtless they might have yet continued to pay dividends nearly as large, had not the cupidity of the gas companies actually driven the consumers to inquire closely into the matter, and learn whether they were being dealt fairly with or not. The fact of the profits on gas being limited by Act of Parliament would alone prove that there must be ample room for fair competition, but the directors of the City gas companies dreamed that they were secure, and even supplied very inferior gas, and this has been one of the gravest errors into which they have fallen. In places of business but little attention would be paid to a slight excess in charge for an article of consumption which, compared with other current expenses, is so unimportant as gas, and, besides this, business men would not, unless their attention were directed by professional advisers, inquire into the cost of making good gas; but when they are supplied with an article injurious alike to sight and to the general health, then perforce they must look into the matter, and the investigation once commenced, every detail connected with it will be examined.

It is absurd to suppose that the impurities of gas cannot be got rid of, at all events to a much greater extent than they now are; means of obtaining carburetted hydrogen, practically pure and of good illuminating power are known, but there is no encouragement for inventors, or rather there has been none recently. The gas companies will not adopt any improvement which may cost them even a trifling increase of expenses, or even temporally disturb their usual routine of working, although ultimately it might prove to their own advantage; opposition, they know, would prove almost certain failure, endeavouring, as it would have to, to stem the influence of the great gas monopoly; it is however remarkable, that for so long a time this monopoly should have tyrannised over the wealthiest and most important town in the kingdom, or probably in the whole world. However, now it seems to totter on its foundations, and unless some entire reform is organised and carried into execution by the directors of the metropolitan gas companies, we may hope to see this—one of the greatest monopolies ever organised—become extinct.

Not only do the gas companies refuse to avail themselves of scientific advice as to the improvement of the article they supply, but they further abuse the confidence of the consumers by their grasping policy in dealing with them; they are proverbially arbitrary and offensive, and utterly disregard public comfort and public interests. The conduct of the gas company in regard to the new street in Southwark is most notoriously disgraceful; the refusal to use the subways made for the reception of gas and waterpipes, in order to prevent the damage done by constantly tearing up the pavement, exhibits an amount of either blind obstinacy or crass ignorance difficult to be conceived. Much has been said of the paramount stupidity and pompous ignorance of parish vestries and local boards, but surely their *quasi* grandeur pales before the more obtrusive and injurious pertinacity exhibited by the directors of the gas companies in opposing both public and professional opinion, we even doubt if their judgment (?) equals that of the general type of county magistrates. Such questions as that of the subways become public; the ratepayers have made the subways to save the expense of frequently renewing the paving; surely they will not tamely bear the double expense. We may expect, and certainly hope, that next session the laying of water and gas pipes in the subways will be made compulsory, as in fact it should have been in the original act.

If such a course were practicable, and we cannot see that it may not be so, a very great advantage would certainly be derived from compelling the gas companies to supply an article not below some definite Parliamentary standard (to be ascertained) both in purity and illuminating power, but more especially in the former quality which so materially influences the health of the metropolis.

The Corporation of the City of London, at length weary of the inconveniences arising from the evils created by the disgraceful conduct of the gas companies, has passed a resolution to oppose them, and measures are being taken to prepare a bill for the next Parliamentary session to give them the powers requisite to enable them to supply the citizens with gas. This will, undoubtedly, be the signal for the commencement of one of the most vigorous Parliamentary contests ever witnessed, the parties to each side having the support of enormous wealth. Not only will the city gas companies have to be met, but they will be supported by the suburban companies, and very possible may receive the assistance of some of the water companies, which may be induced to fear that when the gas question is disposed of, they may become the subject of inquiry with a view to the cheapening of the supply to metropolitan consumers, as, indeed, would not be unlikely, judging from the dividends which some of them now pay: however, we are not now discussing that matter.

It is to be presumed that the Corporation will spare neither pains nor expense to bring to a successful issue that which it has so laudably taken up, and we cannot but believe that with due energy they must be victorious over the present system.

A thorough examination of the matter, such as may be expected before the Parliamentary Committees before whom the Bill must be contested, cannot fail to bring to light the gross evils which for the last few years have existed, and they are such as cannot be glossed over, but they must stand forth in all their deformity. They are facts of the most stubborn character, and of a nature which shows a determination on the part of the companies to do that which is wrong on the broad principle, not only inasmuch as they overcharge their customers, but also by injuring their bodily health unnecessarily, until they are actually forced by external pressure either to reform their mode of procedure or cease to exist. It is difficult after our past experience of them to predict which course they will select, whether they will be content to continue under fairer circumstances, or if their egotistical shortsightedness and absurdly conservative policy will lead them to pursue such a course that they will not bend though they may break.

In conclusion, we will observe that we consider the steps taken by the Corporation of the City as worthy of the highest commendation, and probably the only course which can produce the end which is so much to be desired, that is, that London shall be supplied at a moderate price with gas practically pure and free from ingredients deleterious to health, and of a good quality in regard to illuminating power.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

CONTINUED ACCOUNT OF PAPERS READ ON SATURDAY, SEPT. 9.

THE PHYSICAL AND GEOGRAPHICAL FEATURES OF THE COUNTRY TEN MILES ROUND DUDLEY.

The following is one of the papers taken as read. The subject is one of so much importance that we give the paper in full:—

The district the physical features of which I have undertaken to bring before your notice is, even at a cursory glance, perhaps, the most remarkable in England. Its immense industrial resources, its teeming population, and the consequent effect upon the atmosphere and surfaces of the ground, has given it the distinctive cognomen of the Black Country; and, under certain conditions of weather, few will be found to dispute the title. The district is divided by the range of hills known as the Backbone of England, and forming the water shed of the country. I have taken as a centre the town of Dudley, situated on the top of this range, at a mean height of 700ft. above the level of the sea, and one of the highest, if not the highest, town in England (for I am not aware of any higher), and have included a district of ten miles from that centre. The range of hills runs through the district nearly north and south, and divides it into two distinct drainage areas, the eastern side sending its waters to the Humber, and the western its waters to the Bristol Channel; its greatest height being at the southern extremity of the district at Bromsgrove Lickey, about 1,000ft. above the sea. I will first describe the eastern side of this district, the extreme northern section of which is divided from the rest by a range of high ground, commencing near Pattingham, a little west of Wrottesley Hall, at a height of 580ft. above the sea, running in an eastern direction to Tettenhall, Wolverhampton, Wednesfield, Essington, and Pelsall Wood, the general height of which ranges from 460ft. to 680ft. above the sea. The waters of this district run into the River Penk, a tributary of the Trent, taking the drainage of part of the town of Wolverhampton and a portion of the northern end of the coalfield; but its character is chiefly agricultural, well studded with timber. Wrottesley park is 540ft. above the sea, Codsall 570ft., Bushbury 550ft., and Essington 680ft. above the sea. The next section, that which drains directly into the River Tame, includes the greater part, indeed, nearly the whole of the thickly populated portion of the eastern side, being nearly covered with small towns, the environs intermingling with each other. It is bounded, on the north by the ridge of high ground already mentioned, from Wolverhampton to Essington, at the height of from 500 to 600ft. above the sea; and on the eastern by a continuation of the same ridge to Pelsall Wood Barr, and Erdington, at a mean height of 500ft. but rising at Barr Beacon to a height of 760ft. above the sea. Perry Wood being 490ft., and Erdington 440ft. On the west it is bounded by the water-shed range, at an average height of 700 to 800ft., rising from Wolverhampton at 530; to Goldthorn Hill, 610; Sedgley Beacon, 778; Sedgley, 750; Gornal, 750; Wren's Nest, Dudley, 800; Dudley Castle Hill, 750; Cawney Hill, Dudley, 840; summit of Birmingham Canal Tunnel, 800; Cox's Rough, the top of the Basaltic Quarry, 870; Downing's Hill, the highest of the Rowley range, 892; to Rowley village and Quinton Hill, 735ft.

I may here state that the whole of these heights have been taken from my own observations, and are, I believe, a close approximation to the truth. On the south it is bounded by the high ground from Frankley Hill to Warley Abbey and the Lightwoods, West Smithwick, through part of West Bromwich, to Sandwell Park, at a height ranging from 520 to 750ft. above the sea; Warley Abbey, 750; Lightwoods, 600; Londonderry, 600; West Smethwick, 520;

Sandwell park, 570; and thence due south to the east side of Birmingham, the high ground gradually falling, till it terminates at the junction of the valleys of the Tame and Rea, at a height of 300ft. above sea level. This last ridge of which I have spoken also runs northward through West Bromwich and Hill Top, beyond which it is cut through by the Tame, and appears again at Wednesbury and Darlaston. The district may better, for the purpose I have in view, be divided into two portions, viz., the basin of the Tame in which the several streams which ultimately form the river, take their rise terminating at Bescott Junction, and second, the Valley of the Tame, through which that river flows on its course till it receives the Rea. The basin contains numerous towns, it is in extent about sixty-four square miles, and contains a population of upwards of 240,000. The surface, for the most part, falls gradually from the high ground to the stream, with the exception of the Rowley Range, which, being much higher than the others, falls precipitately for 200 or 300ft., and then gradually making the centre tolerably level. Oldbury being 500ft., Tipton 460ft., Bilston 450, Willenham 450ft., Walsall 400ft., Coseley 500ft., Darlaston 480ft. Wednesbury 500ft., Hill Top 510ft. and West Bromwich 510ft., above the sea, the surface of the ground through the whole of this basin is much broken and disturbed by mining operations, raised in some places by considerable pit mounds and furnace cinder banks, and in some others sinking some feet below the natural water courses, and causing whole fields to be covered with water, called, in the language of the district, "swags." Houses and buildings have their foundations sapped and disturbed, and are rendered thereby in some instances quite uninhabitable, and the canals which intersect the district in numerous directions are allowed to become open cesspools, receiving a great portion of the filth and sewage of the locality where they pass. The normal condition therefore of these towns has been, generally speaking, as bad in a sanitary point of view as it was possible to be; and whenever cholera or other epidemics have visited this country, they have been most disastrously felt in these places.

The passing of the Public Health Act, 1848, induced many of these towns to place themselves under its provisions, and Local Boards of Health were established; but at present no great alteration in the condition of the country has been effected by these bodies. Nuisances are quicker removed, the towns are better lighted and scavengered, but though, in many instances, surveys and levels were taken for the purposes of sewerage, with one exception hardly anything has been done in that direction, and where sewers have been put in they still discharge their contents into the streams or canals, and I have seen an instance of a sewer being put in, under the direction of a Local Board, the invert being dry brickwork, without either cement or mortar, for four or five courses up each side, and discharging its contents into a canal. The necessity of ventilation to sewers is also generally overlooked. The great cause of the reluctance of Boards to proceed with sewerage has been the difficulty of dealing with the sewage at the outfalls. The late Select Committee of the House of Commons upon this subject have concluded that the only really profitable mode of dealing with sewage is its application, by irrigation, to land, but in the vicinity of these individual towns no land under cultivation can be found suitable or sufficiently removed from habitations, and I fear the recent Act, which gives permissive powers to join with other districts, or to obtain land in adjacent districts for the purposes of outfalls, will hardly meet the case in this instance, for the district is very peculiar, and I much fear that until action on the part of Local Boards is made compulsory by legislative enactment our streams and canals will not be relieved from the filth which is now poured into them.

The second portion of this section is of a character quite different from the former. Being a strictly agricultural district, rising gradually from the banks of the river, on either side there are no villages for three or four miles, and it has most forcibly impressed me that here is to be found the real solution of the question: What is to be done with our sewage? As regards the district I have been considering, viz., that, as I have before stated, the whole of the natural drainage of the Tame Basin unites at Bescott Junction, to form the river which flows through this valley, so should our sewage which now when leaving the sewers flows sluggishly through open channels of irregular size and fall, leaving at the sides and in the swags mud and deposits, which under a summer's sun become a nucleus for generating malaria and fever, flow onward through a proper culvert, until in this valley it may, by a proper application to the land, be productive of real benefit instead of a positive evil. The rateable value of the district interested getting rid of this sewage is so great, being in round numbers about £500,000, that the expense, if incurred by the united action of the several Boards interested, would not be felt by the ratepayers in any appreciable degree; indeed, a rate of 1s. in the pound would produce more than sufficient, and, if thrown over a series of years, a rate of one halfpenny in the pound per annum on the average would suffice to accomplish this very desirable result.

The next section is the drainage of the river Rea, which, rising on the eastern side of the Frankley Hills, runs through Birmingham, and joins the Tame on the eastern side of the town at a height of 2[illegible]ft. above sea level. The town of Birmingham ranges from 300ft. to 500ft. above the sea, being at the Town Hall 450ft. It is not, however, my intention to enter into the sanitary state of this town, as you have already had so able a paper read to this section on that subject. The western side of this water-shed now only remains to be considered. The river Stour being the outlet for its waters on their route to join the Severn, it is in extent much the same as the eastern side, draining into the Tame; but the physical features are different. Instead of a gradual fall from the boundary ranges, to a central stream, the whole extent is broken up into a series of valleys, the fall being precipitate, the ground much more broken and irregular. On the north it is bounded by the before-mentioned ridge from Pattingham to Wolverhampton, at an average height of 550ft.; on the east, by the water-shed range before described; on the south, by the Clent range of hills, the highest in this district, running from Bromsgrove Lickey to Hagley, at an height ranging from 600ft. to upwards of 1,000ft. above the sea, the Lickey being nearly 1,000ft., Walton Hill, the highest of the Clent range, 1,0[illegible]ft., and Hagley about 600ft., and by a lower range running from Hagley to near Stewponey, at an average height of 400ft. above the sea, from which point it falls into the valley of the sea at Kinfare, the outlet of this section, at a height 150ft. only above the sea, giving a fall from Walton Hill of 900ft. in a distant of about six miles, and on the west it is bounded by a range of hills forming the water-shed between the Stour and the Severn, commencing at Kinver Edge at 600ft. above the sea, and extending due north by Euville wood, 710ft. with slight variation, to Pattingham, at 580ft. above the sea. This is the entire western drainage area, which may be divided into the northern section, comprising the district draining into the river Smestow and its tributaries, including the villages of Penn, Wombourne, Himley, and Swindon, ranging from Upper Penn, 610ft., to Swindon, 215ft. above the sea. This is chiefly of an agricultural character, with a sparse population, and has no particular characteristics of a sanitary nature to comment upon. The Smestow rises close to Wolverhampton, and passing Compton, Trysall, and Swindon, falls into the Stour near the Stewponey; and the southern, comprising the district draining into the Stour and its tributaries. The Stour rises in the Lickey Hills, passing circuitously Hales Owen, Cradley, the Lye, Stourbridge, Wordsley, Stourton, Stewponey, and Kinfare, and, after passing Kidderminster, ultimately delivers its waters into the Severn at Stourport.

The district known as the Mining District, west of Dudley, is about twenty-five square miles in extent, and includes part of the town of Dudley, Gornal, Pensnett, Kingswinford, Brierley Hill, Hales Owen, Cradley, The Lye, Stourbridge, and Wordsley, ranging from Wordsley 250ft. above the sea, to Dudley 700, and Gornal 750ft. above the sea, with a population of about 100,000. The surface, as before stated, is very uneven, and the towns are straggling and disconnected. It will consequently be at once perceived that as regards sewerage the western side of Dudley is far less favourably situated than the eastern, the numerous hills and valleys causing many of the towns and villages to have two or more natural outlets for their drainage; any combined system of sewerage, consequently, is more difficult and expensive. The sanitary condition, however, is very bad throughout the extent of this district; no sewerage whatever exists, and cellars half full of stagnant water, offal, and vegetable matter, in a state of decomposition, and houses inhabited which are really unfit for human habitations, are circumstances constantly to be met with, and the streams, and canals receive all the drainage which escapes from the surface of the ground, much remaining to saturate the ground and cause miasmatic exhalations. The remedy for these evils is to obtain an outfall, which shall not pollute the streams, and it seems to me to be a necessity that can only be provided for by further legal enactments.

CHEMICAL SOCIETY.

ON THE DECAY OF GUTTA-PERCHA AND CAOUTCHOUC.*

By PROF. WILLIAM ALLEN MILLER, M.D., F.R.S.

The inquiries to which this investigation has given rise have extended over many months, and have included a large number of analyses, but the results obtained may be stated in a small compass, as they are very definite. I have examined numerous samples of gutta-percha cables both injured and sound, which have been in use for several years, and I find in all cases that the deteriorated portions have undergone chemical change, and that change consists in a process of *oxidation*.

Whatever retards or prevents this oxidation, retards or prevents the decay of the gutta-percha, some of the specimens which I examined being as good as new, though they had been manufactured and used electrically for years; whilst others in a few months had become brittle, rotten, and unserviceable. As the general result of these inquiries, I find that whenever the gutta-percha has been completely submerged in water no injurious change has occurred, sea-water appearing to be eminently adapted to the preservation of the gutta-percha. On the other hand, alternate exposure to moisture and dryness, particularly if at the same time the sun's light has access, is rapidly destructive of the gutta-percha, rendering it brittle, friable, and resinous in aspect, and in chemical properties. A gradual absorption of oxygen takes place, and the gutta-percha slowly increases in weight, becoming at the same time proportionately soluble in alcohol, and in dilute solutions of the alkalies. In every instance, however, some portion of the gutta remained unchanged in composition.

My experiments have also been extended to the prolonged action of air, moisture, and light, upon india-rubber, and here also I find that these agents effect analogous changes, though somewhat less rapidly.

The caoutchouc, however, instead of becoming brittle, is converted into a glutinous mass, losing its elasticity, increasing in weight to a certain extent, and becoming partially soluble in alcohol and diluted alkaline liquids.

These deductions are made from the examination of a number of samples supplied to me partly by Captain Galton and Mr. L. Clark, including specimens of coated telegraphic wires suspended in air, specimens of submarine cables specimens of wires sunk in the soil under various conditions, besides experiments instituted by myself upon the action of various agents upon gutta-percha, and they include the results of an extended and well-contrived series of experiments made at the works of the Electric Telegraph Company, under the direction of Mr. L. Clark.

I will here subjoin an abstract of the principal experimental details, and for

* A paper on this subject by Mr. Spiller having recently appeared, it has been thought that the Fellows might be interested in an official report made five years ago to the Joint Committee appointed by the Lords of the Committee of Privy Council for Trade and the Atlantic Telegraph Company, to inquire into the Construction of Submarine Telegraph Cables.—[ED. JOURN. CHEM. SOC.]

the convenience of reference will arrange them under the following distinct heads:—

1st. Experiments upon pure gutta-percha.
2nd. Experiments upon commercial gutta-percha.
3rd. Experiments upon submerged cables.
4th. Experiments upon decayed and damaged cables exposed in air and underground under various circumstances.
5th. Experiments upon caoutchouc.
6th. Experiments upon other compounds.

1. *Experiments on Pure Gutta.*

Pure gutta differs in some of its properties from the commercial gutta. I found on examining the whitest samples purified by Dr. Cattell, that it formed a porous, milk-white mass, wholly soluble in benzol, in ether, in bisulphide of carbon, and in the ordinary solvents of gutta-percha. It is a perfectly pure hydro-carbon, probably containing C_{20} H_{30}. I found it to consist of—

	Found.		C^{20} H^{30}.
Carbon	88·96	or	88·88
Hydrogen	11·04	„	11·12
	100·00	„	100·00

When exposed to a temperature of 212° it softens, but does not liquefy; it loses a trace of moisture, and then gradually absorbs oxygen, becoming brown, brittle, and resinous in appearance. In one specimen the increase in weight amounted to 4·45 per cent. The oxidized portion is insoluble in benzol, which when digested on the brown mass dissolves out a quantity of unaltered gutta, which had been protected from oxidation by the coating of resin.

This resinous mass when thus purified was found to have been produced from the gutta-percha by simple absorption of oxygen, the gutta having in one experiment absorbed more than a fourth of its weight of oxygen from the atmosphere.

2. *Chemical Experiments on Commercial Gutta-percha.*

The gutta-percha of commerce is not a pure proximate vegetable principle, but it consists chiefly of a hydrocarbon, which may for brevity be termed *pure gutta*, or simply gutta, mixed with a product of its oxidation, which is in the form of a soft resin, amounting to about 15 per cent. in the best commercial samples.

The following is the composition of a piece of ordinary good commercial gutta-percha, taken from a piece of new cable supplied to me by Mr. L. Clark:—

Pure gutta	79·70
Soft resin	15·10
Vegetable fibre	2·18
Moisture	2·50
Ash	0·52
	100·00

The moisture reported in this analysis is mechanically diffused through the mass of the gutta-percha, and seems to have some influence upon its pliability and toughness. 100 parts of the commercial sample when dried at 212° till it ceased to lose weight, deducting the ashes, contained:—

Carbon	84·66
Hydrogen	11·15
Oxygen	4·19
	100·00

This gutta-percha softens and liquefies by a heat of 212°. It is soluble, with the exception of a few flocculi of fibrous matter, in benzol, in bisulphide of carbon, and in ether. Alcohol dissolves none of the pure gutta, but extracts a portion of the soft resin. This resin is an oxidised compound, probably in a transitional condition to a higher stage of oxidation. I found it to consist of—

Carbon	76·15
Hydrogen	11·16
Oxygen	12·69
	100·00

The true gutta was extracted nearly pure from this sample by dissolving it in benzol, filtering and adding alcohol, when a coagulum of pure gutta was obtained, which was found to consist of—

Carbon	87·22
Hydrogen	12·04
Oxygen	0·74
	100·00

The presence of the small quantity of oxygen in this case was due to a little of the resin which still adhered to the precipitated mass of gutta.

Commercial gutta-percha may be preserved for months, and even years, with little change, either in water or in air, provided light be excluded. This I have found from my own experiments, and the results which I have myself obtained are confirmed by experiments made by Mr. Clark. The following are some of the most important of these experiments:—500 grs. of thin sheet gutta were exposed under various conditions at the end of last October at the Electric Cable Works. The various samples were examined on the 2nd of July of this present year (1860).

1. In netting exposed to sun and rain in open air.
2. In a bottle open to the air and light, but excluded from rain.
3. In a bottle open to the air, but excluded from light.
4. In fresh water, open to air and light.
5. In fresh water, open to air excluded from light.
6. In fresh water, excluded from air and light.
7. In sea water, exposed to air and light.
8. In sea water, excluded from light but exposed to air.
9. In sea water, excluding both light and air.

The specimens 4, 5, 6, 7, 8, and 9 were wholly unaltered, with the exception of a slight increase in weight, due to the absorption of water, which they lost again after exposure to the air for an hour or two. The tenacity and structure of the material did not appear to have undergone the slightest change.

No. 2, which had been folded up and introduced into a bottle, the mouth of which was open and inverted, had increased in weight from 500grs. to 524·5grs., or about 5 per cent., owing to absorption of oxygen from the air. The outer layers of the sheet, where exposed to light, were brittle and resinous in appearance, but the inner portion, which had been screened from light by the outer folds, was but little altered in texture or appearance.

On examining chemically a portion of the most brittle part, I found a large portion of it to have lost the composition of gutta, and to have become converted into a matter soluble in alcohol, 55 per cent. of the mass being in fact transformed into the resin already spoken of.

The sample No. 3, which had been kept in the dark, had experienced little or no change. It had only increased 2·5 grains in weight, or 0·5 per cent.; and when treated with alcohol gave up 7·4 per cent. of resinous matter to it.

These results agree with those which I made upon gutta-percha which had been exposed to the light of day for the shorter period of two months. This specimen had become quite brittle, had increased in weight 3·6 per cent., and yielded 21·5 per cent. of resinous matter soluble in alcohol; whilst a piece of the same sheet kept in the dark had undergone no sensible change.

Samples of sheet gutta-percha were also subjected in November last to the action of the following liquids, and exposed to diffused daylight:—

A. Boiled linseed oil.
B. Linseed oil not boiled.
C. Stockholm tar.
D. Coal tar.

When examined on the 4th of August, 1860, or at the end of nine months, these liquids were found not to have exerted any perceptible solvent action upon the gutta, which retained its texture and tenacity in all those portions which had been fairly submerged in the liquid, and protected from the light and atmospheric air; but in those portions which had projected into the atmospheric air contained in the jar, where it was also exposed to the effects of diffused daylight, the texture had become rotten, and the material more or less brittle and resinous.

All the liquids above mentioned are calculated to exclude oxygen from the gutta-percha, and thus they are enabled to exert a preservative influence upon it, without, however, in any degree softening or dissolving its texture. Hence they are likely to be highly valuable agents in coating the insulating material.

3. *Experiments on Submarine Cables.*

I have examined several specimens of cable from different lines which have been submerged for periods of time varying from a few weeks to seven years. In no case where the cable has been completely and continuously submerged have I found any sensible deterioration in the quality of the gutta-percha.

No. 1. Holyhead Irish cable (from Captain Galton), taken up in February, 1859, after seven years' submergence.

No. 2, *a. b. c.* Three specimens from the Dutch line, from Orfordness to Scheveniug (Mr. L. Clark), submerged five years, raised in August, 1859.

This cable was enclosed in a coating of galvanized iron wire, and contained a single wire of copper in gutta, bound round with hemp and tape soaked in boiled linseed oil, tallow, and Stockholm tar.

a. External coating of galvanized wire, not damaged by corrosion. This sample had been buried on the Dutch coast to a small depth in sand.

b. and *c.* Outer galvanized wire much corroded, but the gutta-percha quite sound. The gutta-percha wire had in each of these samples been exposed to the air, out of the metallic casing, for some months, and consequently was drier than the sample *a*, taken from its metallic coating just before it was analysed.

No. 3. Cable off Portland (Captain Galton); down for seven months; composed of seven thin copper wires twisted into a strand covered with tar, then coated with gutta-percha, without any metallic protecting envelope.

No. 4. Cable from line between Candia and Alexandria (Captain Galton). Construction similar to the last; it showed superficial erosions of the gutta-percha after submergence for a few weeks, but the composition of the gutta was unchanged.

No. 5. New gutta-percha covered wire (Mr. L. Clark), never used.

The only chemical difference perceptible in these different specimens was in the quantity of water mechanically retained in each.

100 parts of each contained

	1.	2. *a.*	2. *b.*	2. *c.*	3.	4.	5.
Water	0·84	3·36	1·75	1·49	4·8	0·96	2·50
Ash	1·05	...	...	0·76	3·52	0·75	0·50

4. Experiments upon damaged Cables suspended in Air, or placed underground.

Of damaged cables I have had various specimens for examination.

1 to 6. Six examples described by Mr. Saward in his evidence before the Committee, January 12th, 1860.

1. Buried in chalky or gravelly soil, coated with a white, friable crust of altered gutta percha. This was very brittle, and contained 35 per cent. of resin; this resin contained 17 per cent. of oxygen combined with a hydrocarbon of the same composition as pure gutta.

2. Was in soil exposed to leakage of gas pipes, and also was resinous and brittle, but less so than No. 1.

3. Was described as pulpy when raised, as if fermenting; taken from ground into which drainage from oak trees or posts occurred. When forwarded to me it was hard and tough, the copper wire within was slightly corroded and adhered to the gutta-percha, the channel around the wire lined with a pale brown powder. This powder contained traces of copper. It appears to consist of gutta-percha, as it was almost wholly soluble in benzol, and was insoluble in alcohol. The material in this case seemed to have undergone comparatively little permanent change, although so very different in appearance from ordinary gutta-percha, when it was taken up. It fused below 212°. It had been painted with some pigment containing lead, and on burning left an ash amounting to 1·87 per cent.

4. Not very brittle, taken from iron pipes.

5. Exposed to a dry heat near a baker's oven; coated with red lead.

6. Exposed to a dry heat (exact source not indicated). This was extremely brittle, could be powdered without difficulty, and was almost converted into a resinous substance. It fused below 212°, it left 1·03 per cent. of ash when burnt, and appeared to have been coated with some pigment.

In all these samples those which were most brittle contained the oxidised resinous body in largest proportion. This resinous substance varied somewhat in the proportion of oxygen which it contained in the different samples, but presented the same general properties. It was soluble in cold alcohol, and still more largely in boiling alcohol; was insoluble in ether, and but sparingly in benzol; diluted alkaline leys dissolved it with facility, and the solution coagulated on the addition of an acid in excess.

7 and 8. Samples of gutta-percha covered wire taken from a tunnel in the Stour valley, placed in the tunnel in 1850 (Mr. L. Clark). One portion of this, A, was comparatively little injured; the other, B, was brittle and rotten. This sample had been coated with some pigment containing lead.

It would be useless to cite in detail the various analyses which I have made of these several samples, or to give the numbers obtained for the proportion of moisture, ash, and resin which they contained, or to quote the proportions of carbon, hydrogen, and oxygen ascertained to exist in the altered portion, as contrasted with the unchanged portion, present in each sample.

It may be stated generally, that wherever the proportion of resin was greatest, the sample of gutta exhibited the greatest degree of brittleness; and this brittleness was always found to be most marked in the specimens which had experienced the greatest degree of oxidation; and further, that these changes appeared to occur most rapidly and decidedly in those points where the gutta-percha was alternately wet and dry.

5. Experiments on Caoutchouc.

The caoutchouc of commerce is, like gutta, not a pure vegetable principle, and consists of a hydrocarbon of definite composition, mixed with a small quantity of resin, the amount of which varies in different specimens.

The following are the results of my analysis of a sample of pure unmanufactured Para rubber, compared with a sample of good sheet masticated or manufactured rubber:—

	Virgin.	Masticated.
Pure caoutchouc	96·6	96·64
Moisture	1·3	0·82
Resin	1·8	2·06
Ash	0·3	0·48
	100·0	100·00

Or, deducting moisture and ash, its elementary composition gave:—

	Virgin.	Masticated.
Carbon	85·82	85·53
Hydrogen	11·11	12·06
Oxygen	3·07	2·41
	100·00	100·00

Caoutchouc, like gutta-percha, is, as already stated, liable to deterioration, by exposure to the action of oxygen in the presence of solar light, but the gum is less rapidly injured if exposed to their influence in the native state, than if it had been previously masticated. When subjected to the action of air excluded from light, it does not experience any marked change, even during very long periods. It is, however, important to observe that the masticated rubber is much more porous than the unmanufactured caoutchouc. When immersed in water, caoutchouc absorbs a much larger quantity of this liquid than gutta-percha, and the masticated much more than the unmanufactured or virgin rubber. I subjoin the results of my examination of some samples submitted to experiment by Mr. L. Clark.

A.—Virgin Para Rubber, Finest Quality.

500 grains of this was exposed in each experiment, in the form of a narrow tape-like strip of rubber, which had been stretched while hot and suddenly cooled. It was of a very pale brown colour. The various samples were submitted to experiment at the end of October, 1859, and were examined nine months afterwards (August 4th, 1860).

No. 1, which had been exposed in netting in the open air to sun and rain, had become blackened and rotten, but was neither sticky nor crumbled, had increased in weight 34·5 grains or 7 per cent.

No. 2 was exposed in the air and light, but kept dry in a bottle placed mouth downwards; it had increased in weight 14 grains, or 2·8 per cent., by absorption of oxygen, and had become brown, soft, and sticky, especially in the parts most exposed to light. It gave up 11·81 per cent. of an oxidised, soft, and viscous resin to alcohol. The annexed analysis will give an idea of the composition of the resin thus formed:—

Carbon	67·23
Hydrogen	9·54
Oxygen	23·23
	100·00

The proportion of oxygen differs a little in different samples.

No. 3, which was exposed to diffused light in fresh water in an open bottle, had become white and opaque from the absorption of moisture, and had increased 86 grains, or 17 per cent., but it had experienced no other alteration in chemical properties, and when dried resumed its original characters.

No. 4, exposed in sea water in an open bottle to diffused light, had absorbed 3·6 per cent. of its weight of water, but was only a little altered in appearance, not in chemical composition.

B.—Masticated Rubber, Sheet, Best Quality.

A similar series of experiments was made simultaneously upon masticated sheet caoutchouc.

No. 1, exposed to sun and rain, had collected into a sticky mass, which had lost its tenacity and elasticity.

No. 2, in the inverted bottle exposed to diffused light and air, had increased in weight 8 grains, or 1·6 per cent., and had collected into a lump, which was viscous, and had lost its elasticity, especially in the parts most exposed to the action of light. When treated with alcohol it was found to yield 12·64 per cent. of its weight of resinous matter to this solvent. These changes were in marked contrast to No. 3, which was kept in a glass bottle in the dark for the same period, but exposed to the air freely. It had increased in weight only 0·6 per cent., did not show any sign of alteration in tenacity or elasticity, and yielded to alcohol 2·0 per cent. of resin only.

No. 4, a sheet of the same rubber immersed in fresh water, open to the air and diffused light, had increased 87 per cent. by absorption of water, that is to say, it had nearly doubled its weight. It had become white, opaque, slimy, and sticky when pressed, and allowed water to be squeezed out by pressure. It lost weight rapidly by drying when exposed to the air.

No. 5, similar to the last, but exposed in sea water. It was slightly opaque and slimy, but had increased only 5 per cent. in weight by absorption. A second sample, in sea water in a closed bottle, emitted a smell of sulphuretted hydrogen, and had gained 5·6 per cent. in weight by absorption. Its elasticity and tenacity were not impaired. The gradual permeability of masticated caoutchouc to water was further strikingly shown by enclosing a quantity of acetate of potash in bags made of sheet rubber and accurately sealed. They were then immersed in water, and at the end of nine months the salt in each of the bags was found to have become liquefied by the water which it had absorbed, and the bags had in each case gained in weight several grains.

C.—A similar Series of Experiments was made with Sheet Rubber, vulcanised.

1. The sheet exposed in the netting to the sun and rain had lost 2 per cent. in weight; it was scarcely less tenacious than at first.

2. A similar sheet in fresh water absorbed 19 per cent., but was not otherwise altered.

3. A similar sheet in sea water was rather more slimy, and had only gained 1·6 per cent. in weight.

Each of the three substances, viz., natural, masticated, and vulcanised rubber were submitted to the action of the following solvents for nine months:—

A. Boiled linseed oil.
B. Unboiled linseed oil.
C. Stockholm tar.

The *virgin rubber* had resisted the action of the solvents almost perfectly, retaining its toughness, excepting in those parts which were above the surface of the liquid and exposed to light. In the tar this rubber had contracted spontaneously, but was still strong and elastic.

The *masticated rubber* was in each instance greatly swollen and gelatinised, and indeed, in the case of the unboiled oil, was completely dissolved.

The *vulcanised rubber* had also lost its tenacity, and had become swollen and gelatinous, but retained its form and a certain degree of elasticity.

A sample of india-rubber cable (from Captain Galton), which contained six strands of copper wire, each coated with rubber, then bound round with tape and again with rubber, had experienced a singular change, having become, *where in contact with the wire*, quite glutinous and sticky. This change, however, did not progress in the specimen which I kept for some months in my room, but the viscosity on the contrary gradually diminished.*

6. Experiments on other Substances.

An insulating mixture composed of gutta-percha, shellac, and powdered glass or clay, known as "Wray's Compound" (from Captain Galton), was also submitted to experiment.

Heated to 212°, it softened, but retained its shape. It lost by drying 0·5 per

* The quantity of viscous matter was too small to admit of satisfactory analysis. I ascertained, however, that no copper was present in the viscous mass, and that the wire was not corroded. I could not determine whether grease was present in small quantity, as was not unlikely.

cent. of moisture, and when burnt left 22 per cent. of a white ash, chiefly silicate of alumina. This compound absorbs water but sparingly. 500 grains left in fresh water for six months increased 7·5 grains in weight, or 1·5 per cent., and a similar increase in weight occurred in another experiment where *sea*-water was used.

Sample of Gutta-Percha Cable (from Captain Galton) vulcanised by Mackintosh's Patent.

The wire was found to be blackened on its surface from the action of the sulphur, owing to the formation of sulphide of copper, and traces of copper were found in the gutta-percha covering.

INSTITUTION OF MECHANICAL ENGINEERS.

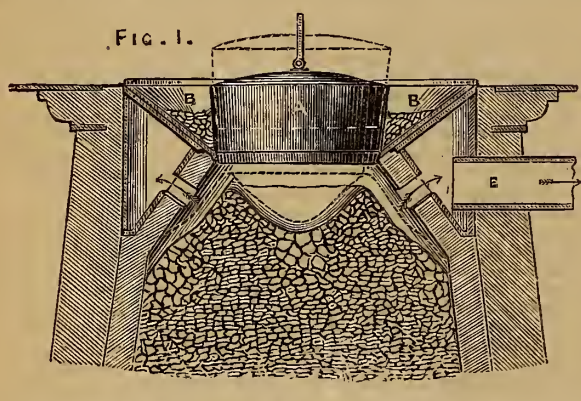
ON THE WORKING AND CAPACITY OF BLAST FURNACES.

By Mr. Charles Cochrane, of Dudley.

At a former meeting of this institution in 1860 the writer read a paper on a method of taking off the gas from a close-topped blast furnace at the Ormesby Iron works, Middlesbrough, and the original construction of closed tap and lifting valve for charging is shown in the accompanying woodcut, fig 1, the materials for the charges being filled into the exterior space B surrounding the charging valve A, which is drawn up into the position shown by the dotted lines for allowing the materials to fall into the furnace; while the gas is taken off from the furnace top by the passage E.

The usual plan of closed top adopted in blast furnaces is that represented in fig. 3, in which it will be seen that the materials are filled in against a lowering cone C, placed in the throat of the furnace, which on being lowered into the

Fig. 1.

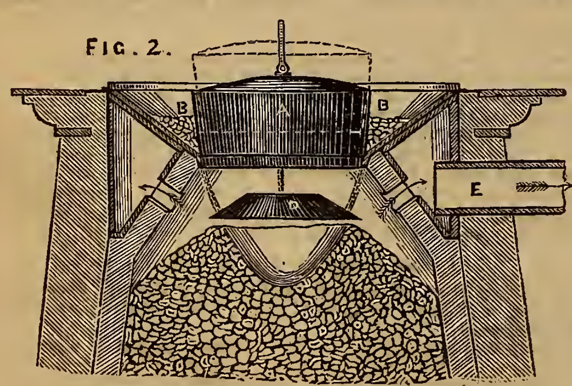


position shown dotted permits their fall into the furnace. The tendency of the material in this case is to roll outwards from the charging cone to the side of the furnace, and thence back again to the centre, as shown in the drawing.

It was thought at the time of adopting the plan shown in fig. 1, that the height of the materials carried by the same furnace would be increased, and that a corresponding economy in consumption of fuel would result, owing to the circumstance that where the plan shown in fig. 3 is adopted the level of the materials must always be maintained at a certain distance below the top, to ensure the fall of the cone C at charging time. The plan shown in fig. 1 was devised with due regard, as it was thought, to the arrangement of the materials in the furnace; and it was intended that they should arrange themselves as shown by the dotted line in that drawing, part of the larger material rolling to the outside of the furnace and part to the centre.

As long as the furnace could be kept so full as to ensure the arrangement of

Fig. 2.

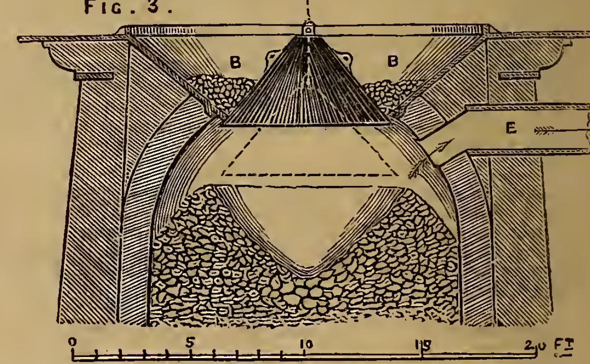


materials shown by the dotted line in fig. 1, there was no reason that it should not work uniformly; but the practical result was that it was found impossible to keep the furnace sufficiently full to secure the distribution of the materials in the manner intended. The level of the surface of the materials was generally below that intended, the consequence of which was that the material on falling into the furnace was shot into the centre, from whence the largest pieces rolled outwards, and the whole charge arranged itself as shown by the full line in fig. 1. The result of this was irregular working of the furnace over a period of many months, during which an explanation of the irregularity was in vain sought for. At one time it was thought the back pressure of the escaping gas had something to do with the irregularity; at another the cause was sought for in the difficulty of keeping the hopper valve A of the furnace tight, and the necessity for using small material around the valve as a kind of lute between every charge to prevent the escape of the gas: until it occurred to the writer that the arrangement of the materials in the furnace was the sole explanation of the difficulty, and that as all the material was shot into the centre of the furnace the small pieces would remain there whilst the large would roll to the outside. Believing that it was of great importance, in order to secure uniform results, that there should be a uniform distribution of the heated gas from the hearth over the entire horizontal area of the furnace at each stage of its height, he considered that the effect of any small material being collected in any portion of the area would be to obstruct the passage of the gas at that part, and so prevent that portion of the material from being heated to its proper degree of temperature.

Deeming this to be the explanation of the irregularities experienced in the working of the furnace, the writer devised a method of distributing the material so as to prevent such a result, by the introduction of a frustum of a cone D, fig. 2, suspended inside the throat of the furnace, which was found to be all that was necessary. The materials then arranged themselves in the desired manner, as shown in the drawing; and the result has since been a perfect uniformity in the working of the furnace. Where previously a yield of foundry iron from the same furnace could not be relied upon for more than about 24 hours at a time, and the annoyance was incurred of the furnace suddenly changing to white iron, the production of white iron except when desired is now unknown. A consideration of these facts will lead to a fair estimate of the importance of the arrangement of the materials in a blast furnace. Anything that opposes the free passage of the ascending heated gas at any part of the furnace must direct the gas into another channel, and the material thus left insufficiently acted upon finds its way into the hearth at a low temperature, and white iron is the result.

The effect produced on the distribution of material by this internal frustrum of a cone is obviously similar to that of the ordinary lowering cone when lowered, shown in fig. 3, and the latter has now consequently been finally

Fig. 3.



adopted at the Ormesby Iron Works as the permanent form of the arrangement, and is now being carried out there.

The most perfect action of a blast furnace the writer conceives to consist in the development of the highest temperature needed for the production of the required quality of iron, in a layer or stratum as little removed from the tuyeres as possible; and the gradual absorption of the heat from the ascending gas by the materials through which it passes, until it leaves the throat of the furnace at the lowest possible temperature. Anything which tends to cause a more perfect absorption of the heat developed in the hearth, or to lower the level of the region of highest temperature in the furnace, will thus be beneficial.

With regard to the absorption of the heat from the gas, it is obvious that the hotter the temperature at which the gas escapes, the more wasteful must be the effect; and theoretically the height of a furnace should be increased until the temperature of the escaping gas is reduced to that of the materials on their introduction into the furnace top. This is the theoretical limit to the height of a blast furnace; but it must not be forgotten that the less the difference in temperature between two bodies, the less rapid is the communication of heat from the hotter to the cooler; hence for the absorption of the last few degrees of temperature from the ascending gas a much greater height of material is necessary than where the gas and the material differ more widely in temperature. Already with 50ft. to 60ft. height of blast furnace in the Middlesbrough district the temperature of the escaping gas does not exceed 500° to 600° Fahr.; and it is a question to be answered only by experiment how far the gain from the heights of 70ft. to 75ft. already accomplished at Middlesbrough, and further heights of 10ft. or 20ft. additional that are contemplated, will compensate for the extra work in raising the materials to the additional height and for the more substantial plant required. In the direction of height there is unquestionably on this account a limit which will speedily be attained; supposing the limit be not previously determined by the necessity for increased pressure of blast and by the increased difficulty in working the furnaces.

As regards the benefit produced in the working of a furnace by lowering the level of the region of highest temperature, it is evident that this benefit is of the same nature as in the previous case, since the lowering of that level is equivalent to an increase in the height of the furnace. The level of the region of highest temperature is dependent upon the heat of the blast, and is brought down nearer to the tuyeres only by using a hotter blast; and in the writer's opinion the chief source of economy yet to be attained in the working of blast furnaces, independent of the more extended application of the waste gas, lies in the use of blast heated to a still higher temperature than that hitherto known. The yield of iron from any ironstone is governed by the per centage of iron it contains, and the consumption of limestone by the nature of the ironstone, and both these are, therefore, fixed quantities for the special materials employed. But that is not the case with the coke, which offers a fruitful source of saving, and in what way therefore this saving is effected by increased temperature of the blast becomes a most important question, involving as it does the general theory of hot blast.

It appears to the writer that in order to explain the effect of the hot blast it is necessary to regard the nitrogen of the atmosphere and the generated carbonic oxide as the great heat "carriers" in the operations of the blast furnace. This consideration involves two others—namely, the time required for heating the nitrogen from its initial temperature at entering the furnace up to that needed for the fusion of the materials in the furnace, and also the method by which the gases are heated. Taking it for granted that the colder, and consequently the denser pure oxygen is, the more intense is the combustion of any body burning in it, there is evidently no necessity for heating this constituent of the atmosphere. It is further obvious that, supposing 3,000° F. be the temperature required for the fusion of the materials on their reaching the hearth, then every pound of the nitrogen introduced by the blast must be raised to that temperature before the fusion can take place.

Now in a cold blast furnace the nitrogen is introduced at the lowest temperature, and requires necessarily the longest time for being raised to the requisite temperature; hence the maximum temperature in the furnace is produced at a higher level, and diffused over a larger portion of the furnace where it is not wanted, and it is consequently impossible in some cases ever to get the temperature sufficiently high at any part of the furnace to produce more than the qualities of iron known as forge iron. In proof of this may be mentioned an attempt made some years ago at the Ormesby Ironworks, Middlesbrough, to produce cold blast iron of a grey or foundry quality. It was in vain, however, that the burden of ironstone was reduced—that is the proportion of coke increased; the temperature of the hearth could not be sufficiently raised to produce any other quality than forge iron, the effect of the reduced burden being only to throw an increased temperature into higher regions of the furnace. The attempt was consequently abandoned—not, however, until it became obvious that the burden might have been still further diminished with only the effect of diffusing the hottest temperature into still higher regions of the furnace.

Whatever heat is imparted to the nitrogen of the atmosphere and also to the carbonic oxide generated in the furnace is of course delivered up again to the materials in the furnace, excepting only the portion lost by the temperature at which the gas escapes at the throat of the furnace. The effect of heating the nitrogen before its entrance into the furnace now becomes more clear. It has a shorter distance to travel up within the furnace before the maximum temperature is attained, for the simple reason that, having been partly heated already, it requires less time to become further heated to the temperature required in the furnace, having got the start by the amount of its initial temperature. Hence the fusing heat is generated nearer to the tuyeres; and this circumstance, together with the smaller expansion of hot blast compared with cold blast on entering the furnace, seems to furnish a satisfactory explanation of the more immediate effect of heated air in preventing diffusion within the furnace of the region of highest temperature.

As to the method of heating the nitrogen, it must be borne in mind that the heat generated in a blast furnace is obtained wholly or nearly so by the imperfect combustion of the carbon of the coke into carbonic oxide as the final result, a process by which theoretically only about one-fourth the total quantity of heat is developed that would he obtained by the perfect combustion of the same carbon into carbonic acid, showing a loss in the fuel of about 75 per cent. of heat; since 1lb. of carbon burnt into carbonic oxide developes only 2,880 units of heat, whilst 1lb. of carbon burnt into carbonic acid developes about 11,700 units of heat; for although the combustion of the carbon of the coke in the blast furnace is partially or wholly into carbonic acid so long as the supply of oxygen is in excess, this condition applies only to the lower portion of the furnace nearest the tuyeres; and this carbonic acid becomes ultimately reduced to carbonic oxide by passing through the excess of carbon in the mass of incandescent coke occupying the upper portion of the furnace. If, therefore, the nitrogen be heated partially or wholly before entering the furnace, by any means involving the perfect combustion of the fuel employed into carbonic acid, it follows that a large saving in fuel must necessarily result; and to give an idea of the real influence of the nitrogen of the atmosphere on the consumption of fuel in the blast furnace, the writer has endeavoured to express numerically the effects produced by taking three different cases of the blast entering the furnace at the various temperatures of 50°, 650°, and 1,150° F. respectively. It is assumed that the air has to be heated within the furnace to 3,000° F. in each case, that 1lb. of carbon burnt into carbonic oxide will develope 2,880 units of heat—that is, will raise 2,880lbs. of water through 1° F., and that the specific heat of air is ·275, compared with that of water as 1·000. It is further assumed that 4,500 cubic feet of blast enter the furnace per minute; and as 1,000 cubic feet weigh 76lbs., the weight of blast entering the furnace per minute will be 342lbs., 77 per cent. of which, or 263lbs. weight, is nitrogen.

In the three cases cited it will be seen that the work to be done within the furnace is to raise the temperature of the air through

2,950° in the first case,
2,350° in the second,
1,850° in the third.

In the first case, namely, to heat 263lbs. of nitrogen through 2,950°, there will be required

$$\frac{263 \times 2950 \times \cdot 275}{2880} = 74\text{lbs. of carbon per minute.}$$

In the second case, namely, to heat 263lbs. of nitrogen through 2,350°, there will be required

$$\frac{263 \times 2350 \times \cdot 275}{2880} = 59\text{lbs. of carbon per minute.}$$

In the third case, namely, to heat 263lbs. of nitrogen through 1,850°, there will be required

$$\frac{263 \times 1850 \times \cdot 275}{2880} = 46\text{lbs. of carbon per minute.}$$

These results show that to raise the temperature of the blast from 50° to 650° before it enters the furnace causes a saving in the blast furnace of 15lbs. of coke out of 74lbs., or about 20 per cent., and that a further increase of temperature from 650° to 1,150° occasions a saving of 13lbs. out of 59lbs., or about 22 per cent. To show that these calculations are not so merely theoretical as might at first be supposed, it may be here stated that in the writer's experience the raising of the temperature of the blast from 650° to 1,150° at the Ormsby Iron Works has accomplished an actual saving of from 17 to 18 per cent. of coke in the blast furnace; and this was effected at an expense of coal outside the furnace of about one-half the weight of coke saved within the furnace. The writer believes, however, that, were it in his power to compare two exactly similar systems of hot-air stoves, the additional fuel consumed outside the furnace would approximate more nearly to one-third of the weight saved inside the furnace than to one-half. But the difficulty of having to compare the ordinary cast iron stoves with the regenerative hot-blast stoves, by which the highest-named temperature of 1,150° is attained, is too great too allow of the comparison being made more precisely.

In the cold-blast furnace the method of heating the air is simply by its direct contact with the heated material and incandescent coke, and it is heated altogether at the expense of carbon burnt only into carbonic oxide instead of into carbonic acid. In the hot-blast furnace, by the more complete combustion of the heating fuel in the hot-blast stoves, exterior to the furnace, the nitrogen is heated not only at a cost of fuel represented by a saving of theoretically three-fourths in the actual weight of coke required within the furnace to raise the nitrogen to the same temperature, but also with the further advantage that instead of burning coke it is coal that is used for the purpose. In other words, for every pound of coal economically burnt outside the furnace in raising the temperature of the blast, 3lbs. of coke will be saved within the furnace, whether the furnace be open or closed at the top.

It may be thought that a comparison made between an open-topped furnace where the gas burns freely as it escapes, and a close-topped furnace where no such combustion takes place, is not a fair one; and that the combustion of the gas at the throat of the open-topped furnace, by imparting heat to the materials at the throat of the furnace, would tell in favour of the consumption of fuel in the open-topped furnace. But facts speak otherwise, and it appears that there is practically no difference whatever due to this cause.

It will thus be seen that a definite limit to the height of a furnace is soon reached in practice; and that the advantage derived from increasing the actual height of a furnace may be partly secured by increasing the temperature of the blast, and thereby lowering the region of maximum temperature in the furnace.

The only question that remains is as to the diameter of the furnace. In reference to this dimension, the danger that has been alluded to from the formation of cold masses in the centre of a blast furnace serves as a caution against the more dangerous formation of cold masses attached to the sides of the furnace, technically called scaffoldings. It is obvious that, if the width of the boshes of a furnace be large in proportion to the height and the volume of the ascending gas, there will be a tendency to unequal diffusion of the heat imparted by that gas over the successive horizontal sections of the furnace, and irregularities in its working will consequently set in. There is then a limit to the diameter of the boshes, the largest of which yet in use is believed to be about 21ft.: beyond this size it appears very questionable whether any beneficial result would arise, though a furnace has been stated to be in course of construction at Cwm Celyn having a diameter of 24ft. at the boshes.

The nature of the materials of the charge in any contemplated increase of the dimensions of a blast furnace must be most scrupulously borne in mind. The density of the coke is the most important consideration; but next to that is the friability of the ironstone itself. In the Staffordshire district it would be useless to build furnaces of the height contemplated and actually employed in the Middlesbrough district, for the simple reason that the Staffordshire coke is friable and would be crushed most injuriously by the weight of superimposed material.

It is thus evident that the actual dimensions of a blast furnace in any particular instance are much dependent upon special local circumstances; but the writer has endeavoured to point out the general principles which guide the determination of the dimensions to be adopted.

DESCRIPTION OF A COAL CUTTING MACHINE.

By Mr. THOMAS LEVICK, of Blaina Iron Works.

The substitution of machinery for manual labour in our various manufactures and industries, the gradual development of railways, and the application of steam to navigation, have increased in a wonderful manner the demand for coal, that being the chief agent in the production of the motive power in all these cases. In the early periods of the working of the coalfields the produce of coal was very limited, the only means of conveying it from the pit to the shipping port being on pack-horses carrying only 3 cwts. each, which were succeeded by the cart, increasing the load to 17 cwts. But by the introduction of railways the annual produce and consumption of coal in Great Britain was raised in 1855 to 64 millions of tons, in 1859 to 70 millions, and in 1860 to 80 millions; and according to Mr. Hunt's returns it has now reached the enormous quantity of nearly 90 millions of tons per annum.

Although coal has thus been so useful in promoting and extending the use of machinery, machinery has not yet returned the compliment by its application to the working of coal; it has only made various futile attempts, and only within the last year or two have any really practical attempts been made to lessen or supersede manual labour in working coal: the working or getting may in fact be considered to remain still in the same condition as in the pack-horse age. Machinery has certainly aided the increased production of coal by winding and pumping engines and by inclines above and below ground; but this kind of machinery has only facilitated the movement of the coal after it has been wrought by the collier. The actual working or getting it from the position in which it has been deposited in the mine ages ago is still accomplished only by tools of the most primitive kind, plied by the strong arm of the sturdy collier under the most disadvantageous circumstances; for he has to wield the pick in a stooping or lying position, most unfavourable to the application of his muscular force, and this frequently in an atmosphere not only not remarkable for its purity but sometimes of a temperature as high as 80° to 90° Fahr.

The constant but gradual increase of temperature in penetrating the earth's crust, which takes place at the rate of about 1° F. to each 60ft. of depth is well known. In the Monkwearmouth Colliery, the depth of which is 1,800ft., the temperature is 80°, and this is considered to be as high as is consistent with the great bodily exertion necessary in the operation of coal mining. There is also an additional augmentation in the temperature of deep mines, consequent on the increased density of the air, and this is about 1° for every 300ft. of depth. Certain portions of the coal in the deeper coal basins lie at depths approaching and even exceeding 4,000ft.; and the temperature of the air at this depth, according to the foregoing data, would be 79° higher than at the surface, 66° being due to the depth and 13° to increased density of the air. The computations, therefore, of the duration of the coal-fields, as has been pointed out by Sir W. Armstrong, require a considerable reduction in consequence of the impracticable depths at which portions of them are situated; and any means of increasing the practicability of working at these depths by the application of machinery becomes consequently a question of serious importance in reference to the duration of coalfields, in addition to the advantages in economy of cost and time of working, and in saving waste of material that are incident to the substitution of machinery for hand labour.

Many attempts have been made during a century past to construct coal cutting machines. One of the earliest was that of Michael Menzies, in 1761, consisting of a pick fixed on the axle of a pulley placed near the face of the coal, to which a reciprocating motion was given by means of a chain passing round the pulley, and connected with a steam engine at the surface, the pick performing the operation of kirving or holing. He also invented a pick machine to be worked by hand.

In 1830 a battering ram for coal mines was proposed by William Wood. This was a heavy ram fixed in a sliding box acting on a wedge, the ram being worked backwards and forwards by manual labour.

The next to be noticed is a plan in 1843, for applying rotary saws or picks, driven by a winch or an engine, for the purpose of severing blocks of coal from the surrounding mass. This was one of the first attempts for using rotary cutters, and the arrangements were complicated.

In 1846 a plan was proposed by Mr. W. H. Bell for suspending a heavy pick or chisel by a chain from a bar running along the face of the work at the roof, so as to be swung by hand against the coal.

In 1852 a machine was applied by Mr. W. D. Hedley, similar in its action to a planing machine, having a cutting tool projecting from the side of a carriage running on railway, and the tool was made to cut deeper and deeper into the face of the coal by repeatedly traversing the carriage, and setting the tool at each successive cut to project more and more beyond the side of the carriage. There were holes in the machine at different heights for altering the tool according to the different heights at which the coal has to be cut.

About the same time a plan was proposed by Mr. C. H. Waring, in which reciprocating or revolving cutters are worked by compressed air or steam. The reciprocating cutters have somewhat the motion of planing or slotting machines, but the rotary cutters are fixed in the circumference of a wheel, and act like a circular saw. The machine is arranged to cut either vertically or horizontally. The apparatus for applying the power is mounted on the frame of the machine, and consists of an oscillating cylinder, worked by compressed air or steam.

In 1861 a pick machine, to be worked by hand, was proposed by Messrs. Ridley and Rothery, the pick working horizontally and vertically, and both motions being upon fixed axes; and about the same time a hand machine was proposed by Mr. Donisthorpe, in which the tool was a bar mounted on grooved rollers, giving it a rapid motion forwards and backwards.

The preceding are some of the principal attempts up to that time to work coal by machinery. They may be divided into reciprocating picks, sliding or planing picks, and rotary saws or cutters; none of them, however, have continued in practical use. The principal practical difficulty in the application of machinery to coal cutting is the confined space it is required to work in. Most of the machines above referred to occupy too much space, and are generally too complicated for application in a coal mine; and machines made to be worked by hand, on account of the friction of the mechanism and the cumbrous arrangement, absorb too much manual labour to give them much or any advantage over the pick worked by the skilled collier.

Not until the last two or three years has anything practically useful been accomplished in the application of machinery to coal cutting; and Messrs. Donisthorpe, Firth, and Ridley's machine working at the West Ardsley Colliery near Leeds was the first machine which may be safely said to have demonstrated the practicability of cutting coal by machinery. This was one of the class of machines working with a pick, which was driven by a cylinder worked by compressed air; and it was followed by another machine, which introduced a trunk arrangement of the driving cylinder, so as to shorten up the connecting rod, thereby considerably shortening the machine, and enabling it readily to traverse the quick curves of mine tramroads, thus removing a serious practical difficulty previously experienced. Both these machines have been successful in performing one operation in coal cutting, namely, "holing," or undercutting a seam of coal horizontally, and on a true plane, or nearly so. But as they were constructed only to cut a groove horizontally, or rather parallel to the plane of the tramway, they were not adapted to meet the cases of inclined seams, so frequently occurring in practice; and as they were also limited to the horizontal undercutting, all vertical cutting that was required in the operation of getting the coal had to be done by hand work. These machines were inapplicable to driving headings; and for that purpose a modification of them has been made, having two pairs of vertical picks, one pair on each side of the machine, and each pair consisting of one pick working upwards vertically from the bottom, and the other working downwards vertically from the top, so as to make the two cuts meet one another. The undercutting, however, in driving the headings was still required to be done by the hand of the collier.

In order that a machine may be generally applicable to coal cutting, it should be capable of cutting in any direction, so as to work the "dip" or the "rise," or cut the vertical cuts. To do this, and at the same time to retain a simple form of machine, since complex machinery would be very objectionable underground, presented great difficulties; but these have now been entirely overcome in the coal cutting machine forming the subject of the present paper, which is the invention of Mr. James Grafton Jones, of Blaina. In this machine the axis of the pick is carried in a revolving headstock, by which it is capable of being turned into any desired position by merely turning a handwheel at the end of the machine, the relative position of the pick and the air cylinder which works it remaining always the same. By this means the pick can be worked in any plane, either vertical, horizontal, or at any inclination; and it is thus enabled to cut the coal vertically in driving headings, and horizontally in holing, or in any inclined direction for working the dip or the rise when the seam of coal does not lie horizontally. Headings may thus be driven, or any of the ordinary operations in the getting of coal or other minerals may be performed by the machine.

The machine is shown in the accompanying woodcut, figs. 1, 2, and 3.

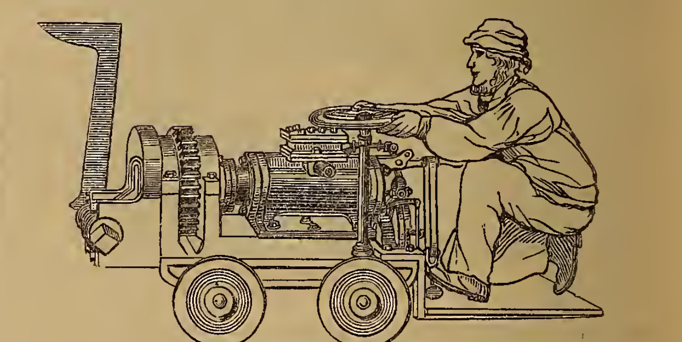


Fig. 1.

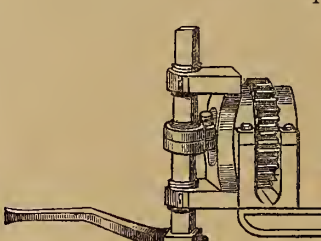


Fig. 2.

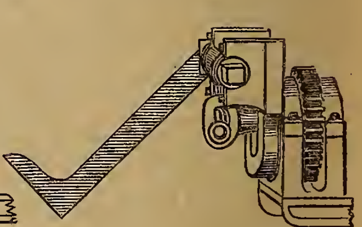


Fig. 3

The air cylinder, fig. 1, is placed horizontal, and is cast in one piece with the bed of the machine; and the piston is forged solid upon the piston rod. The lever pick is keyed upon the transverse axis carried in front of the cylinder; and on the axis is a crank arm, to which the piston rod is connected by means of a slotted head screwed into the end of the rod. The axis is carried in bearings cast upon the rotating headstock; and this headstock is capable of being turned round in its bearings by means of the handwheel fixed on the shaft of the pinion, fig. 1, which gears into teeth on the headstock. The pick can thus be turned so as to cut the coal at any inclination whatever, the piston turning in the cylinder when the headstock is rotated; and when the pick is adjusted for working at any desired inclination, the axis can be locked in that position by means of a pin passing through one of the holes in the handwheel.

The slide valve, by which the compressed air is admitted to the cylinder, is worked in one direction by the piston, which on completing its back stroke strikes against the tappet rod; this rod works through a stuffing-box in the back cover of the cylinder, and is connected to the lever, the other end of which is connected to the slide valve stem. When the tappet rod is struck by the piston, it moves the valve into the position for admitting the compressed air to the back of the piston, for striking a blow by the pick. The valve is retained in this position until the blow has been struck, by means of a spring catch, which is connected by a rod to the treadle. An india-rubber spring passes round the handle formed on the lever, and is attached by means of an adjustable joint to the platform, on which the man working the machine is carried. When the treadle is depressed by the man's foot, it releases the catch, and the india-rubber spring immediately moves the slide valve so as to admit the compressed air to the front of the piston for making the back stroke; and another blow of the pick is then given by the piston striking against the tappet rod. As the work progresses the machine is moved forwards by the handwheel, which communicates motion by the bevil wheels to the carrying wheels of the machine.

From this description it will be seen that, at whatever inclination the coal may lie, the pick is easily put to work at that exact angle, whether to the rise or the dip. It may also be easily put to work at any part of the thickness of the coal, whether it be desired to hole at the bottom or at the top of the measure, or at a parting in the middle or any other portion of the seam, by simply shifting the pick, fig. 1, to a greater or less distance upon the axis on which it is keyed. Fig. 1 shows the pick in position for vertical cut downwards. Fig. 2 shows the pick in the position for holing, and fig. 3 shows the pick in position for making a vertical cut upwards, as in driving headings. In fig. 1 the position of the man working the machine is also shown, kneeling on the small platform at the tail of the machine, with his foot upon the treadle for releasing the slide valve, and holding the handwheel for advancing the machine between each stroke of the pick.

This machine when holing in the coal cuts a groove 3ft. deep, 2in. wide at the face and 1½in. at the back; whereas a collier requires for effecting the same purpose to make a groove or rather excavation 10in. to 12in. wide or even more at the face, and tapering to the back. In doing this the collier is exposed to one of the most frequent and unavoidable dangers of the coal mine, by the large lump of coal breaking off and sliding down suddenly without warning, before he has completed his task.

The machine is calculated to work at the rate of 70 to 80 strokes per minute; and the one at work at the High Royd Colliery, Barnsley, under disadvantageous circumstances, and in the hardest coal in the district, holes from 9 to 10 yards length per hour, 3ft. to 3½ft. deep, including stoppages. In order to make the machine thoroughly effective, it is necessary that it should be on a good rigid road; but at this colliery it is working on the ordinary tramplate road, loosely laid. The pressure of air at which it is worked is 30 to 35lbs. per square inch. In the same seam of coal the collier does only 4 to 5 yards length of holing for a day's work, in place of the 90 to 100 yards done in 10 hours by the machine, the latter thus accomplishing fully twenty times the work that the collier can do by hand in the same time.

A second machine has just been put to work at the Oaks Colliery in the same district, in which an improvement has been made by the addition of a steadying apparatus, consisting of a tailpiece which carries a pair of heavy rollers, these rollers rest upon the tram rails and keep the machine steady under the vibration caused by the blows of the pick when striking literally in holing. This tailpiece follows with the machine when moving in a straight line; and it has the effect of lengthening the wheel base of the machine, and considerably reduces the lateral vibration on the road caused by the powerful blow of the pick when holing. It is readily detached when required to go round the short bends of the mine; and also when driving headings it is not required, as the pick is then working vertically. The machine at the Oaks Colliery holes at the rate of 14 yards to 15 yards length per hour, to a depth of 3½ft., the number of strokes averaging from 60 to 70 per minute, and the pressure of air being 35lbs. to 37lbs. per square inch. The road in this case is a railroad thoroughly well laid.

These machines are also well adapted to work in the ironstone shales and to quarry Bath stone; indeed the pick would work in anything softer than its own point.

The use of compressed air for working underground machinery is not new, though it is only recently and since the introduction of coal cutting machinery that it is being more extensively employed. The first practical employment of it in this country was at the Govan Colliery, near Glasgow, in 1849; the machinery was erected by Messrs. Randolph Elder and Co., and a description of it was read before this Institution at the Glasgow meeting in 1856 (see Proceedings Inst. M.E., 1856, page 145). At the Haigh Colliery, near Wigan, two air-compressing engines were also employed, the air being compressed to 120lbs. the square inch, and carried down a shaft 234 yards deep, and to a distance of 500 yards from the bottom of the shaft. The engines worked by the compressed air at this colliery and at the Govan Colliery were employed for winding underground.

A peculiarity attendant upon compressing the air is the heat developed during compression, which increases rapidly with the pressure. Thus air, which at the atmospheric pressure of 15lbs. is at 32° Fahr., would be raised to 110° by being compressed to 30lbs. per square inch; and at 120lbs. per square inch, the effective pressure in the Haigh engines, the theoretical temperature would be about 450°. A special provision to meet this circumstance is mentioned hereafter. An inconvenience in working these compressed air engines was the liability of the air passages and exhaust pipes to become clogged with ice, in consequence of the water suspended as moisture in the air being frozen by the cold produced in the sudden expansion of the exhaust air. This is avoided in the coal cutting machines by making the slide valve with sufficient inside lap to cause the exhaust air to escape slowly at each stroke, thereby preventing its sudden expansion; and this arrangement, combined with the concussion caused by the stroke of the pick, prevents the exhaust passages becoming clogged with ice. In an air engine at Dowlais, when the air was escaping under a pressure of 15lbs., the temperature of the exhaust air was 29° Fahr.; and the greater the pressure, the greater will be the cold produced in expansion.

There is a loss of power in air compressing engines, arising from leakage and friction in the air pipes, and the mechanical power lost in the form of heat when the air is compressed. The loss from leakage and friction is very small, and if the joints are good, that from leakage will be inappreciable; but the loss from the escape of heat is great. The cylinder in which the air is compressed gets so hot that it is necessary to keep it surrounded with water, the temperature increasing with the pressure to which the air is compressed; and on the other hand when the compressed air has done its work and is allowed to escape, a degree of cold is produced which freezes any moisture that there may be in the exhaust passages. By the compression of the air its capacity for heat becomes diminished; consequently a portion of the latent heat already contained in it at its natural pressure is developed in the form of sensible heat, and this is absorbed by the cylinder and the surrounding water. The air itself does not get sensibly hotter, since only its capacity for heat is changed by the compression, while the excess of heat developed by its compression is rapidly absorbed by the surrounding metallic surfaces which conduct it away. When this air has done its work and again expands to its original pressure, its original capacity for heat returns; and the quantity of heat then contained in it not being sufficient for maintaining the same temperature in its expanded form, it consequently draws heat from the surrounding bodies, thus producing cold. The amount of heat thus absorbed in the act of expansion is the exact equivalent of that which is developed during compression: but the heat developed in compression being lost by conduction, the amount of power equivalent to it is also lost.

The effect produced upon the ventilation and temperature of the mine by the supply of air from the discharge of the coal cutting machine may now be considered. When the machine is working at 60 blows of the pick per minute, it will discharge 24 cubic feet of air per minute at a pressure of 45lbs. per square inch, which by expansion becomes 72 cubic feet of air at the atmospheric pressure, and at a temperature below freezing point. Taking the quantity of air passing along each face of work in the mine at an average of 6,000 cubic feet per minute, at a velocity of 4ft. per second, the quantity of air discharged by each machine would be only 1¼ per cent. of the whole amount. Supposing the temperature in the mine, as at Monkwearmouth, to be about 80° F., it would be reduced only 1° when thoroughly mixed, but it would be considerably cooler round the point of issue. The ordinary ventilating current has frequently had to travel considerable distances, and has acquired a great deal of impurity and a high temperature before it reaches some of the faces of work. But supposing three or four machines to be employed along each face, the current instead of becoming impure would retain its purity and become cooler.

A collier when at work breathes heavily, and inhales about 28 cubic feet of air per hour, and exhales about 1 cubic foot of carbonic acid in the same time. One coal cutting machine may be said to save the work of 20 colliers, who would inhale 600 cubic feet of air per hour; while the machine supplies 4,320 cubic feet per hour of cold and pure air at the place where it is most required.

The fire-damp in a mine having only half the specific gravity of air is very apt to float above the passing current of air, instead of mixing with it, especially where there is any unevenness in the roof forming cavities in which the fire-damp can lie stagnant. The violent agitation, however, produced by the discharge of air from the coal cutting machine will aid materially in the intermixture of the gas with the current of air, and the discharge of air from the machine may be directed to any particular point, as desired.

The advantages of cutting coal by this machine may be summed up as follows:—

1st. The saving of a large percentage of small coal in the process of holing, and a corresponding increase in the proportion of large coal obtained.

2nd. The economy in the cost of getting the coal.

3rd. The improvement in the ventilation and temperature at the working points.

4. The facility with which headings may be driven and ventilated, the machine itself supplying air sufficient for several men, and at a low temperature. The machines being well adapted for driving headings, collieries may be opened and won to their outside boundaries in a much shorter time.

5th. The saving of life and limb to the collier, by removing him from the most perilous portion of his occupation, that of holing or undercutting the seam of coal.

6th. The power of carrying the working into the deeper seams of coal, which lie at so high a temperature as to present serious difficulty in the way of performing the severe labour of cutting the coal by hand work.

INSTITUTION OF CIVIL ENGINEERS.

John Robinson McClean, Esq., President, in the chair.

The first meeting of the session 1865-66, held on the 14th ult., was occupied by the reading of a paper on "the Telegraph to India, and its Extension to Australia and China," by Sir Charles Tilston Bright, M.P., M. Inst. C.E.

After referring to the previous attempts to establish telegraphic communication with India by the Red Sea, and alluding to the causes of the failure of that enterprise, the author proceeded to describe the steps taken by the Government to carry out the line through Mesopotamia and by the Persian Gulf to Kurrachee, which was now in daily operation, connecting England with Calcutta, Bombay, Madras, and all the principal towns of India, and extending as far to the eastward as Rangoon.

A description was given of the manufacture, laying, and electrical tests applied to the submarine cables between the head of the Persian Gulf, Bushire, Mussendom, Gwadur, and Kurrachee, the engineering and electrical superintendence being carried out for the Indian Government by the author and his partner Mr. Latimer Clark, M. Inst. C.E. The cables in question belouged to the class of shallow water cables, the depth being generally about 40 fathoms, and the bottom being principally sand and soft mud, circumstances the most favourable for the deposition of submarine lines. The core was composed of 225lbs. of copper and 275lbs. of gutta-percha per nautical mile, the gutta-percha being applied in four separate coatings; over this was laid a bedding of hemp, covered by twelve galvanised iron wires, the whole being coated with two layers of a compound of bitumen and silica, applied in a plastic state, in combination with two alternate servings of hemp laid in opposite directions. In the construction of the conductor four segmental pieces of copper within a copper tube were used, by which the mechanical advantages of a strand were preserved, while the electrical efficiency was added to in consequence of the cylindrical form of the exterior.

The elaborate system of electrical tests taken during the construction and laying of the cable, and a series of experiments determining, for the first time, the differences of conductivity of gutta-percha and india-rubber at various temperatures, were fully described, a formula being given as a guide in calculating the effect of changes of temperature upon the insulation of submarine cables. A new method of testing the joints in the core separately was introduced, whereby a considerable gain in insulation was attained. The conductivity of the whole of the copper wire used was measured, and all wire below an established standard was rejected. By this means a high degree of conductivity was arrived at.

The total length manufactured was 1,234 nautical miles, weighing in all 5,028 tons. Five sailing vessels and one steamer conveyed this mass of submarine cable to Bombay, and the submersion was commenced by the author on the 3rd February, 1864, at Gwadur, on the coast of Belochistan, the whole being completed by the middle of May in the same year. The cables were laid for the first time successfully from sailing vessels towed by steamers, by which a considerable saving was effected, compared with the cost of sending the cable round the Cape in steam vessels.

It was expected that the Turkish land line, between Bagdad and the head of the Gulf, would have been completed simultaneously with the submersion of the Persian Gulf line. In this, however, much disappointment was experienced, owing to the Arabs, on a portion of the route, in the valley of the Euphrates, being in revolt against the Turks. In consequence of this, the opening of the entire line between Europe and India was delayed until the end of February in the present year, when a telegram was received in London from Kurrachee in eight hours and a half. This was speedily followed by numerous commercial messages to and fro, and a large and remunerative traffic was now daily passing. The author, however, complained of the delays and errors arising upon the Turkish portion of the line, between Constantinople and Belgrade; the service on the portion of the line worked by the Indian Government, between India and the head of the Gulf, being performed rapidly and efficiently.

The difficulties encountered by Major Champain, R.E., in the construction of the Persian telegraph, between Teheran, Ispahan, Shiraz and Bushire, were described, and the loss of the late Colonel Patrick Stewart, R.E., and his devoted services, were feelingly alluded to.

In considering the extension of telegraphic communication from Rangoon to China and Australia, the author entered upon a narration of the advantages and otherwise of the several plans proposed; and considered, although part of the line in the Malay Peninsula, and elsewhere, might be taken by land, that the speediest and most reliable means of carrying the object into effect would be found in the submergence of submarine cables, if properly constructed and laid. The regularity of the working of a good system of cables would, in his opinion, soon compensate for the additional outlay involved over such sections of the line. It was thought that a line might be carried, in a comparatively short time, from Rangoon to Singapore, thence to Batavia joining the Dutch land lines there, and passing from the south-eastern extremity of Java to Timor, onwards to the Australian coast, whither the Australian land lines were rapidly advancing, and would be erected to meet the cable. From Singapore a line would be carried to China, touching at Saigon, or the Peninsula might be crossed at Mergui, and the sea line be carried thence across the Gulf of Siam.

LONDON ASSOCIATION OF FOREMAN ENGINEERS.

At the monthly meeting of members of this society held on Saturday, the 4th ult., Mr. Joseph Newton read a paper on "Foremen and their Associations." He proceeded to review the progress of mechanical improvement during the past half-century, and to demonstrate the part foremen had performed in relation to that progress. The history of the Institution of Civil Engineers, and the good it was now effecting, were dwelt upon at considerable length, and a moral was deduced from its early career and difficulties favourable to the prospects of the Association of Foremen. The duties of employers and workmen towards each other, and the mission of intermediate agents, who were expected to act fairly and dispassionately towards both those classes, occupied much of the writer's attention, and his remarks seemed calculated to smooth down incidental differences, and to allay professional jealousies, and the qualifications necessary to be possessed by foremen for the effective performance of their varied offices were pointed out, and the value of such societies as their own in rendering its members more competent was endeavoured to be shown. Finally an appeal was made for the constant production of papers at the monthly meetings of the association, and more energetic action for the promotion of its general prosperity.

At the conclusion of the paper some applause manifested itself, and Messrs. Briggs, Dubridge, Sanson, and Fishwick, having expressed their approval of the writer's efforts, a vote of thanks was unanimously awarded to that gentleman. The proceedings then terminated.

It may be mentioned that Mr. David Walker filled the chair on this occasion, and that the number of members present was very large.

As Mr. Newton's paper has subsequently been placed in the printer's hands, it is possible that we may notice it next month.

MANCHESTER ASSOCIATION FOR THE PREVENTION OF STEAM BOILER EXPLOSIONS.

The ordinary monthly meeting of this association was held on October 31, when Mr. L. E. Fletcher, chief engineer, presented his report, of which the following is an abstract:—

"During the last two months 550 engines have been examined, and 998 boilers, and 14 of the latter tested by hydraulic pressure. Of the boiler examinations, 746 have been external, 27 internal, and 225 entire. In the boilers examined, 282 defects have been discovered, 3 of those defects being dangerous.

"On the present occasion I have to report the occurrence of six explosions, by which five persons have been killed, and six others injured. Not one of these explosions occurred to boilers under the inspection of this association. I have visited the scene of catastrophe in three instances, and in the fourth have been favoured with a careful report, accompanied with a sketch and photograph from an engineer residing near the spot. Of the remaining two explosions I am not yet furnished with correct particulars.

TABULAR STATEMENT OF EXPLOSIONS, FROM AUGUST 26TH, 1865, TO OCTOBER 27TH, 1865, INCLUSIVE.

Progressive No. for 1865.	Date.	General Description of Boiler.	Persons Killed.	Persons Injured.	Total.
30	Aug. 28.	Cylindrical. Externally fired	0	2	2
31	Sept. 8.	Ordinary Double Flue, or Lancashire. Internally fired...	0	0	0
32	Sept. 14.	Ordinary Double Flue, or Lancashire. Internally fired...	1	2	3
33	Sept. 26.	Steam Tug Boiler applied to stationary purposes. Internally fired	1	2	3
34	Oct. 2.	Particulars not yet ascertained	1	0	1
35	Oct. 16.	Particulars not yet ascertained	2	0	2
		Total	5	6	11

"No. 30 explosion occurred on the evening of Monday, August 28th, at an ironworks. No one was killed by this explosion, and though six persons were hurt, their injuries, except in two cases, were very slight.

"The boiler was of cylindrical construction, with elliptical ends and an internal return horse-shoe-shaped flue. It was externally fired, having a furnace underneath it at one end, the flames from which first passed beneath the bottom of the shell and then through the return horse-shoe-shaped flue to the stack. It was 26ft. long, 10ft. in diameter, and made of plates ⅜ths of an inch in thickness, while the usual working pressure was 18lb. on the square inch.

"The boiler was rent into three pieces. One of these consisted of the front elliptical end, and was blown to a distance of about fifty yards. The second consisted of a ring section of the shell, four plates in width, which had rent longitudinally and opened out into a sheet, and was thrown to a distance of about fourteen yards; while the third comprised the remainder of the shell with the internal flue tube.

"With regard to the cause of the explosion, the primary rent took place at the bottom of the boiler over the fire, where some of the longitudinal seams had been repeatedly repaired, and ran in line for four widths of plate. The principle of external firing, especially with boilers of so large a diameter as the one in question, is radically bad. The plates over the furnace are subjected not only to the impingement of the flames, but also to the disruptive strain caused by the pressure of the steam, the weight of the boiler, and the water within it, while any sediment the water may contain is sure to find its way to the bottom of the boiler, and too frequently to lodge immediately over the fire. This soon tells upon the seams of rivets. They begin to leak and have to be repaired. They leak again, and the repairs have to be repeated. Chipping and caulking seams of rivets by no means strengthens them, and even if new plates are put in it is seldom done with such care as not to strain or injure the old work; when, as in the present instance, in which repeated repairs had been effected, rupture ultimately takes place. In the externally-fired boiler, the pressure of the steam, which is internal, tends to open every flaw. In the furnace flue of the internally-fired boiler the pressure of the steam, which is external, tends to close every flaw, so that defects which would lead to explosion in the externally-fired boiler, would, in the internally-fired one, pass unnoticed, and without the slightest danger.

"No. 31 explosion occurred on September 9th, on the premises of a public company's waterworks. No one was killed or injured.

"It was of the Lancashire, double-flued, internally-fired class, and the explosion had resulted simply from failure of the furnace crowns from shortness of water consequent on the neglect of the fireman. The flue tubes at the furnace ends were hooped at each of the transverse seams, and the crowns had drawn down in each furnace at the width of plate just in front of the fire bridge, the collapse being confined by the T iron hoops to a single plate in each furnace. A sister boiler alongside was undisturbed.

"No. 32 explosion, by which one person was killed and two others injured, occurred on September 14th, to a boiler which was employed on the works of a dyer and calenderer.

"It was an ordinary Lancashire mill boiler, having two furnace tubes, and being internally fired. Its length was 30ft. 6in., its diameter in the shell 8ft. 2in., and in the furnace tubes 3ft. 1in., while the thickness of the plates varied from $\frac{3}{8}$ths to $\frac{7}{16}$ths of an inch in the shell, and was $\frac{7}{16}$ths of an inch in the furnace tubes. The ordinary working pressure was about 40lb. on the square inch, which is not too high for this class of boiler if well made and well kept.

"The external shell of the boiler was rent into at least five or six pieces, while the furnace tubes were torn from the shell intact, and both of them thrown from their original position, one of them to a distance of about forty yards.

"As to the cause of the explosion, the flues had not been in fault, neither had there been any overheating of the plates through shortness of water, but the explosion had arisen from the rupture of the shell in consequence of the plates being reduced in many places by external corrosion to the thickness of a sheet of paper. The boiler appears to have been laid down about eight years since, and to have been a cheap and inferior one. This explosion is one of those due to the most flagrant neglect.

"No. 33 explosion occurred on September 26th, at a brick and tile manufactory, and by it one person was killed, and two others very seriously injured.

"The boiler was of a class not generally made for stationary purposes, but for marine, and was of the construction frequently employed on board steam tugs. It was a second-hand one, and had, it appeared, already seen service afloat before it was set to work on shore. It was cylindrical in the shell, and fired internally, but the flue instead of going straight through from the front to the back, as in the ordinary 'Cornish' boiler, returned in a horse-shoe shape to the front end, and passed out through the bottom of the shell into an underneath brickwork flue leading to the chimney. When these boilers are employed on board steam vessels the return flue passes out through the top of the shell by means of an uptake, on which the funnel is planted, so that to adapt this boiler to stationary purposes this uptake had been removed and exchanged for the downtake leading to the brickwork flue just mentioned. The length of the boiler was about 13ft., the diameter 5ft. 6in., and the general thickness of plates about $\frac{3}{8}$ths of an inch.

"On examining the fragments I found that the boiler was rent into three pieces: the first of these, which consisted of the furnace and return-flue along with the front end plate, was thrown into a pond at a distance of 30 or 40 yards; the second, which consisted of the first ring of plates encircling the shell at the front end, was thrown over an adjoining tile shed; while the third, which was thrown forward a few yards only, comprised the back end plate, and the remainder of the cylindrical portion of the shell. This was rent transversely in a spiral direction round and round the boiler. The chimney stack was thrown down and the engine buried beneath the ruins.

"There is no difficulty in accounting for this explosion. The boiler was badly used and badly constructed. The safety-valve, it appeared in evidence at the inquest, was loaded with three bricks lashed on to the lever with a cord, in addition to the ordinary ball weight, so that the load amounted to 100lb. per square inch. It is not clear, however, that the steam was actually raised to this pressure, since it was stated that the finger of the steam gauge indicated 50lb. but a minute before the explosion, and on since testing the pressure gauge by a mercurial column, it was found to be practically correct. The boiler, however, was so badly constructed that a pressure of 50lb. on the square inch is quite sufficient to account for the explosion, as will be seen from the following:—The return flue tube was oval in shape, measuring 2ft. 6in. vertically, and 1ft. 4in. horizontally. This is a very weak form. All furnace and flue tubes should be truly cylindrical, since any departure from this shape, even though it may not exceed one or two inches, materially impairs their strength. This flue, however, departed from the circular shape by as much as 14in., while it was not of a true oval, but was flat or wall-sided for a height of 18in. from one end to the other. Also the form of the downtake was weak, one side presenting a flat surface of 2ft. 6in. square, the plate at that part being only $\frac{5}{16}$ths of an inch in thickness. This return flue had collapsed, and the plate of the downtake had torn from the shell, in consequence of which all the other rents previously referred to had started. This boiler, though it might have driven a condensing engine at a pressure of about 20lb. per square inch, was certainly not adapted to drive a non-condensing engine at a pressure of about 40lb. or 50lb., so that there is no difficulty in accounting for this explosion when the weak construction of the boiler is considered, in conjunction with the reckless way in which the safety-valve was overloaded.

CORRESPONDENCE.

We cannot hold ourselves responsible for the opinions of our Correspondents.

THE MECHANICAL THEORY OF HEAT.

To the Editor of THE ARTIZAN.

SIR,—I beg the favour of space in the columns of your valuable journal to call the attention of the profession to the unsatisfactory state of the science of thermo-mechanics.

Dr. Joule's equivalent (772ft. lbs. per unit of heat) seems to have been received without much examination, and it does not appear to me to be correct. I have read Dr. Rankine's writings on the subject, but have failed to be convinced by them, and therefore hope that some of your *practical* correspondents may correct me if wrong, or support me if right. If I apprehend Dr. Joule's theory aright, every unit of heat lost cannot produce *more* than 772ft. lbs. of work. Let us take an example. Suppose we have a cylinder of 1 square foot (144 square inches) area, and 2ft. in length (of stroke); let steam be admitted at 80lbs. absolute pressure of about 17·4lbs. per square inch, then the mean pressure will be about 47·8lbs. per square inch; the work done will then be, per stroke, 144 square inches × 47·8lbs. × 2ft. = 13,766·4ft. lbs. To produce this effect, $\frac{1}{2}$ a cubic foot of steam at 80lbs. per square inch is used, the steam being cut off at $\frac{1}{4}$ stroke, or 6in., which weighs ·087lbs.

Now, the total heat of steam at 80lbs. per square inch is 1209·1°, whilst the total heat of the same at 17·4lbs. per square inch is 1,181°; hence the difference between these quantities will be the total heat that has disappeared, and cannot be accounted for but by conversion into mechanical work. Its amount is 1,209 − 1,181 = 28·1° Fahr.; as stated in units of heat, it is 28·1° × ·087lbs. = 2·34 units of heat. No other heat appears to be lost, although some is converted into latent heat which was sensible, but all of which may be recovered by condensation of the steam in water. Dividing the work done in this case by the units of heat converted, we get $\frac{13{,}776\cdot4}{2\cdot34}$ = 5,887ft. lbs. per unit of heat.

I am, Sir, yours &c.,
LOUIS KUBNER.

MERSEY DOCKS AND HARBOUR.

To the Editor of THE ARTIZAN.

SIR,—I have read with great interest the article in your November number, entitled "A Historical and Descriptive Sketch of the Mersey Docks and Harbour," by J. J. Birckel. I was opposed to Mr. Rendel's plan for the construction of the Birkenhead Docks in all its details—the entrance, tidal basin, and sluicing apparatus. I was examined by the committee of the House of Commons upon the respective plans of Mr. Rendel and Mr. Abernethy, and there stated my objections to Mr. Rendel's plan.

I often met Mr. Rendel afterwards, and we had frequent and long arguments on the subject, especially with regard to the sluicing. The large tidal basin (large beyond precedent) was the first grand mistake, having no gates to the river entrance; the basin would silt up more than ordinarily fast. Of course, the impression was that the sluicing would keep the basin clear of mud. I demonstrated, by actual experiment to Mr. Rendel, that with four sluices, each 2ft. 6in. square, with an entrance only 48ft. wide, with 20ft. head of water, and only 2ft. of water to sluice against, that the mud was only removed 60ft. from the sluices, and there remained as a bank, besides the mischief that was done by the water making an immense hole in front of the apron, and undermining the sheet piling.

In the tidal basin at Birkenhead, it was expected that the sluices would clear the mud away with 12ft. of water in the basin.

Mr. Hartley says (with reference to the basin at Birkenhead), "that if, on further sluicing, it becomes evident that the scooping out of the material in front of the apron increases, I would advise large ashlar rubble, mixed with concrete, being filled in, to protect the sheeting." I can assure Mr. Hartley it would not have the effect he anticipates. I have seen it tried, and the water from the sluice tore it all up—for this reason, that it left so many projections for the water to impinge against. The only plan to prevent the scooping is to lay large blocks of granite, or other stone, on a bed of concrete; the blocks to be well cemented, and laid as even as possible, and about an inch below the level of the apron. The fact is that tidal basins are altogether a mistake, the expense is so great to keep them clear of mud, putting on one side the very great inconvenience caused by it in obstructing the passing of heavy draughted ships.

I have had great experience as a dockmaster, and have made the construction and working of docks my especial study, and I strongly recommend, as the cheapest and best plan, to have two entrances to the basin from the river, one for ingress the other for egress; that each entrance should have a lock, at least 60ft. wide and 300ft. long; the entrances to be at right angles with the stream of flood, and bell-mouthed. By having the locks 300ft. long, there would seldom be occasion for drawing the water of the dock down to the river level, consequently the basin and docks would be on an uniform level, with no interruption to the traffic into the basin, and from the basin to the docks during tide time; and another very important thing is, you have no run of water into the docks from the river, and thereby exclude the mud. I would add that each lock should have *three pair of gates*, so that if it was only a short ship going in or out, or a small number of craft, the water in the dock should be economised by using the short lock, that is, using the middle gates.

I would enter more minutely into the question generally, but I am afraid of trespassing too much on your space. In the construction of docks immense sums might be saved, if the advice of practical men were taken (the Birkenhead Docks for instance, though not the only docks), as so much depends on the situation of the entrances (regard being had to the set of the tide) and their construction, so that entrances are not mud traps, &c., whether docks can be profitably worked or otherwise, as the lifting of mud is an immense item in the expenditure of most docks. The supplying and economising of the water of the docks is a question of great importance also.

Since writing the above, I see by the papers that the great low-water basin at Birkenhead is admitted to be a failure, and that the Mersey Dock Board intend to initiate an entirely new plan of dock works at an ESTIMATED cost of £167,000, confirming all I have said in this letter.

Your obedient servant,
J. Hussey,
Dock Master E.I. Docks, London.

REVIEWS AND NOTICES OF NEW BOOKS.

The Slide Valve, practically considered. By N. P. Burgh, Engineer. London: E. and F. N. Spon. 1865. 76 pp.

In the work before us, the author appears to have said a good deal on a subject which might with advantage have been treated more briefly. We do not at all underrate the importance of a correct understanding of the action of the slide valve, but we think that the subject being already thoroughly treated in a practical manner in many of the really able works which have been written on the steam engine, Mr. Burgh's book is somewhat superfluous. To do it justice, however, it may be observed that the work may prove of some utility as an elementary introduction for the use of Tyros just entering the profession, for whom, we presume, it is written. Descriptions are given in this treatise of common slide valves, and also of a few double-ported valves.

In scientific books, especially such as profess to be practical, we are not in the habit of looking for very elegant composition, as the ornate is resigned in favour of the useful where the latter exists, but we do expect fair English. Mr. Burgh writes (p. 24), "In the days that the side lever engine rejoiced in being supreme, the slide valve was deemed necessary to have a stroke from 6in. to 24in." We hope for a better performance next time.

Treatise on Iron Shipbuilding: its History and Progress. By William Fairbairn, Esq., C.E. London: Longman, Green, and Co. 1865. 313 pp.

It is with unfeigned satisfaction that we take up Mr. Fairbairn's new book on iron shipbuilding, which, like all the other productions of the same eminent author, is characterised equally by the careful manner in which it is arranged, and by the thoroughly practical nature of the vast amount of information which it contains. The work commences with a history of naval construction since the introduction of iron for that purpose. The second division treats of the law of strains, and the properties of the material, and the mode of applying it, so as most advantageously to withstand the strains to which iron ships are liable. The third division treats comparatively of wood and iron built ships. The fourth, of the different forms of construction of ships of war. The fifth, of the question of ordnance. The sixth, the properties and resistance of iron armour plates. The seventh, of the resistance of shot and shell when fired against armour plates. The eighth, the construction or build of iron ships, comparing mercantile with naval vessels. The ninth, the changes which are in progress relative to the construction of ships of war. The tenth and last division contains a treatise, by Mr. Tate, on the strength of materials in relation to the construction of iron ships. It will be easily understood, from Mr. Fairbairn's unequalled experience in all matters connected with the strength of materials, that the work before us is such as he only can produce. The fact of its publication is all that is necessary to be known for it to be immediately sought by all interested in the engineering profession.

A Treatise on the Screw Propeller, Screw Vessels, and Screw Engines. Illustrated. By John Bourne, C.E. New Edition. Part II. London: Longmans, Green, Reader, and Dyer. 1865.

In this part of Mr. Bourne's valuable work there are two plates illustrative of the paddle engines of the *Great Eastern*, and one showing an elevation of the screw engines of H.M. gunboat, *Shearwater*. In the letter-press, the account of the different forms of screw propellers which are being proposed is continued; also the appendix, containing results of experiments on a screw steam packet.

The Iron Ship Builders, Engineers, and Iron Merchants' Guide and Assistant. By H. Burlinson and W. H. Simpson. London: McCorquodale and Co. 1865.

Although for many years past various tables of weights of iron have been published, affording more or less assistance to those who deal with that material, yet, until lately, one which could be pronounced perfect has been a desideratum, and that desideratum is now supplied by Messrs. Burlinson and Simpson. The arrangement of the tables is excellent; their scope may be judged from the fact that the weights of upwards of 150,000 different sorts of iron plates are given. The work is invaluable to those who are in the habit of getting up estimates.

Inorganic Chemistry for Science Classes. By Fearnside Hudson, F.C.S., F.A.S.L. London: Whittaker and Co. 1865.

The work before us appears to have been got up with considerable care. Amongst its principal features may be noticed the following:—A list of systematic names of the various chemical salts and compounds; the adoption of the new equivalents for the elements throughout the work; rules for calculating the percentage composition of a compound by weight and by volume; its formulæ deduced; its specific gravity determined as referred to hydrogen; with numerous other chemical calculations, illustrated by examples.

Of late years science students have generally been examined in some of the above calculations. Professor Hoffman, late of the Science and Art department, always gave a fourth of the questions where a knowledge of these rules was indispensable, which is also required to enable the student to fill in the Society of Arts Examination Papers on Chemistry.

Many of the latest improvements in chemistry are mentioned, and, taken as a whole, the work cannot fail to prove most valuable to all students of chemistry.

NOTICES TO CORRESPONDENTS.

J. B. (Dublin).—We believe the screw-shaft bearings to which you refer are perfectly satisfactory in practice if the cast iron is of good quality; it should not be too soft.

J. B. (Carigaline).—To determine the *height* of any object by a vertical angle, multiply the distance horizontally of the object in feet from the point where the observation is taken by the tangent to the angle of elevation of its summit: the product will be its height in feet.

Udor.—You may determine the *minimum* thickness of your reservoir wall by the following formula:—

Let t = *average thickness* of wall.
d = depth of water in feet.
w = weight in lbs. per cubic foot of wall.
l = horizontal distance in feet of centre of gravity of wall from its outer toe.
n = number of times strength of wall is to exceed pressure on it.

$$t = \frac{10 \cdot 4 \cdot n \cdot d^2}{w \cdot l}$$

Iron Master (Cullompton).—You will find it most convenient in estimating the weight of wrought iron girders of *uniform section* to multiply the sectional area in square inches by the length in yards, and 10·3 for the weight in *lbs. including rivets.*

W. May.—The tractive resistance of a train on a level *does* vary with the velocity; at average speeds it ranges from 10lbs. to 25lbs. per ton; but the *additional* power requisite to ascend an incline depends upon its steepness only, being such a fraction of the train's weight as represents the rate of ascent—thus a gradient of 1 in 100 would require an additional tractive force of 22·4lbs. per ton.

Loco (Swindon).—We believe the locomotive chimneys expanded at the top were introduced by Mr. Sinclair, of the Great Eastern Railway.

F. M.—The electrical resistance of a copper conductor is found by dividing the square of its length in feet by its weight in pounds, and multiplying the quotient by 140. The result is in electrical units.

PRICES CURRENT OF THE LONDON METAL MARKET.

	Nov. 4.			Nov. 11.			Nov. 18.			Nov. 25.		
	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
COPPER.												
Best, selected, per ton	99	0	0	99	0	0	119	0	0	119	0	0
Tough cake, do.	96	0	0	96	0	0	116	0	0	116	0	0
Copper wire, per lb.	0	1	0½	0	1	0½	0	1	2¼	0	1	2¼
„ tubes, do.	0	1	1	0	1	1	0	1	3¼	0	1	3¼
Sheathing, per ton	101	0	0	101	0	0	121	0	0	121	0	0
Bottoms, do.	106	0	0	106	0	0	126	0	0	126	0	0
IRON.												
Bars, Welsh, in London, per ton	7	12	6	7	12	6	7	12	6	7	12	6
Nail rods, do.	8	10	0	8	15	0	8	15	0	8	15	0
„ Stafford in London, do.	8	10	0	8	15	0	8	15	0	8	15	0
Bars, do.	8	12	6	8	12	6	8	12	6	8	12	6
Hoops, do.	9	15	0	9	15	0	9	15	0	9	15	0
Sheets, single, do.	10	10	0	10	10	0	10	10	0	10	10	0
Pig, No. 1, in Wales, do.	4	10	0	4	10	0	4	10	0	4	10	0
„ in Clyde, do.	2	17	6	2	17	3	2	17	9	2	18	6
LEAD.												
English pig, ord. soft, per ton	21	0	0	21	15	0	20	15	0	21	10	0
„ sheet, do.	20	10	0	21	0	0	21	0	0	21	0	0
„ red lead, do.	22	0	0	22	0	0	22	0	0	22	0	0
„ white, do.	26	0	0	26	0	0	26	0	0	26	0	0
Spanish, do.	19	0	0	20	0	0	20	0	0	20	0	0
BRASS.												
Sheets, per lb.	0	0	10	0	0	10	0	1	0½	0	1	0½
Wire, do.	0	0	9¾	0	0	9¾	0	1	0	0	1	0
Tubes, do.	0	0	10¼	0	0	10¼	0	1	1¼	0	1	1¼
FOREIGN STEEL.												
Swedish, in kegs (rolled)	13	0	0	13	0	0	13	0	0	13	0	0
„ (hammered)	15	0	0	15	0	0	15	0	0	15	0	0
English, Spring	18	0	0	18	0	0	18	0	0	18	0	0
Quicksilver, per bottle	8	0	0	8	0	0	8	0	0	8	0	0
TIN PLATES.												
IC Charcoal, 1st qu., per box	1	12	0	1	12	0	1	12	0	1	12	0
IX „ „ „	1	18	0	1	18	0	1	18	0	1	18	0
IC „ 2nd qua., „	1	9	6	1	9	6	1	9	6	1	9	6
IC Coke, per box	1	6	0	1	6	0	1	6	0	1	6	0
IX „ „	1	12	0	1	12	0	1	12	0	1	12	0

ARCHITECTURE OF IRON BRIDGES.

Notwithstanding the eminence to which the practice of engineering as a profession has attained, there is one great blot upon most of the important engineering works of the present century, which consists in the exhibition of features indicative of want of taste. Speaking æsthetically, the lovers of art are justified almost literally, in saying that whatever the engineer touches he spoils, for he appears to delight in going against rules of beauty, and wherever he can he will introduce straight lines.

In no class of works has this deficiency in attention to those elements, which if not scientifically useful, yet are important in other respects, been more evident than in the railway bridges which are increasing in number rapidly in all parts of the kingdom, obstructing the view of the observer when close, and when seen in the distance deforming the landscape. None but utilitarian ideas would appear worthy of regard now; the designers of large works seem to forget that it behoves them not only to find the bare means of carrying passengers over this river or that road, but also to erect a structure which shall not offend the eye; civilisation demands something more than the mere attainment of material ends, and with the improvement of art in any country will progress the mental culture and polish of its inhabitants.

Since iron has so largely entered as an element into the construction of important works, art, as far as it is concerned with architectural effect, has suffered, not only by the direct ugliness of certain parts consisting of that metal, but also by reason of the incongruities which arise where masonry and metal are combined without the exercise of sound judgment in their distribution.

In order to produce an effect which shall be pleasing, and that without either detracting from the strength and stability, or increasing in an exorbitant degree the cost of the work, a peculiar combination of qualifications is requisite in the designer. An architect would probably, in favour of æsthetic considerations, sacrifice some of the scientific principles upon which the use of iron for building purposes depends; and, moreover, he might be liable to eradicate, or endeavour to eradicate from his design, the characteristic forms of metallic constructions, and thus the mode of ornamentation adopted would prove unsatisfactory, by reason of not being in accordance with the nature of the materials dealt with. On the other hand, the engineer would probably attend only to those scientific principles which with the architect become of less importance, and so the æsthetic effect would be bad. When the two have combined the results have been frequently worse still, because of the incongruities introduced; thus, in one case which occurs to our memory, the girders of a viaduct were designed by an engineer far too strictly practical to be guilty of producing a pleasing effect by anything he originated, and the piers were devised by an architect who dealt with them very much as he might have treated a pedestal that was intended to be very ornamental, in stone. The piers were, however, like the bridges of iron (of course cast). The result of this combination may be readily imagined. The sides of the piers were enriched by imitation sculpture of an intricate design, from which the eye passed to the dead flat lines of the girders extending from it; these girders consisting each of straight top and top and bottom flanges, filled in with a lattice web of the plainest and most unsightly description.

Thus it is evident that the whole work should be designed by one individual (assisted, if necessary, with the advice of others), in order that it may have that unity which cannot be obtained when its different elements are the productions of different minds, and, therefore, based upon different ideas, and without which no satisfactory result can reasonably be expected.

We had hoped that the various strictures bestowed from time to time upon the railway bridges which have so richly merited them would have had some effect in inducing those to whom the execution of such works is entrusted to somewhat mend their subsequent designs, but in this we have been egregiously disappointed. All that has been said about the hideous girders at the London Bridge station of the South Eastern Railway seems not to have at all affected those to whom the demerit of their design is due, as is evidenced by the works with which the Thames is now being deformed at Southwark, and we are unwilling to think that the eminent engineers connected with the extension of the South Eastern Railway, to which our observations apply, are *incompetent* to produce anything better; hence we are driven to the conclusion that they, having obtained the necessary parliamentary powers to enable them to deface every site over which they pass, utterly disregard every consideration except such as are concerned with the fulfilment of their undertaking sufficiently well to ensure the approbation of the Government Inspector when he is called upon to examine the line, previous to its being opened for public traffic; and as railways must continue to be made, so long as *all* the principal engineers, by a sort of tacit understanding, continue to turn out nothing in the shape of bridges but what is unsightly, they are none of them likely to suffer in their practice on this account.

A great mistake has frequently been made as to the merit due to certain designs, in which credit has been given for good taste where really none has existed, the only notable feature evident being *magnitude*, which in itself will always impart some degree of grandeur capable of drawing the observer's attention, so as practically to render the defective details tolerably secure from comment. How frequently do we hear the roof of the station at Charing Cross praised; it is said to be a fine roof, but there does not appear to us to be one element of beauty in it: it is large, and that is about all. The filling-in at the entrance end of the station is about as unsightly as it well could be. The side walls are entirely massive; but, of course, as they are built to afford the greatest space for advertisements, there could be scarcely any ornamental effect introduced.

Westminster Bridge is often cited as a structure which combines at once great strength with beauty of design, and this praise is not unmerited, for certainly in appearance there is no bridge of metal in the kingdom to equal it; the graceful curve of its arches, and the consistent style of decoration pursued throughout, produce a most pleasing effect. There is, however, a serious defect asserted by some as existing in this bridge, a defect in principle. It is said not to act as an arch which suffers compression only, but to be a compound of brackets or cantilevers and straight girders—a mode of construction which involves a liability to vibration—which must very seriously affect the joints. This may to any required extent of course be obviated by making the elements of the arches stronger, but therewith comes increased expense; hence all the desiderata are not found in Westminster Bridge, although one great difficulty is overcome.

We cannot refer to Westminster without being reminded of the Lambeth Bridge. Conspicuous as it would be anywhere, it is the more notoriously so where it stands, from its contiguity to the handsome structure to which we have just alluded. Lambeth Bridge exhibits a design worthy of credit for the ingenuity which must have been expended in avoiding anything that could at all make it passable; verily, we believe there would have been not even a cornice or moulding if it had not been necessary to carry pipes from one side of the river to the other, which pipes are made to do a double duty—to try to be ornamental as well as useful; however, in the former attempt they do not succeed.

It is very unfortunate for the metropolis that it is helplessly forced to submit to the deformities with which it is day by day afflicted. Let a railway company once "get their bill," then there is no antidote; and that bill cannot be effectively opposed on the ground that the works, when complete, will in all probability be a disgrace to London; and if it could, the promoters could easily *promise* to erect bridges more worthy of the town they are proposing to benefit by their scheme; the matter can easily be got out of, as a hundred other similar difficulties are in the railway world—*when the parliamentary powers are obtained.* Unfortunately, those who might have the influence necessary to alter the evil of which we complain are not very willing to exert it, as they are concerned financially in such undertakings, and are easily persuaded that the exhibition of a little more taste would cost a great deal more money: they are guided by what they are told by those who have the management of the project.

Charing Cross Railway Bridge is not particularly unsightly, but we are of opinion that it might, by a slight modification of design, have been built for less money, or made much more ornamental for the same amount as has been expended on it in bringing it to its present condition.

What is evidently wanted is a thorough reform in the mode of designing girder bridges. The principles must be adhered to, but the form altered sufficiently to relieve the flat, or rather hollow, appearance which they present; this end is not attained by the one curved member of the bowstring girder, as the remaining straight elements are sufficiently numerous to maintain the ascendancy.

It is also useless to add ornamentation to a girder designed on the ordinary system, as by so doing it is not possible to conceal defects which are inherent, not only in the details themselves, but in the general outline also of the structure; hence, as we have stated above, it is only from a complete alteration of the radical form of each element that we can hope to obtain that improvement which is so great a desideratum in our works of magnitude executed in iron.

RECENT LEGAL DECISIONS

AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

Under this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical hearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least—less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

Partridge v. the Edgware and Highgate Railway.—Compensation Case.—This inquiry was held at Edgware before Mr. Under-Sheriff Burchell and a special jury. Mr. Serjeant Parry and Mr. Channell appeared for the claimant, and Mr. Lloyd for the Company. The Company, it appeared, took a strip of land out of the middle of nearly 18 acres of grass land, with a frontage to Dean's Brook-lane, Hendon, dividing the remainder into two pieces of 6½ acres and 10½ acres; but altering the road, by raising it to cross the railway, so that 300ft. of the remainder would have no frontage. The witnesses for the claimant, Mr. H. Baker, of Kilburn, Mr. E. Roberts and Mr. R. C. Driver, both of London, valued the land at £250 per acre, as accommodation and not agricultural land, making, for the quantity taken (adding 20 per cent.) £350 to £386, and for the severance and damage £750 to £800. The railway would be nearly on a level with the land, and no communication would be given. The Company did not call any witnesses, but relied on a speech by counsel, who contended that the damage was imaginary, and that all necessary communications would he given by two justices; that there was no value in the land beyond that for agricultural purposes; that there would be little or no injury or depreciation; and suggested that £400 or £450 would be ample compensation for land and damage. The jury, after considering for a short time, assessed the value of the land at £350, and the damage at £500, total, £850.

Non-completion of Contract.—The case of Russell (clerk to the Merthyr Tydvil Board of Health) *v.* Tucket, recently tried in the Court of Queen's Bench, was an action by the local Board of Merthyr Tydvil against the surety of a contractor, to recover damages for non-completion by him in due time of certain works he had undertaken to execute for them. The defence in substance was, that the specification was not duly signed by the Board. The Act required that the contract should be executed by five members of the Board, and the contract itself was so executed; but the specification which was referred to therein, and so incorporated therewith, was not so signed, and this fact formed the basis of the defence set up by the sureties. The Lord Chief Justice and the other members of the Court thought that there was neither a legal nor an equitable defence. As to the equity, it was rather the other way, for the sureties had not, and could not have been dammified. It was not as though there had been no specification drawn up at the time of the contract. There was such a specification, and it was identified, and had been acted upon. What did it matter now that the specification had not been regularly signed? The contract itself had been so signed, and referred to, and identified as the specification. Judgment for the Board.

Principal and Surety.—In the case of the Union Bank of Manchester (Limited) *v.* Beech, the defendant had given a guarantee to the bank to secure a floating balance due from one Taylor, a customer to the bank, and the guarantee contained a proviso that no forbearance to, or composition with, the principal (the debtor) should discharge the defendant, but that the bank might deal with the principal at their discretion. Afterwards the debtor entered into a deed of arrangement, which the plaintiffs (the bank) executed. The deed contained an assignment for the benefit of creditors and a release of the debtor, without any reservation of rights against sureties. It was held by the Court of Exchequer that the deed did not discharge the defendant from his liability as surety.

Shareholder's Non-Liability as Contributory.—The Lords Justices have reversed the decision of the Master of the Rolls, in *re* the Agriculturist Insurance Company (Lord Belhaven's case). Lord Belhaven had agreed to take shares in the company, and he paid a deposit in respect of them, but afterwards refused to accept them. An action for calls being threatened, a compromise was entered into between him and the directors, whereby he was to pay £50, and he released from all liability in respect of the shares. The deed of settlement authorised the directors to enter into compromises, and the transaction was made known to the shareholders, and confirmed at a general meeting. The company being afterwards wound-up, it was held by the Lord Justices that, in the absence of all suggestion of fraud or collusion between the shareholders and the directors, the arrangement was valid and binding, and that the appellant's name was improperly inserted in the list of contributories.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

Enlargement of the National Gallery.—The Commissioners of Works and Public Buildings have issued their plans for the extension of the National Gallery, preparatory to their being submitted to Parliament. The portion of land proposed to be taken is at the back of the Gallery, on the north side of Trafalgar-square, bounded by Hemming's-row on the north, by St. Martin's-place on the east, by Duke's-court on the south, and by Castle-street on the west. It is proposed by the commissioners to purchase St. Martin's Workhouse, and Archbishop Tenison's Grammar School, which stand on the site indicated.

Sewage Utilization at Preston.—A report by Mr. J. Newton, C.E., on this subject, has been presented to the Corporation, and printed by their order. Mr. Newtons plan is to appropriate the sewage at Marsh-end, near the junction of the two mains which drain the whole town into the Ribble, and from this point to force the sewage, by means of a forty-horse power engine, through iron pipes, of 20in. in diameter, on to the marsh lands purchased for the purpose. The cost he estimates at £73,000, including the purchase of 865 acres of Clifton-marsh, and the annual expenses at £5,043, or £5,168 an acre. He anticipates from the working of the scheme a revenue of £7,500 per annum, clear of all expenses.

Serpentine.—The fracture of the common serpentine is harsh and brittle, but that of the commercial serpentine is in flakes, like slate. It is adapted for taking the finest carving, and wears even better than granite. Serpentine also retains its polish out of doors. The comparative degrees of strength of serpentine, Portland stone, and Devonshire marble, is shown by the statistics of the test made before the committee of the Institute of British Architects, on the 7th of August, last year. The shafts of each material were 1ft. in length and 3in. in diameter. The trial resulted as follows:—

		First Fracture.	Broken.
Portland stone, No. 1	Tons	7·3	10·25
Ditto, No. 2	„	8·7	8·7
Devonshire marble	„	9·2	10·7
Serpentine, No. 1	„	12·15	16·25
Ditto, No. 2	„	16·92	17·62

The figures relating to the fractures represent the hydraulic pressure applied, and indicate the superior weight-bearing qualities of serpentine. Thus it is shown that in regard to polish, hardness, strength, durability, and beauty, serpentine is a stone that is very desirable for the ornamentation of buildings.

Steam Cranes at Bordeaux.—At a recent meeting of the Institution of Civil Engineers of France, a paper was read by M. Maldaut, "On the Use of Steam Cranes at the Port of Bordeaux." In July, 1863, the Bordeaux Chamber of Commerce advertised for tenders for the right of loading and discharging vessels at that port, by means of apparatus to be supplied by the contractors. Fourteen or fifteen plans were sent in from France and England, based on the application of water power and of steam, for the purpose. Under the advice of the consulting engineers, however, and after an examination which lasted almost a whole year, all the plans submitted were put aside, and it has now been decided simply to extend the application of steam to all the cranes of the port, in accordance with the experience that has been derived from four of these cranes during seven years past. It is found that the average daily expenses of a 1½-ton steam crane (1,500 kilogrammes), of 2 horse-power, employed in the ordinary discharging of a merchant ship alongside the quay, are 12fr. 80c., or 10*s.* 2½*d.* per day. If the work of one man turning a winch be taken equal to six kilogram-metres per second (2,577 foot-pounds per minute), a machine of 2-horse power will perform as much lifting work as twenty-five men, or about the same as six hand-cranes worked by four men each. In the presence of such manifestly satisfactory results, it is difficult to understand why the use of steam cranes is not more general.

Timber of Australia.—The *Inquirer*, Western Australia, says:—"It is perhaps of no very great moment to the persons immediately concerned in the transaction, that an engagement should have been entered into to deliver on board a ship, at Freemantle, 600 loads of mahogany sleepers, for an Indian railway, at £3 13*s.* 6*d.* per load; for the mere facts are, we presume, that the timber is to be had at the price, and that it is suitable for the intended purpose; nor, if the matter merely rested with the buyers and sellers, would it be worth notice otherwise than as a mere topic of the day. But, in truth, it concerns the whole colony to know that millions of acres in its vast area produce a timber which no other part of the world produces; and because it is virtually indestructible by white ant and seaworm, people will take the trouble to come here and buy it. It is no novelty to us to be told that our timber is good, or that if it can be supplied at a certain price there will be a demand for it; the same is said of everything under the sun which may be comprehended under the general designation of "raw material;" but it does so happen that our colony is the only part of the world where this commodity exists, and where the supply is virtually inexhaustible."

Statistics of the Dublin Exhibition.—In 1853 but one colony (besides India) and seven foreign countries were represented. This year twenty-one colonies, exclusive of India, and twenty-one foreign countries have obtained space. The number of works of art exhibited in 1853 was 1,493, while this year they amounted to 2,072. At a rough estimate the value of the industrial objects may be set down at more than £400,000, and the fine arts at nearly £300,000, making a total value of £700,000. The Exhibition has been open for 159 days and 51 evenings, and the entire number of admissions of every kind has been a little over 900,000, being an average of about 5,000 by day, and of 3,000 by night. The number of visitors was a quarter of a million under those of 1853; and the total receipts, about £45,000, are considerably under those of 1853, which amounted to £60,000. But for the Exhibition of that year it was necessary to erect wholly new and special buildings, at a net cost of upwards of £40,000, while for this year's Exhibition building, erected by a joint-stock company, a moderate equitable rent is all that the funds are chargeable with.

The Cholera and Water.—The Registrar-General, in his return for the past quarter just issued, says:—"It is gratifying to know that London and some of the other large towns are now in a far better condition to encounter the epidemic than they were either in 1848-49 or in 1853-54, when the disease killed 55,181 and 24,516 persons of both sexes and of all ranks in England and Wales. Cholera, like small-pox, is one of those zymotic diseases which exist in all climates. Under favourable conditions their products assume an active form, capable of inducing in other bodies the same morbid changes by which they were generated. For all practical purposes it may be assumed that the discharges of patients in the epidemic, either casually touching the mouth, or entering in dust and vapour through air or water, induce diarrhœa or cholera in a certain proportion of those exposed to their influence. Now London was supplied with the sewage water of a river by several companies in 1848-49; all except one got their water beyond the reach of the London sewage in 1853-54; and the mortality fell proportionately as the water became purer. At the present time the water of all the companies is comparatively little contaminated by zymotic pollution. The London pumps have also been placed under inspection. The drainage is in rapid progress. Analogy justifies the hope that, as the city is purified, and as the means of diffusion are cut off, the destructiveness of the disease will be diminished. The epidemic has hitherto commenced generally about October, and has only proved excessively fatal in the following summer. Thus all our towns have six months' notice and the whole winter for the preparation of defensive works. Every district in the kingdom should at once appoint its health officer."

Clay and Glycerine for Modelling.—We read in *Cosmos* that a mixture of clay and glycerine, which keeps its plasticity for any length of time at all temperatures, has been found very useful by modellers. The clay must be well dried before it is mixed with the glycerine. It is said that the mixture can be used in place of wax for the most delicate work.

Bankers' Safes.—Messrs. Thos. Milner and Son, of the Phœnix Safe Works, Liverpool, have completed a bankers' cabinet, intended to form one side of the public room behind the tellers' counter at the Bank of Brazil. Messrs. Milner have several times before constructed bankers' strong rooms, intended to be stowed under ground and carefully built in with brickwork, but this is the first time they have brought the principle of beauty to bear so largely on their work, and so contrived a group of safes as to form a really handsome piece of furniture. The cabinet comprises fifteen safes, arranged in three tiers, and of graduated sizes, the lower tier safes 2ft. 6in. in height, the centre 5ft. 6in., and the top tier 2ft. 4in. All the safes are 3ft. in width, except the centre one in each tier, which is 4ft. wide. The height of the structure, including the cornice and intersecting supports, &c., is 17ft. The doors are composed of two plates of half-inch wrought iron, with quarter-inch hardened steel between, so that supposing the outer iron plate pierced, there would still be no room to "work at" the surface of the steel plate beneath. They are also fitted inside with the double chambers containing the fire-resisting composition. In addition to all these precautions against thieves and fire is introduced another, suggested by the bold and successful robberies in jewellers' shops in London about twelve month's ago. The top, bottom, and front edges are fitted with square blocks or "guards," which, when the door is shut, drop into corresponding recesses in the side, top, and bottom framing of the safe. The weight of the cabinets is 25 tons.

A NEW DECANTER.—A very ingenious contrivance has been made by MM. Toselli and D'Allmagne, of Paris. They blow a small globe within a decanter or claret jug. This globe, which has its opening at the side of the larger vessel, serves to hold a freezing mixture to cool wine or water in summer, and in winter may be filled with warm water to take the chill off Burgundy or port.

SCIENCE EXAMINATIONS OF THE COMMITTEE OF COUNCIL ON EDUCATION.—The following are the results of the reports of the examiners on the examination which took place throughout the United Kingdom during the month of May last, comparing the numbers of candidates in 1864 with those of 1865. In geometrical drawing they have increased from 312 to 608; in machine drawing, from 155 to 293; in building construction, from 55 to 74; in mathematics, from 78 to 182; in theoretical mechanics, from 43 to 94; in applied mechanics, from 26 to 50; in magnetism and electricity, from 269 to 291; in inorganic chemistry, from 851 to 946; in geology, from 164 to 170; in animal physiology, from 479 to 548; in zoology, from 174 to 182; in vegetable physiology, from 121 to 229; in metallurgy, from 70 to 93; in navigation, from 99 to 103; in nautical astronomy, from 70 to 82; in steam, from 63 to 76; and in physical geography, from 70 to 121. In five of the subjects there has been a slight decrease—viz., in acoustics, light, and heat, from 253 to 244; in organic chemistry, from 142 to 139; in mineralogy, from 28 to 19; in systematic botany, from 70 to 33; and in mining, from 22 to 15. The progression during the last five years has been as follows:—In 1861 there were 878 candidates; in 1862 there were 1,943 candidates; in 1863, 2,671 candidates; in 1864, 3,644 candidates; and in 1865, 4.593 candidates. The total number of prizes given in 1865 was 1,482, against 1,318 in 1864. The number of medals awarded in 1865 was as follows:—8 gold medals, 1 certificate instead of a gold medal, 17 silver medals, 6 certificates instead of silver medals, 22 bronze medals, and 12 certificates instead of bronze medals. The following were the successful candidates for the Royal Exhibition awarded after the result of this examination:—For those at the Royal School of Mines, London—Thomas Jones, Woolwich; Edward Collens, Bristol; John A. Griffiths, Manchester. For those at the Government School of Science, Dublin—Frank Clowes, London; James Craik, London; John Conolly, Bandon; and W. B. Leonard, Drogheda.

NEW STEAM FIRE-ENGINE FOR LIVERPOOL.—On the 17th ult. a new steam fire-engine which had been manufactured by Messrs. Merryweather and Sons, engineers, London, was attached to the Liverpool Fire Brigade. Soon after its arrival it was tested in the presence of the mayor and members of the corporation, and the results were very satisfactory. The engine is constructed of Lowmoor iron and gun-metal, and runs upon four high wood wheels; is easily drawn by two horses, and can be drawn completely round in its own length, *i.e.*, 13ft. The boiler is of a vertical tubular description, with a heating surface of 127ft.; it is fed by a Gifford's injector, a feed pump, and the main pump which supplies a reservoir over the steam cylinder. The advantage of having these three systems is that the boiler can be fed by each one of them independently. There are two steam cylinders each 6¾in. in diameter, and two horizontal double-action pumps each 4¾in. in diameter, and an 18-in. stroke, with one delivery each. At each end of the pump are two valves, one for induction and one for delivery, both of which are on the underside, thereby cleaning the pumps from grit or dirt at every stroke. The induction pipe is in front of the pumps, and is 4½in. in diameter. The weight of the engine complete is 40 cwt. It was again tested at the Central Fire Station on the 18th ult. under the personal direction of Mr. Merryweather, jun. To supply the engine with water three jets were attached to the mains, and for delivery one 40ft. length of hose was attached to each side of the engine. The fire was lighted, and in 6min. 5lb. of steam was generated; in 7½min. 20lb; in 8min. 40lb.; in 9¼min. 80lb. The engine was then set to work. A 1¼in. jet of of water was projected vertically at least 150ft.; a 1½in, jet about 120ft.; and two 1in. jets were projected at least 150ft. The results were extraordinary, the engine working with perfect ease and delivering about 350 gallons of water at a working speed of between 70 and 80 strokes per minute, and a steam and water pressure of between 80lb and 100lb.

THE FOREIGN COAL TRADE.—The exports of coal, cinders, and culm from the United Kingdom have continued to increase. In September they amounted to 842,698 tons, against 811,882 tons in September, 1864. and 794,195 tons in September, 1863. In the nine months ending Sept 30th, the exports attained a total of 6,938,213 tons, of the value of £3,306,224, as compared with 6,615,915 tons, of the value of £3,100,212 in the corresponding period of 1864, and 6,239,329 tons, of the value of £2,767,875 in the corresponding period of 1863. The exports to France experienced a slight check in September; but, taking a general view of the first nine months of this year, they show a very large increase, having amounted to 1,177,183 tons, as compared with 1,065,192 tons in 1864, and 978,016 tons in 1863 (corresponding periods). The exports have declined this year to Holland, Spain, Italy, the United States, and British India; but they have increased very largely to Prussia (in which direction the demand was seriously affected last year by the Dano-German war), and have respectably advanced as regards Brazil, Russia, Sweden, Denmark, the Hanse Towns, &c. Considering the very large quantity of coal which France imports from Belgium, and the great expansion in the indigenous coal production of the French Empire, the growth in the French demand for British combustible is not a little remarkable

STONE BREAKING MACHINERY.—In the stone breaker, or "quartz cracker," as it is more generally called, introduced by the Bullock Ore Dressing Machine Company, the moveable jaw is so adjusted as to receive the same forward and downward movement at the top as at the bottom, and thus all parts of the jaw are moved with equal force against the rock. At the same time, by a change of the length of one or both of the levers, more or less motion, and of course more or less force, may be given to the top or bottom, as it may be required, to meet any condition that may arise, at a very trifling expense. The jaws may be adjusted in a moment so as to discharge the rock the size of nuts, or in a fine dust. The cost, power, and capacity of this cracker are in proportion to its size, and the amount of power applied to work it.

PISTON PACKING.—Mr. Edwin Kendall, of New Lebanon, N.Y., proposes, instead of the usual metallic rings, to provide a brass spring, coiled in continuous circles, and inserts it between the heads or flanges of the piston. It is claimed that this method of packing a steam piston is cheaper, more expeditious, and less liable to get out of order than that generally used, and requires no attention after it is put in until it is worn out.

THE USE OF WATER AS FUEL.—An interesting discussion was held at the New York Association for the Advancement of Science and Art, at the Cooper Institute, on the Use of Water as Fuel. Dr. William E. Hagan, of Troy, N.Y., has recently been conducting a series of experiments to determine whether steam could be advantageously used as an aid to combustion. The subject was brought before the association at their last monthly meeting, and a committee appointed to test the merits of Dr. Hagan's plan. The committee reported through the chairman, that although they had been testing the matter by experiment for a week, that inasmuch as the apparatus used by them was not adapted to determine with extreme accuracy the exact difference made in the combustion of coal by the introduction of the steam, they had not prepared a formal report of the results obtained. The chairman of the committee, Dr. Leonard D. Gale, however, gave a very interesting informal account of the experiments made, and the results thus far obtained. The first object which the committee sought to obtain being the value of the discovery for domestic purposes, they had conducted their first experiments with an apparatus much resembling a common cooking stove; in fact, differing from one only in having attached to it in front a thick piece of cast iron, with a cavity in the centre very much like a common "water back" to a stove. On the top of the apparatus were four kettle holes, in each of which a kettle of water was placed, while another vessel of water was placed in the oven behind. The amount of heat produced during the various experiments was determined by the weight of water evaporated from the vessels. The experiments were conducted for three days by burning coal in the apparatus in the ordinary manner, the amount of coal placed in the stove being carefully weighed each day, as also the amount of ashes and residuum left and the amount of water evaporated. For the other four days a small stream of water was admitted into the central cavity of the hollow iron front above described. which, being converted by the heat of the fire into steam, passes through a series of small openings into the centre of the burning coal. As in the other experiments, the amount of coal consumed and of water evaporated was carefully determined and noted. The nett results of the seven days' experiments showed that while 1lb. of coal burned in the ordinary way in the apparatus would evaporate on an average 3 82·100lbs. of water, the same coal burned in connection with the steam would evaporate 5 49·100lbs. of water per pound of coal, the proportion being as 50 to 75. In other words, that the use of the stream of steam, in connection with the coal, increased the available heat obtained from the latter about 50 per cent. We give the figures in gross, although Doctor Dale gave them in detail at considerable length. As in these experiments a great part of the heat was necessarily lost by radiation from the exposed surface of the stove, it was impossible to determine accurately the exact amount of increase of heat caused by the presence of the steam; but enough was shown to demonstrate that the subject is well worthy the attention of economists. Dr. Hagan stated that a locomotive was now running on the New York Central Railroad, in which, by the use of his system, 30lbs. of water were converted into steam by an average consumption of 1lb. of coal, This company are now applying the principle to six more of their locomotives, and are about to construct twenty others, built expressly to include this principle. After some discussion the further consideration of the subject was again referred to the committee, who were instructed to examine it thoroughly, and report at some future meeting.

UTILISING BLAST-FURNACE GASES.—The plan now carried out for more than a year past by Mr. Addenbrooke, at the Rough Hay Furnaces, Darlaston, consists in forming a ring of openings in the wall of the furnace all round the neck, at a depth of only 4ft. below the furnace top, through which the gas is drawn off by the suction of a chimney into an external flue surrounding the neck of the furnace, whence the descending gas main conveys the gas to the steam-boilers and hot-blast stoves, where it is consumed. The gas openings are formed by a series of cast-iron segments or boxes, built into the wall of the furnace flush with the lining, each casting having an inclined opening through it 1ft. high, sloping upwards and outwards into the neck flue. The materials in the furnace mouth are kept charged up to about 3½ft. above the top of the gas openings in ordinary working; and the opening of the gas-valve which covers the descending gas main is so regulated that under no circumstances is the whole of the waste gas drawn off from the furnace, but there is always a small quantity of gas escaping through the materials above the gas openings, and burning out at the open top of the furnace. This precaution is necessary to prevent the risk of any air being drawn down by the chimney through the materials in the furnace top; and also in order to ensure the due preparation of the materials charged, by drying and warming them in the furnace top before they descend lower into the furnace. At the same time all excess of gas produced by the furnace beyond the quantity drawn off through the gas openings escapes with perfect freedom at the furnace mouth, the same as in the present ordinary open-topped blast-furnaces where the waste gas is not utilised.

SAFETY-VALVE.—The object of Mr. Naylor's invention is to prevent the steam whilst blowing off through the safety valve from rising in pressure beyond the limit to which the valve is adjusted. The valve is loaded by a spring acting through a lever, one end of the lever bearing upon the valve, while the other end is bent down out of the straight line to such an extent that the point of attachment of the spring, instead of being in the same straight line with the bearing points of the valve and the centre pin, is at an angle of 55° to that line; and, therefore, when the valve is lifted by the steam pressure the depression of the tail end of the lever causes the effective leverage at which the spring acts to be shortened simultaneously with the extension of the spring. Hence the increased pressure of the spring, consequent upon its extension by the lifting of the valve when blowing off, may be entirely counteracted by the shortening of the leverage at which it acts; and in practice the bent form of the tail end of the lever is so adjusted that, when the valve lifts by the steam blowing off, the load upon the valve is actually diminished, notwithstanding the increase of pressure of the spring.

THE ANGLO-SWEDISH STEEL AND IRON COMPANY (LIMITED).—A prospectus with regard to the above company has been recently brought before the public. It states that an arrangement has been effected to amalgamate the very extensive iron, steel, ship-building, and engineering works and estates of the Högbo Steel and Iron Works Company, in Sweden, with the Northfield Steel and Iron Company, near Rotherham, in England, both of which works are in full operation, and to form the same into a company, with limited liability. The Högbo Company, in Sweden, possesses superior facilities for the manufacture of steel and iron by the Bessemer method, and at these works, the Bessemer process for producing steel first became a practical success. It has, however, been found absolutely necessary, for the full development of the resources of the Högbo Company, to secure a depôt for their steel ingots, together with forging and rolling power in England, and the Northfield Steel and Iron Company having already in existence extensive plant specially adapted for the forging and rolling of steel ingots, it has been agreed to work the two concerns under one management and in one interest. The whole of the estates and properties of the vendors, including blast furnaces, rolling mills, foundries, engine and shipbuilding works, together with stationary engines, railways, ships, tools, &c., used in carrying on the same, will be taken at a valuation. The vendors accept as part payment of the purchase money the sum of £200,000 in shares of the Company, with £12 10s. only credited as paid up on each share, thus becoming proprietors of £100,000 of the capital of the Company, the whole of which the vendors agree to hold for five years; and that no dividend shall be payable on such shares so held by them during such period, until the other shareholders shall have been paid 15 per cent. per annum on the paid-up capital. The vendors further accept, as part payment of the purchase money, the Company's debentures for £200,000, redeemable in three, five, and seven years. A mortgage of £200,000, already secured on part of the property proposed to be purchased, will also be transferred to the new company.

French Engineering.—The *Avenir Commercial*, an excellent authority on such matters, states that, from the 1st of January to the 31st of August last, there were exported in divers forms, such as tools, machines, bridges, rails, &c., 95,000,000 kilogrammes of iron work, and there will probably be about 200,000,000 in the whole year. Workmen's wages and the profits realised on these exports will not be less than 200,000,000f., or £8,000,000 sterling. The French dockyards are now building two screw steamers for Russia, and at Havre for the same country a 2,400 horse-power steam engine. At Nantes a regular flotilla of iron lighters are in course of construction for foreigners; in Paris, dredging machines for Egypt; at Bordeaux, several plated ships have been ordered for the King of Prussia, and for the Italian Government a cuirassed frigate to be called the *Ancona*. A short time ago the *Palestro*, a cuirassed corvette, for the same Government, was launched at Seyne, near Toulon. At Seyne, also, they are building for the Turkish Government three cuirassed gunboats, and the Emperor of Brazil has ordered two cuirassed brigs, and a corvette with 250 horse-power engines. The same firm is building two cuirassed steam corvettes, of 300 horse-power each, for Italy, and three batteries for Turkey, besides a considerable amount of machinery for the Isthmus of Suez Company. Five or six millions' worth for sugar works are ordered for Egypt. From this list should not be omitted the 17 locomotives which the ironmasters of the Creuzot are to send to England; those which the works of Alsace are preparing for a German railroad; and castings from the foundries of Marquise for England.

NAVAL ENGINEERING.

The "Vixen" an iron-cased twin-screw gunboat was launched from the Deptford Green Dockyard on the 18th ult. She is an interesting experiment of the combination of wood and iron principle. Her 4½in. armour-plates are sheathed with wood, so that she can be coppered, and thus not have her speed retarded by the foulness to which iron ships are liable, while she is quite their equal in strength. The *Vixen* is 160ft. in length, 32½ft. in breadth, 13½ft. in depth, and her builders' measurement is 740 tons. Her twin-screw engines are 160 nominal horse power. She is to be armed with two 300-pounder shunt guns and two 24-pounder howitzers. Her complement of men will be 80, and she will carry 97 tons of coals, sufficient for six days' consumption at full power, or 12 days' ordinary steaming; 10 tons of water for 4 weeks use, and 10 tons of provisions for 12 weeks. Her total displacement, when fully equipped, will be about 1,121 tons.

Anti-Fouling Compositions.—An examination of the various iron plates submerged upwards of 12 months since in Chatham harbour, each coated with one of the numerous anti-fouling compositions has been instituted by the officials of the establishment, when, with the single exception of a pair of plates coated with Gisborne's anti-fouling mercurial mixture, the whole were more or less thickly coated with shellfish and seaweed, while on the plates treated with the mercural mixture scarcely a mussel was to be seen, excepting in places where the paint had been rubbed off. As many as eight different compositions were tested.

New Government Transport.—The Admiralty, in conjunction with the Council for India, has commissioned Messrs. Laird Brothers, of Birkenhead, to construct a large iron screw steamer, to be called the *Euphrates*, and which is intended to be exclusively employed in the transport service between this country and India.

Cable Testing.—The strain to which the navy cables are subjected, states "Chambers Journal," varies from four tons to ninety-one tons, according to the thickness of the iron which forms the links. Some of the machines are now so powerful that they could test to nearly twice the strain deemed necessary for any of the government cables. It is found that one-fourth of the cables ordered by the Admiralty prove defective under the test; which comprises the tension-strain of each section separately, and the minute examination of every link, stay-pin, shackle, swivel, and staple. The cable is not rejected, but the maker replaces the defective piece by another; or else it is done at the dockyard, and he is charged the cost. Down to the present time, chain-cables belonging to the royal navy have been in better repute than those in the merchant service, owing to the more scrupulous testing. An under-writer, or ship-insurer, will grant better terms if a ship's cable have borne the Admiralty test, than if only the commercial test is applied. At Liverpool and elsewhere, testing-machines are kept, where commercial cables are tested, registered, and stamped for a certain fee, and a certificate given with each tested cable. But then there is, if not rascality, at least recklessness in some of the shipping people; for it is known that cables which have failed under the Liverpool test have been sold at a low price to such shipowners as do not scruple to risk life if they can save a little money by it. The superb chain-cables supplied to the *Great Eastern* by Messrs. Brown and Lennox bore a test such as has never been used for any others; the stoutest of them were tested up to one hundred and forty-eight tons, and resisted a breaking strain up to one hundred and seventy-two tons; as much as twenty-four pounds per ton was paid for these cables.

The iron-cased Screw, *Lord Clyde*. 24, was taken outside Plymouth Sound on the 11th ult., to undergo a trial of her engines. In consequence of bad weather she was only able to make two runs at the measured mile, but these, considering her peculiar construction, were very satisfactory. The *Lord Clyde* was built at Pembroke on the lines of Mr. Reed, Chief Constructor for the Navy. She is 208ft. long, 58ft. 9in. broad, and has a depth of hold of 20ft. 9in.; her burden is 4,067 tons. Her engines are fitted with cylinders of very large diameter for the purpose of using the steam expansively; also with surface condensers, superheaters, and tubular boilers, having brass tubes 2½in. outside diameter, and containing an aggregate heating surface of 19,000 square feet, with a grate surface of 700 square feet. There are nine boilers arranged in two groups, one of four pieces and the other of five, each group having a chimney 7ft. 1in. in diameter. The engines are capable of exerting an indicated power of 6,000 horses, being a multiple of 6 to 1 of their nominal power, and, as close as their requirements would admit, are of the same style of double piston rod engine as those made by the same firm with ordinary condensers, which are well known both in the British and foreign navies. They are a pair of direct-acting horizontal engines, with double piston rods, having cylinders of 116in. diameter, with a stroke of 4ft. Each cylinder weighs upwards of 30 tons, and the crank shaft weighs 25 tons. The slide valves are placed vertically on the outside of the cylinders, and are worked directly by means of a solid link motion. Although the cylinders are brought well towards the fore and aft centre line of the ship, there is ample space between the connecting rods and the cylinders for getting to the glands of the stuffing boxes of both the piston rods and the air pump rods, which latter are worked from the main pistons of the engines. The connecting rods are 9ft. 5in. long, being seven times the length of the crank. The air pumps and the foot and delivering valves, which are of india rubber, working on brass seats, can be easily examined and removed. The feed and bilge pumps, in brass, are fitted with india rubber valves, and worked direct from the cross heads. Gridiron expansion valves are also applied, and are worked directly from the shaft by means of eccentrics and rods. The condensers are fitted on Hall's system, with vertical tubes, the end of every tube having a small stuffing box and packing gland, both in the top and bottom tube plates of the condensers. The condensing water is circulated by means of two centrifugal pumps, one to each condenser, which are worked by a pair of independent donkey engines. In addition to the ordinary starting gear, steam cylinders are fitted to facilitate the handling of these large engines. The machinery is fitted with a four bladed propeller, fixed on the stern shaft. The cylinders are the greatest in diameter, and the engines therefore the largest that have yet been supplied to the British navy. The draught of water of the *Lord Clyde* was forward, 22ft. 4in.; and aft, 24ft. 10in. The vacuum in the condensers, forward, 27in.; aft, 28in. Speed, first run, 4min. 26sec.; second, 4min. 26sec., equal to 13·533 knots per hour. The speed of the screw was 12·825, showing a negative slip of ·708, or nearly three-quarters of a knot. Revolutions, first run, 55½ per minute; second, 56; indicated horse power, 6,110; nominal, 1,000; propeller, four bladed; diameter of screw, 23ft.; pitch, 22ft. 6in. Wind north-east, force, 1 to 2. Sea smooth.

The Turkish Ironclad, the "Sultan Mahmoud." has undergone a trial of her speed and machinery. She is an iron frigate, ironclad with 5½in. plates, and is upwards of 4,000 tons burden. She is engined by Messrs. Ravenhill, Hodgson, and Company. The ship was built by the Thames Iron Shipbuilding and Dry Dock Company (limited). She was tried and commenced her official run at the Maplin on the 15th ult., and afterwards proceeded on her voyage to Constantinople, calling at Plymouth. The speed of the ship was over 12 knots per hour, the engines making 55 revolutions per minute. The engines are of excellent workmanship, and showed no signs of hotbearings.

The "Vestal" has been successfully launched at Pembroke Dockyard. The *Vestal* is intended as a despatch vessel, and has a projecting prow from beneath the water-line. Her dimensions are as follows:—Length between perpendiculars, 187ft.; length of keel for tonnage, 158ft.; breadth, extreme, 36ft.; breadth for tonnage, 35ft.; depth in hold, 19ft.; burden in tons, 1,081; armament, four heavy guns; horse power, 300.

The "Bristol," 39, steam frigate, 3,027 tons, 600 horse-power, which has been fitting in Sheerness dockyard for service on the West Coast of Africa, was taken on the 17th ult. to the measured line off Maplin Sands for the final trial of her engines, previous to leaving for her destination. She made six runs on the measured mile, with the following results:—First run, 7 min. 3 sec.; revolutions of engines, 57·25; speed due to time, 8·511, Second run, 4 min. 41 sec.; revolutions of engines, 58; speed due to time, 12·811. Third run, 7 min. 13 sec.; revolutions of engines, 56; speed due to time, 8·314. Fourth run, 4 min. 43 sec.; revolutions of engines, 58; speed due to time, 12·721. Fifth run, 6 min. 58 sec.; revolutions of engines, 56; speed due to time, 12·632. Her true mean speed was 10·596. Two runs were also made at half-boiler power, giving a true mean speed of 8·054. The draught of water forward was 21ft. 2in.; aft, 24ft. 1in. The load on the safety valve was 20lbs. The state of the sea was rough, and the wind was blowing from N.N.E. with a force of 5 to 6. The vessel was fully rigged, having all her stores on board and 404 tons of coals. The engines and boilers performed their respective duties very satisfactorily, and had the weather been favourable a greater speed would have been obtained. On the 16th ult. the *Bristol* made her final trip of speed at the measured mile in Stokes Bay. The wind did not exceed a force of 4. The ship's draught of water was 20ft. 1in. forward and 23ft. 1in. aft, the wind being at a force of from 3 to 4. It was from S.S.E., and there was a slight movement of water over the vessel's course, but not enough to affect her speed in the slightest degree. Under these conditions ten runs were made—six with full and four with half-boiler power—with the following results:—Full boiler power, six runs, 12·371, 10·286, 12·587, 9·524, 13·043, 9·549 knots; the mean of the six runs giving the ship a true measured mile speed of 11·272 knots. The mean vacuum was 26½in., with the safety valve loaded at 20lbs., and the revolutions of the engines were maximum 60, minimum 58. The four runs with half-boiler power gave 11·726, 7·214, 11·077, and 8·163 knots—the ship's mean speed being 9·346 knots. In testing the ship in making circles, she exhibited no properties differing from the greater number of ships of her class, or calling for particular remark. In comparing the results of this trial with the Maplin Sand trial, it will be found the ship gained an additional speed of 0·676 knot with full boiler power, and 1·292 knot with half-boiler power, a mean excess of 2 being also gained in the revolutions of the engines.

New Turkish Ironclad Frigate.—The new Turkish frigate, which is to be named the *Turkistan*, and which is being built by the Thames Iron Ship-building Company, will not differ materially in size from several of the ironclads already existing in this country, her proposed dimensions being 365ft. long, 60ft. in breadth, mean draught of water, 26½ft., and 1,150 nominal and 6,000 indicated horse power. It is, however, in the character and arrangement of her armour and armament that she will be widely different from everything else afloat, rendering her, in this respect, the most formidable vessel of war the world has yet seen. At the express request of the Sultan, she has been designed by our Chief Constructor of the Navy, and consequently she will embody in a striking degree all the improvements suggested during the construction of the latest of the iron frigates composing our ironclad squadron. The *Turkistan* will be protected from stem to stern at the water line, and over a battery containing sixteen of the largest guns in each broadside, the armour plates everywhere being 8in. in thickness, in addition to which the "skin" of the ship will be double throughout, as is the case with the *Bellerophon*. Two of the protected 300-pounder or other larger broadside guns will, at the same time, be placed at a height of about 20ft. above the water, and will thus have a range of fire all round the bow and stern, so that guns of the most powerful kind may be brought to bear upon the enemy in all directions and in all weathers. The engines of the frigate are to work up to a great power, in order to produce a speed in excess of that of the fastest ironclad ships.

The Launch of the Screw Steam Frigate "Endymion" took place on the 18th ult. at Deptford. The *Endymion* is one of the old class of frigates destined to carry 36 guns. She was laid down on the 20th of October, 1860, and was under construction until the 1st of February, 1862, when the work was suspended. She was again taken in hand on the 7th of February, 1864, and a number of shipwrights, ranging from 150 to 200, were kept on until she was complete. The principal dimensions are as follows:—Length between perpendiculars, 204ft.; length of keel for tonnage, 207ft. 11⅛in.; breadth extreme, 47ft. 10in.; ditto for tonnage, 47ft. 4in.; ditto, moulded, 46ft. 8in.; depth in hold, 17ft. 3in.; tonnage, 2,478 30-94 tons. The engines, which are supplied by the firm of Messrs. Napier, of Glasgow, are of 500 nominal horse-power. The length of her engine-room and boiler space are 64ft. 9-in. Her armament will consist of four 100-pounder Armstrong rifled muzzle-loading guns, weighing 125 cwt. each, and 14·8in. guns, weighing 65 cwt. each on the main deck, and 9·110lb. breech-loaders, weighing 82 cwt. each on the upper deck, as swivel and pivot guns.

Naval Appointments.—The following appointments have taken place since our last:—E. Mathews, promoted to the rank of Enginer; P. T. Gruchy, Chief Engineer, additional, to the *Cumberland*, for the *Endymion*; J. Mangnal, Chief Engineer to the *Cumberland*, for the *Barracouta*; W. Inglis (B), promoted to the rank of Acting Engineer; W. Ambler and O. Douglas, promoted to the rank of First-class Assist.-Engineers; T. O. Lewis, Chief Engineer, to the *Spiteful*; T. Huard, Engineer, to the *Spiteful*; W. Shelton, promoted to the rank of Engineer; T. Goodwin, First-class Assist.-Engineer, additional, to the *Revenge*; S. Sheldan, First-class Assist.-Engineer, to the *Spiteful*; J. M'Gran, promoted to the rank of First-class Assist.-Engineer; D. Robb, Chief Engineer, to the *Oberon*; W. Pilcher, Chief Engineer, to the *Malacca*; E. D. Dooley, Engineer, to the *Osborne*; N. Stearn, Engineer, to the *Malacca*; M. Litt, promoted to the rank of Engineer; J. Wyllie, promoted to the rank of Acting Engineer; J. Crew, First-class Engineer, to the *Malacca*; R. Dobson and P. M'Cormick, promoted to the rank of First-class Assist.-Engineers; J. R. R. Osborn, Master, to the *Cumberland*, for the *Icarus*; R. T. Martell, Engineer, to the *Irresistible*; H. W. Masterman, Second-class Assist.-Engineer, to the *Spiteful*; R. Dillon, Engineer, to the *Oberon*; J. Mather, Engineer, to the *Fisgard*, for the *Vixen*; F. Scott, First-class Assist.-Engineer, to *Oberon*; C. Beal, Chief Engineer, to the *Indus*, for service in the *Vestal*; J. Lovering, Chief Engineer, to the *Asia*, for service in the *Arrogant*; W. Castle, Engineer, to the *Tamar*; T. E. Buckle, Engineer, to the *Dauntless*, for service in tenders; and R. Macaulay, First-class Assist.-Engineer, to the *Dauntless*.

MILITARY ENGINEERING.

THE ENGINEER AND RAILWAY VOLUNTEER STAFF CORPS.—The first inspection of this corps was held by General Sir John Burgoyne, R.E., G.C.B., Inspector-General of Fortifications, on the 6th ult. The Engineer and Railway Volunteer Staff Corps was enrolled in January, 1865, "for the purpose of directing the application of skilled labour, and of railway transport to the purposes of national defence, and for preparing in time of peace a system on which such duties should be conducted." As a staff corps it consists only of officers who are defined by two rules as "civil engineers, and contractors, and officers of railway companies." At present the only commissions filled up are 21 of the lieutenant-colonels, who constitute a council for considering the various questions submitted by the Secretary of State for War. This Council is selected from "civil engineers of standing and experience, who have directed the chief railway and other important works of the country, and general managers of leading lines of railway." The chairman of the Council, as well as honorary colonel of the corps, is Colonel M'Murdo, C.B., and the lieutenant-commandant is Mr. G. P. Bidder, past president of the Institution of Civil Engineers. For some time past the council has had under consideration an elaborate "exercise," prepared by the honorary colonel. It may be sufficient here to state that it is under two heads, the first involving voluminous calculations to work out, by means of existing railways, the simultaneous movements of the entire available military forces of the country, with guns, horses, and stores, and their distribution along a given stragetic line; the second dealing with the engineering features of the line of coast supposed to be threatened and the country behind it, so as to show the facilities or the difficulties in the landing of a hostile army, and the best means of applying the skilled labour of the country to such works as might be required by the military engineers for strengthening the positions of a defending army and for obstructing the advance of an enemy. Another question has also been submitted to the Council by General Sir John Burgoyne, R.E., G.C.B., as to the most available means of rapidly dismantling railways before an advancing army, and of as rapidly reinstating them when re-occupied by the defending army. In accordance with the programme of inspection, approved by Lord De Grey (under whose auspices and authority this corps was formed), the inspecting officer, on his arrival, received from the commanding-officer a "Field State" of the corps, and each officer was individually presented to him. There were then read a *résumé* of the work of the year, the minutes of the last meeting, and a report of the sub-committee, consisting of Lieutenant-Colonels Bidder, Gregory, Hemans, and Manby, on the engineering points of "Exercise No. 1," after a personal examination of the "coast and country extending from the River Thames to the Wash," a very comprehensive report was read on a scheme for the transport of troops, as required in "Exercise No. 1," by Lieutenant-Colonel Hawkins. Reports by Lieutenant-Colonels Barlow, Hemans, Allport, Clarke, Grierson, Cawkwell, and Scott, on the several questions before the council, were then brought forward and read. At the conclusion of the business the inspecting officer addressed the corps, expressing his great gratification at finding that their labours, although comparatively unseen, were so thoroughly understood, and so energetically pursued. He impressed upon them the importance of their duties during peace, in the preparation for and during war, in the execution of the most arduous duties, upon which the safety of the armies of the country might depend, instancing the example of the occurrences during the recent war in America; and, after noticing in complimentary terms the manner in which the official duties were performed, he urged upon the members a continuance of the same zeal and energy. In reply to the request of the corps, as conveyed to him by the Lieutenant-Colonel-Commandant, Sir John Burgoyne expressed the pleasure with which he accepted the position of honorary member of the corps.

STEAM SHIPPING.

ATLANTIC AND PACIFIC NAVIGATION.—In New York it is said that the Pacific Mail Steam Ship Company, established in 1848 for the purpose of forming the connecting link of a through route to the gold fields of California, have completed the purchase of the entire interest and fleet of the Atlantic Mail Company, better known as the "Vanderbilt Line." The Pacific Mail Company has attained a very high position amongst the steam corporations of the world, and by the completion of this arrangement the entire line of communication from New York to San Francisco, *viâ* the Isthmus of Panama, excepting, of course, the railway portion, is placed under its control, and it is intended to commence a branch service to China and Japan, several steamers of 5,000 tons being in process of construction. The Pacific Company gives us a mail service with our Pacific colonies, which, without its aid, would be incomplete; and the addition of a line to China will undoubtedly affect, in a large degree, the commerce, not only of this country and of the United States, but of the world. In anticipation of this amalgamation, the Pacific Mail Company procured from the United States Legislature, power to increase its capital from 5,000,000 dols. to 10,000,000 dols., nearly £2,500,000 sterling. The additional capital has been raised, and the whole of the arrangements are now so far advanced that the first steamer under the new *régime* will sail from New York on the 1st of November next. The Pacific fleet consists of ten splendid side-wheel steamers, with an aggregate of 28,074 tons builders' measurement. The Atlantic fleet, which under the amalgamation arrangement falls into the possession of the new corporation, comprises, together with the new steamers for the line in course of construction—fifteen vessels, with an aggregate of 40,666 tons builder's measurement. When the new vessels are finished, the fleet of the company will consist of about thirty of the largest vessels afloat, having a gross measurement of over 80,000 tons. There is a careful organisation for the prevention of fire; each steamer is supplied with an ample number of boats (all lifeboats), and kept always furnished with masts, sails, oars, compass, and (though last not less) bread and water regularly renewed.

STEAM SHIPBUILDING ON THE CLYDE.—The *Arbutus*, screw, has been purchased by the City of Glasgow Steamship Company, and will be employed as a sister ship to the *Falcon* steamer, plying between Glasgow and Londonderry. The Turkish ram *Abdul Aziz* has made a satisfactory trial trip on the Clyde. The *Roe*, paddle, is stated to have been sold to the Midland Railway Company. The *Roe* was built in 1864 by Messrs. Caird & Co., of Greenock, for Messrs. Burns' line of Glasgow and Belfast mail steamers. On this route she has proved herself an efficient vessel. Messrs. R. Napier and Sons have launched the *Pereire*, built for the French Compagnie Générale Transatlantique. The *Pereire* was contracted for in February, and will be ready for sea in February, 1866. Her dimensions are—length, 350ft.; breadth, 44ft.; depth, 29ft. She will be propelled by engines of 1,000 horse-power. During October the following steamers were launched by Clyde firms:—The *Zaid Zafar*, paddle, 442 tons; the *City of Aberdeen*, screw, 906 tons; the *Kinsale*, screw, 611 tons; the *Sunda*, screw, 120 tons; the *Avon*, screw, 722 tons; the *Capri*, screw, 1,680 tons; a screw for sale, 507 tons; the *Taranaki*, screw, 550 tons; the *Venezia*, screw, 650 tons; the *Malta*, screw, 2350 tons; the *Mandingo*, screw, 1,300 tons; a paddle for sale, 621 tons. Messrs. D. Hutcheson and Co. have contracted with Messrs. Thomson, of Glasgow, for the construction of three saloon steamers (similar to the *Iona*, but of smaller dimensions), to be added to their already large fleet on the Clyde, Caledonian Canal, and west coast trades. By this addition a daily communication will be kept up between Inverness and Glasgow during the summer and autumn months by passenger steamers, and twice a week by goods boats. The sailings from Oban to Skye, as well as to Staffa, Iona, and Glencoe, will also be considerably increased. The *Llama*, paddle, has made a satisfactory trial trip, although it was made in a stiff gale of wind, with a heavy sea. Messrs. Burns at once took the steamer over from her builders, Messrs. Caird and Co. The *Llama*, which will be commanded by Captain M'Pherson, will be shortly put on the Glasgow and Belfast station, in connection with the *Buffalo* and *Wolf*. The *Kinsale*, screw, lately launched by Messrs. Henderson, Coulborn, and Co., attained on her trial trip, between the Cloch and Cumbrae Lights, an average speed of 12½ miles per hour. The *Kinsale* is owned by the Clyde Shipping Company, and was built for the Cork and Waterford trade. The Turkish screw steam ram *Abdul Aziz*, 4,200 tons burden, and 900 horse-power, recently built and engined by Messrs. Napier and Son, Glasgow, for the Turkish Government, has sailed from the Tail of the Bank for Constantinople.

TRIAL TRIP OF A NEW STEAMER AT SUNDERLAND.—On the 4th ult. the new iron screw-steamship, *United Service*, recently built by Messrs. Haswell and Son, left the South Dock, Sunderland, and proceeded northward on a trial trip. The trial was considered highly satisfactory in all respects, and a speed of 9½ knots was attained. The *United Service* is owned in London, and is intended for general trade, having accommodation for thirty first class passengers in addition to her space for cargo. She is classed 17 years, is 978 tons register, and of the following dimensions:—Length, 220ft.; breadth, 30ft.; depth, 20ft. Her engines are of 96-horse power, built on Maces's patent, by Messrs. Close, Burlinson, and Co., of Millfield Engine Works.

TRIAL TRIP OF THE SCREW STEAMER "COMO."—This vessel, recently launched from the yard of Messrs. Haswell and Son, at the South Dock, Sunderland, has made a most successful trial. She was built from a model of Mr. Petrie's, manager to the firm, and is 190ft. in length, 28ft. in breadth, 17ft. deep, and between 800 and 900 tons burthen; while her engines, which are of 80 horse-power, were built by Mr. George Clark, of Monkwearmouth. The vessel left the South Outlet and steamed steadily northward. On passing Tynemouth the speed of the vessel was increased, and when put upon her merits at the measured mile, her performance was announced at the rate of ten knots; but it must be considered that she was half laden for the trip.

THE TURKISH PADDLEWHEEL YACHT, "FUAD," went down the river on her official trial on the 20th ult., and made the prescribed run at the Lower Hope. She was built by the Millwall Company, under the direction of Mr. Charles Lungley, and is of iron. Her principal dimensions are:—Length between perpendiculars, 258ft.; extreme breadth, 29ft. 6in.; depth of hold, 18ft.; and 1,076 tons burden. Her rate of speed was registered at 16½ knots per hour. The engines, of 300-horse power, nominal, are on the oscillating principle, with feathering paddlewheels, made by Messrs. Ravenhill, Hodgson, and Co. During the trial, which was highly successful, they made 41 revolutions per minute.

STEAM NAVIGATION IN RUSSIA.—The Russians are rapidly covering their seas and large rivers with steam vessels, mostly built in this country. Messrs. C. Mitchell and Co., of Low Walker, on the Tyne, have just received an order to build two screw steamers of 500 tons each, for the navigation of the Caspian Sea, to which sea these vessels will sail direct from this country. The same firm are also about to build two more powerful steamships for the Russian Steam Navigation Company, and intended for their fleet on the Black Sea trading with the Crimea. They will be fitted up to carry a large number of passengers, and they will be supplied with engines by Messrs. Penn and Son, of London, with all the modern improvements for the economy of fuel.

RAILWAYS.

THE TAFF VALE RAILWAY COMPANY have completed the erection of two commodious engine-sheds at Aberdare, in which it is intended to house ten or twelve locomotives. By this arrangement the sidings at the different collieries will be cleared at a much earlier hour than usual, and greater facilities will thus be afforded for the transmission of coal to the port of shipment.

PETROLEUM GAS ON RAILWAYS.—The London and North-Western Railway have had some of their carriages experimentally lighted with gas made from petroleum. The apparatus containing the gas occupies half the space under one seat, and the compartments were quite as brilliantly lighted as they would have been by ordinary coal gas.

LOCOMOTIVES ON RAILWAYS.—The number of locomotives at work on the twelve principal railways of Great Britain at the close of 1864 was as follows:—Caledonian, 262; Great Eastern, 376; Great Northern, 345; Great Western, 697; Lancashire and Yorkshire, 398; London and North-Western, 1,187; London and South-Western, 207; London, Brighton, and South Coast, 203; Manchester, Sheffield, and Lincolnshire, 179; Midland, 512; North-Eastern, 663; and South-Eastern, 214.

NORTH LONDON RAILWAY COMPANY'S CITY EXTENSION.—If any proof were required of the necessity of railway accommodation for the metropolis, and the remunerative character of such undertakings, it would be found in the result of the opening of the North London Railway Company's City Extension line. The published returns of that company for the week ending the 29th October showed a total receipt from passengers of £1,956, and for the week ending the 12th November (being the first entire week after the opening of the City branch), £2,957, whilst the number of passengers is stated to have been 158,935, as compared with 85,982. So soon as the goods traffic of the London and North Western Company is also conveyed over it, it must prove a highly remunerative branch.

RAILWAY "OVER" MOUNT CENIS.—The *Moniteur* publishes an imperial decree, authorising Messrs. Brassey, Fell, and Co. to establish a railroad on the imperial road over Mount Cenis, between St. Michael and the Italian frontier, and to work the same by means of steam locomotives, on the system invented by Mr. Fell, until the entire completion of the railway from St. Michael to Suza, through the tunnel of the Alps. The portion of the railway already formed, and on which experiments were successfully made last summer, is about a mile and a half in length, and runs up one of the steepest gradients of the whole road.

THE PACIFIC RAILWAY, on the western side, will next year be extended to the summit of the Sierra Nevada mountains, 104 miles from the city of Sacramento, which is itself 2,700ft. above tide water. 4,000 men, chiefly Chinese, are now engaged on that railway, and the state of California has donated 2,100,000 dollars for its prosecution. To meet this, the railway on the eastern side of America now extends from New York to 200 miles beyond St. Louis, the border city between Illinois and Missouri.

LOCOMOTIVES FOR THE EAST INDIA RAILWAY COMPANY.—The contracts for the locomotive requirements of the East India Railway Company are said to be given out as follows:—30 to the Avonside Engine Company (limited), Bristol; 20 to Cross and Co., St. Helen's, Lancashire; 20 to James Morison and Co., Newcastle-on-Tyne; and the remainder to Messrs. Kessler, of Carlsruhe, at a very low price. The associated French tenders of Messrs. Schneider and Co., of Le Creusot, and J. F. Cail and Co., of Paris, were unsuccessful.

INTENDED NEW RAILWAY BRANCHES.—Many of the great railway companies, such as the Great Western, the London and North-Western, the Midland, the Caledonian, and the Bristol and North Somerset, are issuing notices of intention to apply to the new Parliament for powers to form numerous minor railways, such as branches, branchlets, and junctions, all tending to ramify the railway system amongst the lesser towns, villages, and country districts throughout the country. Pneumatic railways in Manchester, and in Brighton and Hove, have been announced in similar notices; as well as a considerable addition to the number of metropolitan lines, including a Hampstead, Holloway, and Kingsland line, in connection with the North-London and the London and North-Western; Clapham and London-bridge lines, by the Elephant and Castle, in connection with a Waterloo and Whitehall extension line from Waterloo to Newington Butts; a Crystal Palace and South London junction line; East London lines—South-Western extension—to Deptford, with junctions in Camberwell with the London, Chatham, and Dover, in Bethnal-green with the Great Eastern; and so on.

RAILWAY ACCIDENTS.

An accident occurred on the Manchester, Sheffield, and Lincolnshire line, between Sheffield and Penistone, on the 6th ult. For several months past the line has been overworked, and the collision at Woodhouse, to tne west of Sheffield, was attributable to this cause. To this also may be ascribed the accident on this occasion. The increase of the goods traffic, consequent upan the cessation of the American war, has been so great that tbe utmost resonrces of the company could not overtake it. A fast train from London left Sheffield a few minutes before five o'clock, and wos driven at the usual high rate of speed towards Manchester. All went well until the train approached Deepcar, where a goods train and a cattle train were in possession of both pairs of rails. The official in charge of the station, knowing that the express was due, was doing his best to clear the line, and the cattle train was being shunted on to the up-line, behind tbe goods train. The trains were protected by tbe signals, but ran past them, and came in violent collision with the rear of the cattle train, knocking the break and six of the waggons off the line, but doing very little damage. Tbe express was going very fast when tbe collision occurred, but the engine shows no marks of damage. Several of tbe passengers in the express were severely shaken.

BOILER EXPLOSIONS.

One of the five boilers at Great Wheal Bury in connection with the large pumping-engine exploded on the 12th ult., doing great damage to the boiler house, the debris being scattered in all directions. Some injury was also caused to the steam chest, which will prevent the engine from working for some time. Fortunately no one was injured; bnt the engineman had a narrow escape, he being at the time in the act of opening tbe door of tbe engine house leading to the fires.

An Accident occurred Recently at Belgium at the blast furnaces of Thy-le-Chateau, near Charleroi, caused by the bursting of a steam boiler. Four of the workmen were killed on the spot, and eight more have since died. Nineteen others were more or less scalded, some so severely that little hope is entertained of their recovery. The boiler being quite new, tbe bursting is supposed to have been cansed by some defect in the metal.

Explosion of a Steam Thrashing Machine Boiler.—On the 6th ult., at Swinderbury, near Lincoln, two men were killed by the explosion of a boiler attached to a steam thrashing machine. The engine had been in use nine years. Seven or eight men employed on the machine had left work to have lunch, and they had just completed tbeir meal when the explosion occurred. The thrashing machine was torn to pieces, and the wheels wrenched off and doubled up. The boiler, which was of 7 horse-power, was lifted 10ft. in the air, and fell at a distance of 97ft. from tbe spot where it had stood. the valves were blown to the top of the granary and broken into pieces. The cover to the man-hole (a heavy piece of iron) was blown into a field 185 yards off.

DOCKS, HARBOURS, BRIDGES.

Failure of the Great Low-water Basin at Birkenhead.—This failure has led the Mersey Dock Board to initiate a new plan of dock works at Birkenhead, and it has been resolved to promote a bill to close the Woodside basin, to convert the low-water basin into a wet dock, and to excavate the foreshores at the northern entrances, The alterations in the basins are estimated to cost £167,000. What the excavations will cost it is impossible at present to estimate, as tbe foreshore at 14ft. deep comes upon solid rock; and the last bill obtained by the Board provided for a depth of 17ft. It is hoped, however, that some modification of the previous Act may be obtained as to depth, and thus an enormous expense avoided.

Railway Bridge across the Mersey.—A bridge is now being constructed for the London and North-Western Company, across the Mersey, between Runcorn and Liverpool. It approaches the north-east bank of tbe river at Runcorn Ferry, which it crosses at Runcorn by a bridge consisting of three wrought iron trellis girder openings, 305ft. in width each, and 75ft. in height, on the under side of the girders, above the level of the river at high water, thns permitting any vessel of ordinary size to pass under it. On tbe Lancashire as well as on the Cheshire side of the river, these girders are supported by abutments crowned with castellated turrets, rising nearly 40ft. above the railway level, whilst in the river the girders are supported by stone piers. The railway is carried through Runcorn by a viaduct of thirty-two arches. By this addition to the railway eight miles are saved in the distance between Liverpool and London.

New Bridge at Prague.—The foundation-stone has been laid of a new suspension bridge over the river Moldau, at Prague, which is to be named in honour of the Emperor, "Franz Joseph's Brucke." The ceremnuy was performed by the Governor of Bohemia, in presence of the Cardinal Archbishop of Prague, Prince Schwarzenberg, and many others of the nobility and clergy. The bridge is to be constructed from the designs of Messrs. Ordish and Le Feuvre, of Westminster, who were successful against eleven competitors from Holland, Austria, Germany, and France.

The Ganges Canal.—From tbe state papers on the Ganges Canal, published in the supplement to the *Gazette of India*, of the 26th of August last, we gather the following:—There has been a loss of 35 lacs of rupees, equivalent to £350,000, as shown in the Secretary of State for India's despatch, No. 34, of 30th June, 1863; and the object of this note is to point out how these heavy losses may be avoided for the future, as well as to show the cause thereof. Tbe Ganges Canal was made by officers who had a theorctical knowledge of civil engineering, but had no practical experience in canal works: hence they were obliged to learn as they proceeded. We know it is proposed seriously to construct railways in India on the same plan, and no doubt this would have been done had they been executed from imperial funds. We formerly pointed out the heavy losses which had occurred from the appointment by Government of consulting engineers, who had, some of them, never seen a railway constructed in their lives. What would have been the result if the construction itself had been entrusted to officers of the like limited experience, instead of the qualified civil engineers who were sent out from England? Why, heavy loss, such as has occurred on the Ganges Canal from a similar cause. Had one or more civil engineers of large experience in canal works been induced to go to India and act as consulting engineers to Government instead of failure, there would probably have been success in that important and gigantic undertaking.

Harbour of Refuge and Commercial Docks at Newhaven, Sussex.—An important meeting of the inhabitants of Lewes and the neighbourhood has been held at tbe County Hall, for the purpose of receiving Captain Roberts's address upon the great scheme for a harbour of refuge and commercial docks, &c., at the port of Newhaven. After some discussion of tbe subject, the following resolution was unanimously adopted:—"That this meeting is prepared cordially to support the formation of a harbour of refuge and commercial docks at Newhaven. That tbe plans now submitted to tbe meeting by Captain Roberts appeared to be well adapted for that object. That the members for the borough and county be requested to use their influence in support of the Bill that may be introduced in the coming session of Parliament, which offers the best plan for a harbour of refuge and commercial docks at Newhaven, including a Government guarantee of 4 per cent. upon the requisite capital for such an object."

The Harbour Trust of Swansea have determined to apply in the coming session of Parliament for powers to raise £40,000 for the improvement of the shipping facilities at the port. It is satisfactory to announce that the trade of the port is gradually recovering from the effects of the late injurious reports respecting the break out of the yellow fever.

New Bridge at Prague.—The foundation stone has been laid of a new suspension bridge over the River Moldau, at Prague, which is to be named in honour of the Emperor "Franz Joseph's Brucke." The ceremony was performed by the Governor of Bohemia, in presence of the Cardinal Archbishop of Prague, Prince Schwarzenberg, and many others of the nobility and clergy. The bridge is to be constructed from the designs of Messrs. Ordish and Le Feuvre, of Westminster, who were successful against eleven competitors from Holland, Austria, Germany, and France.

Irrigation of Northern Italy.—The Council of Administration of the Cavour Canals has addressed a circular to tbe Syndics of the Communes of the Lomellina and the Novarese, in which it is stated that, by the spring of next year, the Grand Canal from Chivasso to the Ticino will be ready throughout its whole extent to receive the waters of the Po, and to distribute tbem to such adjacent territories as may be adapted for their reception. In former times reference has been made to the importance of the work now so near completion. The proposed irrigation of a vast tract of land which, for want of water, has hitherto been in great measure unproductive, ought to prove of immense advantage to Piedmont, and to go some way towards compensating it for the loss of the capital.

MINES, METALLURGY, &c.

Slate Quarrying in Portugal.—Situated about nine miles from the city of Oporto and close to the small and industrious town of Vallougo, are the quarry and workings opened and developed by Mr. Nicholas Ennor. The slate, which is found here in great abundance, possesses many admirable features, being of a tough, hard nature, capable of being split into enormous slates of 12ft. square, and of all thicknesses, and also of being manufactured into roofing slates, which is gradually superseding all other modes of roofing; it is equal in quality to the best Bangor slate, being susceptible of a high and beautiful polish, will preserve its original colour, and remain unaffected by moisture for very many years. The proprietor has now transferred his right to a limited liability company of English proprietors, termed tbe Vollongo Slate and Slab Quarry Company (Limited), who will work the quarries on an extensive scale, with a view to exporting slates and slabs from Portugal to England and other countries.

Treatment of Sulphurets.—A furnace, designed to simplify and cheapen the process of desulphurising auriferous and argentiferous sulphurets, has been invented by Mr. William Bruckner, of San Francisco. It dispenses with the large and cumbrous reverberatory hearth, and tall and expensive chimney, necessary for getting up a suitable draft. The laborious and tedious process of hand stirring is also obviated. The furnace consists of a cylindrical iron grating, lined with brick, and having an orifice at each end about one-third the diameter of the cylinder. Upon tbe inside of the cylinder will be noticed a winding ridge, or rifle, the object of which is to distribute tbe ore, and keep it constantly exposing fresh surfaces to the action of the flames, as the cylinder is made to revolve. This revolution may be produced in any convenient manner. In the one on exhibition it is caused by an endless chain passing over a revolving pulley. The cylinder rests upon friction rollers, upon which it is caused to revolve, instead of upon an axis. A small furnace is placed at one end, from which the flame is caused to pass into and tbrough the cylinder; atmospheric air is also allowed to pass freely into the cylinder to hasten the process of desulphurisation. The first cost of construction, the cost of fuel for continuing the operation, and that of labour for attendance, and time occupied in the process, are all vastly reduced. We are not aware that it has yet been subjected to any protracted practical experiment, but we can see no reason, either mechanical or philosophical, which shall militate against its successful introduction against the ordinary reverberatory hearth, for desulpurising ores. It is well worth the careful examination of all parties interested in metallurgical operations.

Manufacture of Welded Iron Tubes.—In the ordinary manner of constructing heating-furnaces used in the manufacture of these tubes the furnace is made in two compartments, each compartment being provided with a fire-grate. One of the said compartments is called the back hole or warming furnace, and the other is called the welding furnace. The skelp, or partially formed tube to be welded, is first heated in the back hole or warming furnace, and afterwards transferred to the welding furnace, where it is raised to a welding heat. The invention of Mr. James Fisher, of West Bromwich, consists in dispensing with the fire grate at the back hole or warming furnace, and in so constructing and arranging the back hole or warming furnace, and the welding furnace, that the warming furnace shall be heated by the waste heat from the welding furnace. He builds the warming furnace and welding furnace side by side in the ordinary manner, but builds the warming furnace without any fire grate. He builds the welding furnace in the ordinary way, excepting that he closes the end of the said furnace, instead of making it communicate directly with the stack. He perforates the wall separating the two furnaces with a series of holes, through which holes the flame and heated air from tbe welding furnace pass into the warming furnace, and from thence to the stack. By this arrangement the two furnaces are heated by tbe fire from one grate—namely, by the fire of the welding furnace grate. It is claimed, tbat by constructing the heating furnaces according to this invention great economy is effected in the fuel employed.

Drainage of the South Staffordshire Coal Field, in Relation to Mining Operations.—At the Dudley and Midland Geological Society, Mr. E. B. Martin, Stourbridge, read a paper on this subject. The paper originated from the discussion which took place after the Conference of mine agents, held about two years ago, under the auspices of the society. Many difficulties have had to be overcome in the drainage of the coal field in former times, and though the work was not very completely done, yet, on the whole, the engines used in raising water from the South Staffordshire mines will now bear favorable comparison with those to be found elsewhere. These engines are of the most varied description, and perform very unequal duty, owing to the fact that many of them have been at work for a long period. The weight of water raised daily from the mines is about 220,000 tons, or nearly ten times the weight of coal raised in the same time. This quantity of water may be more clearly appreciated by considering tbat it would fill an ordinary canal twelve miles in length, and would cover eighteen acres of land 10ft. deep. It requires about 5,000 horse-power to lift this from the various depths, and the plant employed represents about half a million of capital. The drainage area of the coal field is about 125 square miles; and as it is situated on some of tbe highest ground in the country, scarcely any water is brought into the district by streams. The amount of rainfall in Sonth Staffordsbire is equal to 108,000,000 gallons per day, which, with 4,000,000 conveyed in by water companies, makes a total of 112,000,000 gallons per day to be accounted for. The streams flowing out take off about 52,000,000 gallons, and 13,000,000 are diverted into the canal, leaving only 47,000,000 gallons for evaporation and percolation into the mines. This amount is less tban the precolation alone, as proved by the quantity of water pumped (50,000,000 gallons). This leads to the conjecture tbat the great quantity of water found in the mines is due to something else besides the rainfall. Of the 50,000,000 pumped, about 37,000,000 flow into the canals, and the remaining 13,000,000 into tbe natural channels. No reliable information has been obtained as to how the water flowing from the canals is disposed of, but if it be taken for granted tbat all the water which finds its way into the canals is either kept there or carried off the district, it increases the difficulty of accounting for tbe quantity of water found in the mines, because then the quantity pumped would soon empty the mines altogether. The foregoing statistics appear to indicate that the great quantity of water found in the mines can only be accounted for by supposing that very much of that raised finds its way back, to be re-pumped. The whole surface of the coal field is more or less perforated by pits, or dislocated by mining operations, or divided into catch-water pits by the deposit of spoil hanks. In many places swags may be found filled with water, which has no means of escape except by percolation through the bottom. There is no question that if the pumping from the mines could have been conducted on one complete system much capital and annual expenditure could have been saved, and the cost of raising water might have been brought down to something like one penny per ton. The evils pointed out are doubtless beyond control now, and it may be, perhaps, inexpedient to make much change in the system of draining the present coal fields, but as the time must soon come when coal must be sought in an extended area, it is hoped that some of those evils may be then avoided, and especially that some combined effort may be made to effect the pumping of water from the mines at a cheaper rate.

Smelting Zinc Ores.—The invention provisionally specified by Mr. A. Reynolds, of Bagillt, consists in the arrangement of a furnace (such as a blast-furnace) with a flue or condenser, in such a manner that zinc can be smelted in it instead of in retorts. The zinc passes off in vapour with the smoke at the top of the blast-furnace, and in order to retain the zinc in the metallic form, air must be carefully excluded from the top of the furnace, or preferably coke must be placed in the flue, or charcoal may be employed instead; the coke will be heated by the smoke, or may be heated otherwise, so as to reduce the zinc to the metallic form. The zinc from the smoke is subsequently condensed in suitable chambers.

Cast Steel.—An invention has been patented for a Mr. A. Lohage, the object of which is the better preparation of the molten steel, especially in large masses, before it is formed or allowed to pass into the mould or into ingots. The furnace has a movable fire-proof funnel, through which the molten metal reaches the interior of the furnace (as in Patent Dec. 31st, 1858). The nose of this funnel reaches to the bottom of the bed of the furnace or nearly so, and is in part cut away on the part furthest away from the fire, placed to allow the metal to flow out therefrom upon the bottom of the furnace. The molten steel is conveyed through the funnel (previously heated red-hot) into the furnace, the temperature of which has been raised to about the melting point of steel, preferring an excess, to prevent any cooling. He pours slag into the furnace with the steel, or previously melts slag therein, to obtain a protecting cover for the molten steel. The heat of the furnace is kept up by blast till the metal is over melted, and the whole mass has become thoroughly uniform. The metal is then run into heated receivers, and thence into the moulds. The process is claimed to be equally applicable to steel melted in crucibles, and by any other process.

Manufacture of Steel and Iron.—Mr. John Firth, of Sheffield, steel manufacturer, proposes to take ordinary moulding boxes lined with loam or any other fire-resisting material or ordinary moulds, and after the molten metal is run into the mould, and while in a state of fusion, employ pressure obtained by the action of a screw, or a lever, or hydraulic or steam power, or in any other convenient manner, applied to the stoppage or plug fitting the inside of the mould, so as to consolidate the casting, and thereby improve the quality of the steel and iron. He then takes the casting or ingot so prepared, and uses it either with or without hammering.

Gun-Metal Tuyeres.—Mr. Sollo's new tuyere is made in a single casting of gun-metal, an alloy of copper with a small proportion of tin and spelter; and as copper has no affinity for iron, no iron from the furnace becomes attached to the nose of the gun-metal tuyere, however long a time it may have been in the furnace, in fact, the gun-metal tuyere never "irons," and therefore rarely requires to be taken out or changed. The general form of the ordinary wrought iron tuyere has been adopted for the gun-metal tuyere; and in order to insure keeping the nose of the tuyere properly cool in working, an ample supply of cold water is constantly maintained to the tuyere, and the supply water-pipe is carried forward inside the tuyere to within a few inches of the tuyere nose. The first gun-metal tuyere was put to work by Mr. Solly at the Willenhall Furnaces more than nine months ago, and has been at work ever since until recently, when it was purposely taken out, and found to remain in complete working order. This tuyere was exhibited at the meeting, together with a second gun-metal tuyere of slightly different pattern, which had been at work for three months without being once taken out, and was in perfect condition; and, also, an ordinary wrought iron tuyere, which had required to be taken out after only three days' work, in consequence of the nose having "ironed" badly.

Lead Works in America.—At the last census there were in the United States 28 lead-smelting establishments, employing 203 hands. The capital invested is 286,922 dols.; cost of raw material, 938,561 dols.; cost of labour, 58,260 dols.; annual value of products (ending June 1), 1,094,122; tons of pig lead, 10,395.

GAS SUPPLY.

Lighting of Bombay with Gas.—On the 7th of October last, a portion of the town of Bombay was for the first time lighted with gas, which excited the greatest wonder amongst large numbers of the natives. The gas appeared to be of good quality, and burned brilliantly.

Gas in Belgium.—The amount of gas sold by the Belgian General Company for Lighting and Heating by Gas—which has works in operation at Prague, Tournai, Louvain, Charleroi (including Marchienne-au-Pont), and Chemnitz, while others are in course of construction at Catana, Sienna, and Rimini—in the year ending August 31st, 1865, was 145,971,627 English cubic feet, as compared with 136,082,002 English cubic feet in the year ending August 31st, 1864. In September, the quantity of gas sold by the company was 10,703,826 English cubic feet, as compared with 10,339,144 English cubic feet in September, 1864, showing an increase of 364,182 English cubic feet. The works at Sienna and Rimini will be brought into activity at once.

Explosion of a Gasometer at Nine Elms.—An accident, causing loss of life and great destruction of property, happened, on the 31st of October last, on the works of the London Gaslight Company, at Nine Elms, in the explosion of a gasometer fully charged with gas. The explosion occurred soon after two o'clock, when the workmen had returned from dinner, and a large and massively-constructed building, called the "meter-house," near to the gasometer, was completely blown down, killing several on the spot, and injuring many others, some of whom have since died.

WATER SUPPLY.

Waterworks for Dantzig, Prussia.—Mr. Aird, an English engineer, has offered to construct the waterworks at Dantzig on the following conditions:—The company is to receive a yearly sum of 37,000 dollars, or about £5,500, from the town, and to be sole owner of the works for forty years. After this time they become the property of the town. The estimate of the expense is £225,000. The Berlin correspondent of the *Star* says, in reference to this:—"I have not heard whether Mr. Aird's proposal has been accepted. If it has, it is to be hoped that the Dantzig Water Company will give more satisfaction than the English company of the Berlin waterworks is giving here at present. The water used to be clear, but for some time past it has been very turbid. I suppose the explanation is, that the filtering apparatus is not on a sufficiently large scale to meet the increased demand."

The new Water Scheme for Huddersfield.—At a special meeting of the Huddersfield Improvement Commissioners, Mr. Crosland, M.P., on behalf of the Waterworks Commissioners, explained the projected scheme for increasing the water supply of the town and district. The plan comprises the supply of Longwood, Lockwood, Mold Green, Newsome, and Lindley, in addition to Huddersfield, with water obtained from a catch-ground of over 1,500 acres at Meltham, and a reservoir of 84 acres at Blackmoorfoot, to store a supply and furnish compensation to mill-owners. The present waterworks, when the mains are full, are calculated to supply Huddersfield township (34,000 inhabitants) with thirteen gallons per head daily; the projected works are calculated to supply the townships mentioned (present population 63,000) with twenty-five gallons a head daily if the population were 100,000. The cost of the scheme is estimated at £100,000 or £120,000, if two streams be included, and a reservoir made in the Wessenden Valley, which is doubtful. The scheme, as a whole, was favourably received by the Improvement Commissioners.

Water Supply in the North.—An extensive scheme has been proposed by Mr. Thomas Dale, C.E., of the Hull Corporation Waterworks, for the supply of water to various towns, from the lake districts of Cumberland and Westmoreland. In this scheme, in laying down the main trunk pipes, he proposes to make provision for the following quantities of water to be supplied daily to the towns enumerated, viz.:—

	Gallons.		
Lancaster	2 millions.		
Preston	8 „		
Wigan	4 „		
Dewsbury	3 „		
Wakefield	3 „		
Liverpool	40 „		
Leeds	15 „		
Bingley	1 „		
Kendal	2 „		
Bolton	8 „		
Blackburn	6 „		

	Gallons.
Keighley	2 millions.
Bradford	10 „
Huddersfield	4 „
Burnley	4 „
Rochdale	4 „
Halifax	4 „
Colne	1 „
Bury	8 „
St. Helen's	2 „
Total	131

There are also many small towns and districts lying contiguous to the line of main trunk pipes, for which due allowance in the capacity of the discharge of the main pipes must be made. From the Ullswater and Hawkeswater Lakes, in particular, Mr. Dale proposes to take the water. The main trunk would consist of several distinct lines of pipes, laid side by side, so that should repairs or contingencies arise, ample provision would be made to retain a constancy of flow. At all stations where branch supplies were required for towns, &c., reservoirs would be constructed to receive the discharge of waters from the mains. He proposes that the various towns thus to be benefited should combine financially to carry out this project. He is of opinion that the outlay for construction, &c., would not exceed, for the supply of each million gallons of water daily, the sum of from £60,000 to £70,000.

APPLIED CHEMISTRY.

Manufacture of Oxygen Gas.—Messrs. Parker and Tanner, of Birmingham, propose to manufacture oxygen gas by heating a mixture of nitrate of soda and quick lime. They obtain as by-products caustic soda, and a compost consisting of lime and nitrate of lime.

Results of the Explosion of Nitroglycerine.—The new blasting material is a light-yellow oily fluid—a compound of glycerine and nitric acid, its chemical formula being $C_6H_5O_3(NO_5)_3$, which gives 18 parts of oxygen; and Mr. Nobel claims that as by combustion the carbon takes 12 atoms of oxygen, and the hydrogen 5, its complete combustion leaves a surplus of O_1 only. He states, moreover, that each 100 parts of exploded blasting oil leaves a residue of—carbonic acid, 58; water, 20; oxygen, 3½; and nitrogen, 18½ = 100; and that as the specific weight of the oil is 1·6, one volume produces nearly 1,300 volumes of gas—that is to say, steam, 554; carbonic acid, 469; oxygen, 39; and nitrogen, 236 = 1,298 volumes. Weight for weight, the blasting oil bears very favourable comparison with gunpowder, which is calculated to produce ordinarily about 250 volumes of cold gas only; the nitro-glycerine would, consequently, appear to be, other things being equal, about five times as effective as gunpowder. But Mr. Nobel goes further than this, for he remarks that it is difficult to determine the degree of heat produced by an exploding substance, and that, according to theory, the blasting oil, on account of its complete combustion, ought to develope a more intense heat than gunpowder, and this appears to be borne out by experiment; whence he assumes that the heat developed by the explosion of nitro-glycerine is twice that generated by gunpowder, and from this calculates that nitro-glycerine, compared with gunpowder, possesses about 13 times its power, when volumes are considered, and 8 times its power for equal weight; and that owing to its rapidity of explosion its advantages are still greater.

Accidental Formation of Sulphide of Silver (Argyrose), by Dr. T. L. Phipson, F.C.S.—About eighteen months ago I filled a silver match box with the common large French matches which are used in the cafes, &c., at Paris. On my return to London this box lay for months in a drawer that was rather damp. On opening the box recently, I was surprised to find the inside lined with very brilliant crystals of a black colour and metallic lustre, which reminded me at once of some specimens of silver ore I had received a few months back from the Don Pedro mines of Mexico. I had no doubt these crystals—modified octahedra of the first system—were argyrose (or silver glance) accidentally formed. On examining them with a powerful lens, which enabled me to make a drawing of their crystallised form, and finding afterwards that they contained about 87 per cent. of silver, this supposition proved exact. It is therefore not improbable that this mineral may have been formed in nature by the prolonged action of sulphurous vapours upon metallic silver.

Notes on Zirconium by Dr. T. L. Phipson.—After having found that magnesium heated to fusion in close vessels with the acids silicic, boracic, and carbonic, liberated the radicals of these acids, I thought that zirconium might be prepared in the same manner; for many facts show a great analogy between this body and silicium. In 1865 I had not enough of pure zirconia to make the experiments in a conclusive manner. Since then I have prepared a certain quantity with the zirconian syenite of Norway. I obtain thus a zirconia containing about 2 per cent. of yttria. On repeating the experiment I found that oxide of zirconium is reduced as easily as silicic acid or boracic acid, under the influence of magnesium. The reduction takes place at the moment the magnesium begins to melt, and zirconium is obtained in form of a velvety black powder. Dilute hydrochloric acid dissolves the whole of the magnesia formed. In this manner one can easily obtain large quantities of amorphous zirconium. I have also reduced titanic acid. But whilst silicium and titanium (in some of my experiments) can form gases on combining with hydrogen, boron and zirconium do not. The five bodies, carbon, boron, zirconium, silicium, and titanium, form evidently a group of very similar elements.

Reaction of Metallic Thallium on a Few Solutions of Metals.—Thallium immersed in solutions of sulphate, nitrate, and acetate of copper, deposited in flakes (similar to iron) metallic copper; thallium in $AgONO_5$ deposited silver; thallium in $AuOSO_3$ deposited gold; thallium in $HgOSO_3$ (sulphate of the red oxide) deposited mercury; thallium in PbOA deposited lead. The gold appeared in flakes, partly floating and partly at bottom; mercury in small globules; lead as crystallised mass on top of the thallium, very similar to thallium on zinc. When thallium is put into a solution of the nitrate of cobalt the metal is covered with a blue coating, which, from it becoming green on exposure to the air, appears to be similar to that basic salts of cobalt precipitate which is thrown down by KO.

LIST OF APPLICATIONS FOR LETTERS PATENT.

We have adopted a new arrangement of the Provisional Protections applied for by Inventors at the Great Seal Patent Office. If any difficulty should arise with reference to the names, addresses, or titles given in the list, the requisite information will be furnished, free of expense, from the office, by addressing a letter, prepaid, to the Editor of "The Artizan."

Dated October 23rd, 1865.

2738 A. Chaplin—Steam boilers
2739 J. Murray—Indicating the names of streets or other places
2740 W. Clark—Sewing machines
2741 W. Clark—Paper

Dated October 24th, 1865.

2742 W. Snell—Hydro-carbon lamps
2743 F. H. Grey—Fire-arms
2744 M. T. C. Nash and C. J. Nash—Cooking certain vegetables
2745 H. Bateman and E. G. Garrard—Pumps for raising liquids
2746 C. Matthews, H. B. Southwick, & J. Fereday—Furnaces for the consumption of smoke
2747 D. G. Staight, S. Staight, and J. Cheveiton—Pianoforte keys
2748 A. V. Newton—Sewing machinery for using waxed thread
2749 W. Clark—Bath apparatus

Dated October 25th, 1865.

2750 G. Haseltine—Uniting pieces of leather in the manufacture of boots
2751 G. L. Scott—Moulding toothed wheels
2752 W. M. Scott—Breech-loading fire-arms
2753 G. A. Huddart—Buttons, and in attaching them to garments
2754 W. E. Newton—Preparation of photographic papers
2755 A. B. Blackburn—Facilitating signals made by passengers in railway trains

Dated October 26th, 1865.

2756 T. R. Crampton—Construction of roadways and other surfaces
2757 A. Krupp—Projectiles
2758 H. A. Durfrene—Attack and defence in case of maritime war
2759 E. Hunt—Steam engines
2760 J. Johnson—Crossings to be employed in railways
2761 G. Davies—Cleaning the tubes of boilers
2762 H. Wilde—Telegraphs
2763 H. B. Barlow—Mules for spinning
2764 T. Page—Raising sunken vessels
2765 W. Smith—Working submarine electric telegraphic wires
2766 L. Bennett—Needle
2767 G. W. Bacon—Gymnastic exercises

Dated October 27th, 1865.

2768 S. Sequelin—Preparation of waxy or fatty substances
2769 E. Heywood—Calendering and finishing woven fabrics
2770 R. B. Sanson—Roller skates
2771 T. Greenwood—Wheels
2772 W. E. Newton—Breech-loading fire-arms
2773 J. Garnett—Driving machinery
2774 J. Bernard—Blasting or cutting rock
2775 G. Clark—Packing and labelling bottles

Dated October 28th, 1865.

2776 T. B. Jordan—Generating steam in combined vertical cylinders
2777 J. Murray—Attaching and detaching the sails of vessels
2778 J. H. Kitson and J. Kirby—Producing accelerated motion
2779 J. Combe—Preparing flax
2780 F. H. Gossage—Indicating and registering high temperatures
2781 S. Cotton—Hackling flax
2782 J. Buckingham—Screw wrenches
2783 J. Buckingham—Lathe chucks
2784 W. Westmoreland and E. Westmoreland—Sewing machines
2785 C. E. Goodman—Boots and shoes
2786 H. Larkin—Lamps for the combustion of magnesium
2787 J. Hinks—Lamps for burning liquid hydrocarbons
2788 J. Stanley—Knickerbockers

Dated October 30th, 1865.

2789 W. Whittle—Nails
2790 F. Tolhausen—Skates
2791 R. D. Dwyer—Coating the bottoms of steel and iron ships
2792 A. Braquenie—Double-faced carpets
2793 E. Meldrum—Distillation of coal
2794 R. Girdwood—Envelopes
2795 W. Deakin and J. B. Johnson—Ordnance
2796 W. E. Newton—Mining picks

Dated October 31st, 1865.

2797 G. E. Dooisthorpe—Machinery for combing wool
2798 D. P. G. Matthews—Distributing sand on the rails of railways
2799 D. B. White—Ventilators
2800 C. Chattaway—Fire-arms
2801 G. Robinson—Caustic soda
2802 T. F. Cashin & J. Felix—Fasteners for driving straps
2803 R. Cassels and T. Morton—Furnaces
2804 A. Deslandes—Metallic pipes
2805 C. Emmet—Steam hammers
2806 M. Bayliss—Spikes
2807 W. E. Newton—Transmitting motion to propelling shafts
2808 H. Y. D. Scott—Treating and deodorising sewage water

Dated November 1st, 1865.

2809 E. A. Phillips—Lanterns for burning hydrocarbon fluids
2810 J. Sellars—Artificial gum, size, or stiffening matter
2811 A. Jackson, J. Clough, and C. Ashley—Looms for weaving
2812 I. Baggs—Preserving provisions
2813 A. Boissonneau—Artificial eyes
2814 L. Pfeiffer—Travelling bags and other similar receptacles
2815 S. Solomons—Transparent slides for magic lanterns
2816 J. K. Farnworth—Raising and lowering carriage windows
2817 A. V. Newton—Dressing millstones
2818 C. H. Wood and E. L. Barret—Purification of gas
2819 A. H. Gilmore—Supporting doors in any required position
2820 J. Curtis—Morticing soft or hard wood and drilling iron

Dated November 2nd, 1865.

2821 H. Jones—Articles employed in the game of indoor croquet
2822 W. E. Gedge—Curing smoky chimneys and economising heat
2823 W. B. West—Plaiting machines
2824 M. Campbell, A. C. P. Coote, and C. A. H. Wolfram—Drying peat
2825 L. Schad—Colouring matter
2826 E. Rushton—Apparatus for reeling cotton or silk
2827 W. E. Dobson—Dressing lace
2828 B. F. Brunet—Ascertaining the degree of torsion and resistance in the threads of textile substances
2829 L. Pebeyre—Burning petroleum
2830 G. Bartlett—Artificial manure
2831 C. F. Henwood—Projectiles
2832 E. Clark—Sheathing iron vessels
2833 J. Webster—Generating gases

Dated November 3rd, 1865.

2834 R. C. Lilly—Penholder
2835 H. Bessemer—Steel
2836 F. Tolhausen—Shuttle motion for looms
2837 J. J. McComb—Compressing cotton and other materials
2838 J. B. Elkington—Copper
2839 R. Smith—Mounting and driving millstones
2840 G. Wilson and W. K. Hydes—Buffing apparatus for railway carriages
2841 A. H. Brandon—Signals
2842 E. J. Northwood—Plating or combining gold and other metals
2843 A. Heald—Looms for weaving
2844 H. J. Sanders—Drawing corks

Dated November 4th, 1865.

2845 H. Radcliffe—Communicating between passengers and guard
2846 A. Jemmett—Scattering artificial manures
2847 J. Nadal—Bottle fountain for pocket and other purposes
2848 W. Brett—Truck or barrow for wheeling and tipping coke
2849 P. B. O'Neill—Self-acting apparatus for applying steam boilers with water
2850 J. King and A. Watson—Fastenings for carpet and other bags
2851 T. Page—Preventing vessels sinking
2852 W. Gardner—Locks
2853 J. Thys—Preventing the transmission of heat or cold
2854 J. C. Edington—Extinguishing fires in warehouses
2855 F. Campbell—Treating or curing the tea leaf
2856 J. Whitworth—Preparing the ammunition for rifled ordnance

Dated November 6th, 1865.

2857 W. T. Hamilton—Boring mortices in wood or other material
2858 R. Sims and R. Burns—Formation of railway carriages
2859 A. Paraf—Printing and dyeing textile fabrics and yarns
2860 R. C. Mansell—Wheels
2861 R. Flude—Finishing the soles of boots
2862 W. Hebdon—Machinery for measuring woollen and other cloths

Dated November 7th, 1865.

2863 T. Grayson and J. O. Donoghue—Cement
2864 C. J. Viehoff and J. A. Matthiessen—Steering indicators
2865 W. Esplin and J. Clark—Steering gear for navigable vessels
2866 M. J. Roberts—Preparing cotton
2867 D. Barker—Bricks and artificial stone and marble
2868 H. Bateman—Igniting cigars or tobacco
2869 W. E. Newton—Checking the recoil of cannon or ordnance
2870 F. Prange—Steel
2871 H. Hides—Splint for surgical purposes
2872 G. A. Jasper—Cleaning sugar
2873 F. G. Bennett—Facilitating the walking of invalids
2874 G. A. Smith—Cushions for billiard tables

Dated November 8th, 1865.

2875 W. Manwaring—Reaping machines
2876 R. Swires—Grinding and pointing cards on carding engines
2877 C. Mole—Boots and shoes
2878 W. E. Gedge—Forges
2879 J. A. Raine—Locks
2880 J. H. Johnson—Inserting glass plates in plinnt fabrics
2881 N. Beard and J. Maiden—Lubricating the cylinders of steam engines
2882 G. A. Ermen—Paper
2883 J. Eastwood—Sizing yarns
2884 T. Westley and W. Bibby—Pulley blocks for general purposes
2885 C. Cochrane—Separating dust from the gases evolved from blast furnaces
2886 W. D. Allen—Casting hoops of steel suitable for making tyres
2887 J. B. O. Lassus—Renewing the teeth of worn-out files

Dated November 9th, 1865.

2888 T. Berrens—Thrashing machine
2889 B. Pitt—Doors, locks, latches, and such like fastenings
2890 J. E. Avy—Self-acting regulator or dial applicable to public conveyances
2891 W. E. Newton—Preparing the surfaces of paper

Dated November 10th, 1865.

2892 T. Redwood—Preservation of meat and the concentration of its juices
2893 E. Myers—Wet gas meters
2894 E. T. Hughes—Producing from rosaniline blue and violet colouring matters
2895 A. V. Newton—Embossed wood
2896 W. Middleton—Machines for fret cutting or sawing
2897 T. Whitwell—Furnaces
2898 E. J. Davis—Rendering brewers' grains more suitable for animal food

Dated November 11th, 1865.

2899 H. C. Carden—Apparatus for measuring intervals of time
2900 J. Norris—Lifts for raising passengers or goods
2901 D. Slater—Cabinet furniture
2902 C. W. Jones—Fire-arms
2903 W. E. Newton—Making amalgams or alloys of metals
2904 A. V. Newton—Rolling shafts
2905 J. A. Nicholson—Regulating the flow of fluids in pipes
2906 J. Millar—Cartridges
2907 S. Hand and J. Slater—Railway signals
2908 W. R. Lake—Crank axles of locomotives for railroads
2909 W. Reid—Supplying cattle with food and water on railways
2910 D. A. Jones—Socks or inner soles for boots and shoes

Dated November 13th, 1865.

2911 W. T. Hamilton—Cutting tenons
2912 P. Ellis—Cylindrical double pan water closet
2913 G. H. Goodman and E. Bow—Crushing stone and other mineral substances
2914 W. Moseley—Electric telegraphy
2915 E. Guthrie—Bricks
2916 N. H. Felt—Cutting and rounding the soles of boots
2917 W. Williams—Door springs
2918 J. Stephens—Portfolios
2919 W. Fox—Preserving meat
2920 J. H. Whitehead—Heating the feed water for steam boilers
2921 H. C. Davis—Nail machines
2922 W. R. Lake—Producing papermakers' pulp from cane
2923 J. J. Long—Cutting timber
2924 H. E. Newton—Ventilating millstones

Dated November 14th, 1865.

2925 H. A. Bonneville—Threading needles
2926 S. Middleton—Securing the contents of bottles
2927 J. Williamson, J. Lindley, and J. Coleman—Breaks
2928 J. A. Louhat—Railway steam engines and carriages
2929 J. Dixon—Refining iron
2930 W. E. Newton—Prevention of accidents on railways
2931 T. A. Westoo, J. Tangye, and R. Chapman—Moving heavy bodies
2932 T. Dohie—Permanent way of railways
2933 W. Clark—Connecting drums or pulleys with their shafts
2934 J. T. A. Mallet—Manufacture of oxygen
2935 S. L. Gill—Gas stoves

Dated November 15th, 1865.

2936 H. Clifton—Churns
2937 W. Bunger—Photographic lenses
2938 C. Atherton and A. H. Renton—Apparatus for steering ships
2939 G. Chambers and G. Gregory—Locks or catches for portemonnaies
2940 A. Alison and H. Hoskins—Cutting tunnels and sinking shafts
2941 A. Wells and W. Hall—Submarine telegraph cables
2942 L. A. Velu, E. E. Fosse, and L. E. A. Fosse—Stopping railway carriages
2943 H. Cochrane—Drying moulds
2944 J. Goodier and J. F. Kilshaw—Feathering the paddles of propellers for navigable vessels
2945 W. Clark—Manufacture or purification of hydrocarburets
2946 W. Easton—Pumps for raising liquids

Dated November 16th, 1865.

2947 M. Caton and H. Holden—Looms
2948 J. de la Haye—Construction and laying of submarine cables
2949 O. Sarony—Rests employed when taking photographs
2950 A. V. Newton—Manufacture of caramel
2951 A. V. Newton—Roasting coffee
2952 R. Jones—Preserving animal and vegetable substances

Dated November 17th, 1865.

2953 S. H. Huntly—Obtaining fresh water from salt and impure water
2954 E. and J. Bullock—Photography
2955 J. H. Smith and G. R. Smith—Draughting the patterns for coats
2956 W. H. Cope—Taking off the fibre from cotton seed and cleaning it
2957 G. Carter—Convex iron washers
2958 J. R. Cooper—Breech-loading fire-arms
2959 T. J. Perry—Metallic wheels
2960 W. Clark—Knitting machine needles
2961 R. A. Brooman—Shawls
2962 P. J. Fallon—Treatment of spirituous liquors
2963 T. M. Tennant—Furnaces
2964 W. E. Newton—Hardening malleable and non-malleable iron
2965 J. Harbert—Gas
2966 J. H. Whitehead—Endless cloths
2967 L. G. Speyser—Bricks
2968 W. Payton—Measuring the passage or flow of liquids
2969 L. E. Laurency—Life nets to be used in buildings houses

Dated November 18th, 1865.

2970 G. Taylor and J. Fernie—Steel castings
2971 S. H. Huntly—Cooking apparatus
2972 F. Wilkins—Production of hydro-carbon and other vapours
2973 J. C. Walker—Treatment of flour and the manufacture of bread
2974 H. Clifton—Sewing machines
2975 I. Lazarus—Bows or ties for articles of dress
2976 T. B. Heathorn and J. H. G. Wells—Gun carriages
2977 A. Vescovali—Increasing the adherence of locomotive wheels to the rails

Dated November 20th, 1865.

2978 A. Rickett—Cleaning or dressing currants and other fruits
2979 J. B. Fenby—Fastenings for doors
2980 J. B. Edge & E. Hitd—Spinning and doubling cotton
2981 C. Whitney—Breech-loading guns
2982 J. Weams—Ships
2983 S. Norris—Knitting machines
2984 W. J. Burgess—Cotton gins
2985 G. Smith and C. Ritchie—Brooms
2986 G. P. Hemming—Trap or liquid sealing to the covers of cisterns
2987 W. Clark—Bleaching feathers
2988 J. Pitt—Sewing machines

Dated November 21st, 1865.

2989 R. Walters and T. E. M. Walters—Cutting metallic plates
2990 S. Bennett—High pressure cocks
2991 F. Pope—Locks
2992 W. Gray, E. Gray, and J. Gray—Beaters for thrashing machines
2993 A. C. St. P. de Sincny—Manufacture of sulphur
2994 G. Smith, G. Smith, jun., and C. W. Smith—Hair-brushing apparatus
2995 T. R. Harding—Application of pressure to rollers of spinning and other machinery
2996 A. V. Newton—Condensing exhaust steam
2997 W. Parsons—Sash fastening for windows
2998 W. Wells and S. Marland—Obtaining artificial light

Dated November 22nd, 1865.

2999 T. W. Nicholson—Printing machines
3000 C. P. Cowper—Protecting the sides and bottoms of ships
3001 A. V. Newton—Ejectors for discharging bilge water
3002 S. A. Bell—Friction matches
3003 W. Birt—Communicating between passengers and guard
3004 S. Hunter—Anchors
3005 A. Lancefield—Stamping railway tickets
3006 J. H. Johnson—Boxes
3007 J. J. Field—Soap

Dated November 23rd, 1865.

3008 C. H. Chadburn—Inking and marking telegraphic instruments
3009 T. Redwood—Preservation of animal substances
3010 N. Greenhalgh and J. Mallison—Sizing and dressing yarns
3011 J. Ellis—Stays and bodices
3012 W. R. Mulley—Sheathing iron ships and iron-framed ships
3013 E. G. Lamson—Breech-loading and repeating fire-arms

Dated November 24th, 1865.

3014 H. J. Cox and W. Loach—Manufacture of air-tight coffins
3015 G. W. Turner—Pottery, earthenware, or ceramic articles
3016 J. Wauthier—Obtaining motive power
3017 C. Reader—Elastic belt
3018 J. Whitworth—Casting iron
3019 G. Moreton—Lacing boots and shoes
3020 S. C. Salter—Shrinking cotton and other textile fabrics
3021 R. Mallet—Mounting ordnance
3022 W. E. Newton—Shields for trunks
3023 W. E. Newton—Spiral springs for upholstery and other purposes
3024 A. V. Newton—Railways, and in spikes for securing the rails in position

Dated November 25th, 1865.

3025 W. A. Lyttle—Furnaces
3026 J. Draper and W. Leech—Water gauges for steam boilers