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THE WORLD IS ITS FIELD.

THE ENGINEERING MAGAZINE

VOL. XXIII. APRIL, 1902. No. 1.

THE REPORTS OF THE ISTHMIAN-CANAL COMMISSION.

By John Geo. Leigh.

By his timely, impartial, and thoughtful contribution to a discussion which has for its sole aim the enlightenment of the public upon one of the most important questions of the day, Mr. Leigh places the whole subject of the route for the isthmian canal before the reader in a manner at once authoritative and convincing; authoritative because based upon the reports of the Commission itself, and convincing because of the clear and logical manner of the presentation.—THE EDITORS.

A BRIEF personal note must of necessity preface this article. It is with very pronounced appreciation of the privilege accorded me that I accept the hospitality of THE ENGINEERING MAGAZINE to participate in a discussion which has done much to enlighten the civilised nations upon certainly the most important material question of the day—whether judged from the standpoint of world-politics, of economics, or of science. The distinction is the more marked because I follow such authorities (to mention but a few) as General Abbot, *facile princeps* in all that relates to hydraulic engineering; Mr. W. Henry Hunter, chief engineer of the Manchester Ship Canal; Mr. Charles Paine, past president of the American Society of Civil Engineers, and Professor Lewis M. Haupt, of whom it is only necessary to remark that he has served upon the two latest and most important of isthmian canal commissions. My position in relation to the question is peculiar, perhaps unique, for although I have devoted to the subject many years of careful study, I am absolutely without concern, present or potential, in the adoption of any route. I am not even engaged in engineering work, nor am I associated, however remotely, with any of the powerful interests—shipping, commercial, or insurance—so closely identified with the future of the enterprise. I write as a well-wisher of the great American nation, profoundly grateful for what it has achieved, and is yet destined to accomplish, in the service of mankind; and I take up my pen today the more readily because I regard the present as a critical juncture in the history of what should be a beneficent undertaking, fulfraught with glory and preferment to the United States, and of advantage to all the world. Than the isthmian canal there is no movement with which I have larger sympathy, and I very devoutly hope that my words may have influence for good.

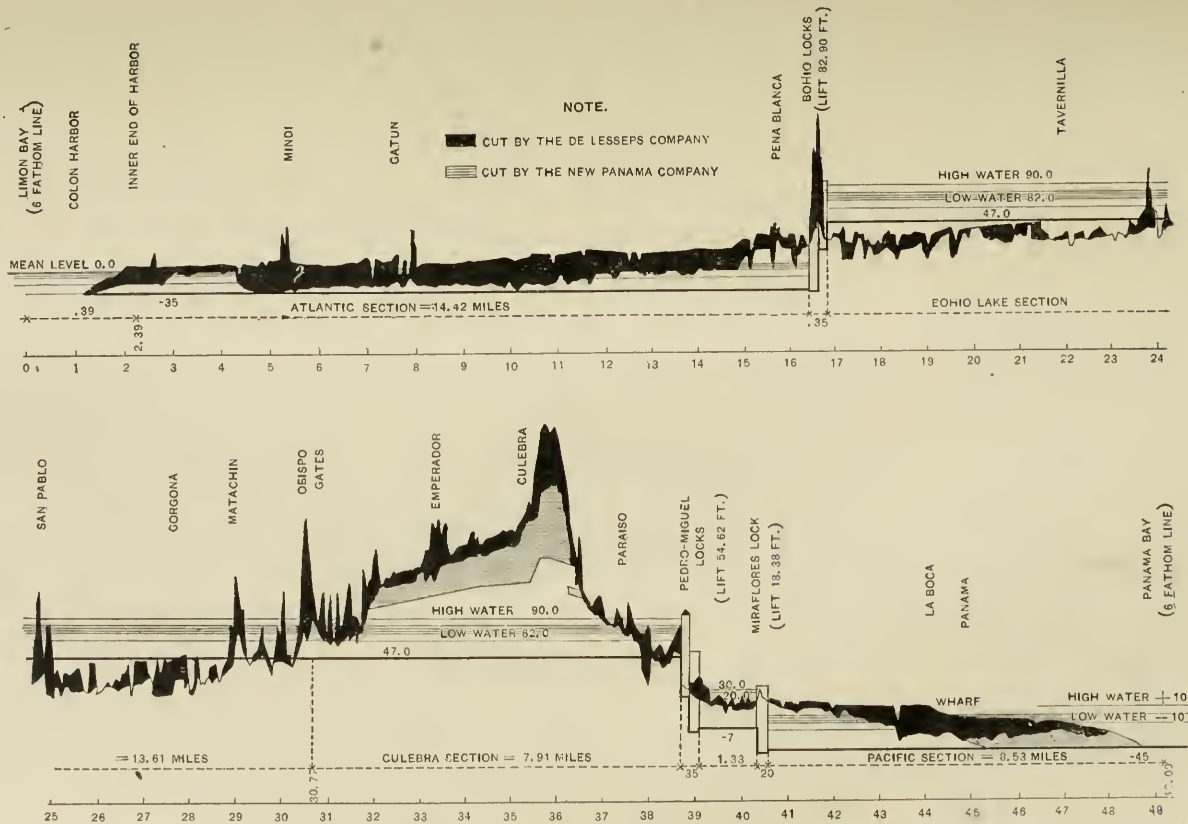
Thanks to faulty wording of the acts of appointment or to niggardly appropriations, Congress may be held responsible in greater or less degree for the comparative failure of some of the early canal commissions, boards, and surveys. No such plea, however, can be urged in connection with the existing deadlock, for which, it seems to me, the Isthmian Canal Commission is very largely, if not wholly, to blame. The Commission was never asked, directly or indirectly, to "recommend" a particular route, nor was it inconveniently hampered (except possibly from within) by the self-evident proposition that any canal constructed by the United States must necessarily be placed under the latter's control, management, and ownership. The main and most important object of its appointment was to accumulate for the guidance of the Executive and Congress full and reliable information on a given number of points—a very honourable and, in my opinion, sufficiently onerous task for any body of men, however numerous or distinguished. The Commission was, however, in no sense restricted as to the scope of its investigations or the presentment of its views. "You will be guided," wrote Mr. Secretary Hay to Rear-Admiral Walker on June 10, 1899, "by the provisions of the act of Congress," but "your duties will not be limited by the terms of the act, and if any line of inquiry should suggest itself to you in the course of your work as being of interest or benefit, I am confident you will not fail to give it whatever attention it may seem to deserve. The President trusts that the Commission will fulfil the important duties confided to them in such a manner that when their report is prepared, it will embrace all the elements required for his own guidance and for the final action of Congress."

The Commission, therefore, would have been not only justified, but quite in order, had it differentiated its findings from various points of view—for example, technical, financial and political. Had this been done—it would have been at once the most easy and straightforward course—the Commission might have recorded facts as they were, not as it wished them to appear; might have stated plainly what it longtime only ventured to suggest; and would most certainly have earned for itself the confidence of the nation, instead of exciting doubts as to its own singleness of purpose. Throughout the reports, preliminary and "final," three facts stand out in high relief:—(1) an enforced avowal that the completion of the Panama enterprise must necessarily be more feasible and less costly than the construction of any other inter-oceanic canal; (2) an amiable predisposition to speak well of each of the rival schemes adopted by the Commission, the one from the Nicaragua Canal Commission, the other from the International Technical Committee; and (3) a strained endeavour to justify, against the ill-disguised preferences for Panama, the following remarkable and, in my opinion, quite uncalled-for peroration—that " 'the most practicable and feasible route' for an isthmian canal, to be 'under the control, management and ownership of the United States,' is that known as the Nicaragua route."

I have welcomed as a logical and courageous act the Commission's recent reversal of its original vote. This, however, does not in any degree involve a restoration of faith in the accuracy of the Commission's reports. In the document transmitted to Congress in December last, the Commission placed on record a number of facts and figures, interesting and valuable from many points of view, but certainly not above reproach when applied, as was their prime purpose, to a comparison of the Panama and Nicaragua projects. Truth to tell, no fair comparison is possible on the bases, practically identical in each case, suggested by the Commission; and the more the report is considered, the more manifest must this fact appear. The Commission inherited from its predecessor, the Nicaragua Canal Commission, a scale of unit prices, intended originally for exclusive use in connection with Nicaragua estimates. In 1899, however, this scale, with a few insignificant changes, was adopted as a basis common to both canals, no discrimination whatever being exercised in connection with the very different conditions under which work would be conducted along the two routes. Some suspicion of the unfairness and futility of such a proceeding appears to have dawned upon the Commission during the drafting of the final chapters of its report, for on page 256 we may read a laboured attempt to argue that the relative magnitude of the two enterprises may best be measured by the total estimated cost of construction, not by length and other physical conditions! In other words, we are asked to believe that $5,630,704—the difference of cost, as estimated by the Commission, of acquiring and completing the Panama Canal and building, in very unpromising virgin soil, a navigable channel between Greytown and Brito—"measures the difference in the magnitude of the obstacles to be overcome in the actual construction of the two canals and covers all physical considerations, such as the greater or less height of dams, the greater or less depth of cuts, the presence or absence of natural harbors, the presence or absence of a railroad, and the amount of work remaining to be done.

Not $5,630,704, but at least ten, and possibly twenty, times that amount, represents the difference of expenditure needful in Nicaragua on account of excavation alone! It is admitted by the Commission that the aggregate excavation required in connection with the Panama enterprise cannot, under any circumstances, exceed 100,000,000 cubic yards, of which 43,237,200 cubic yards will be concentrated in the 7.91 miles between the Obispo gates and Pedro Miguel locks. On the other hand, the adoption of the Nicaragua route would involve 190,000,000 cubic yards of earth and rock excavation, of which 10 per cent. only would be centralised in the cut through the western divide, the remainder being spread over practically the entire length of route.

Instances without number could be quoted for the purpose of showing how sophistical are the figures which we have been asked to accept as reliable "estimates" for the construction of a Nicaragua canal. I will content myself, however, with a single example, certainly not the most glaring which might be cited. I have noted with interest the proposed expenditure, under the head of "Harbors," for Panama and Nicaragua respectively. Although there already exists at each terminal of the Panama Canal a more or less commodious harbor, the Commission has estimated that there should be expended in improving the entrance and harbour at Colon no less a sum than $8,057,707, of which $1,936,991 would be devoted to work outside the jetty, and that for dredging the channel outside the Panama Railroad Company's wharf at La Boca a further amount of $1,464,513 should be appropriated. All money spent in improving natural harbours, for which there is always need, is, in my opinion, well-invested, and I consequently take no exception to either of the above estimates, although that for Colon certainly appears excessive. What, however, is to be said of them in comparison with the expenditures proposed by the Commission for creating at the two ends of the Nicaragua route entirely new harbours? For the harbour, entrance, and single jetty planned at Brito, the Commission puts forward an estimate of $1,509,470, and for the very troublesome work anticipated at Greytown

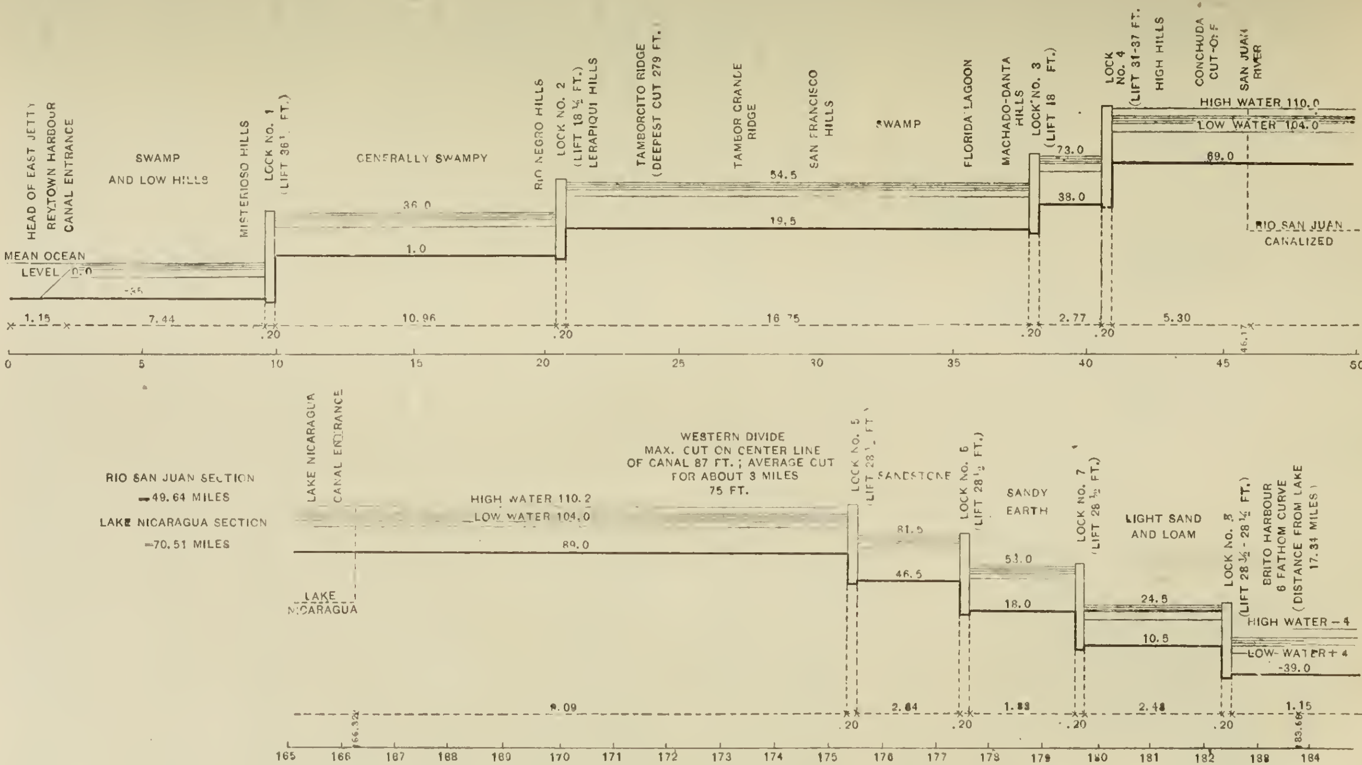


PROFILE OF THE PANAMA CANAL. PROJECT RECOMMENDED BY THE ISTHMIAN CANAL COMMISSION.

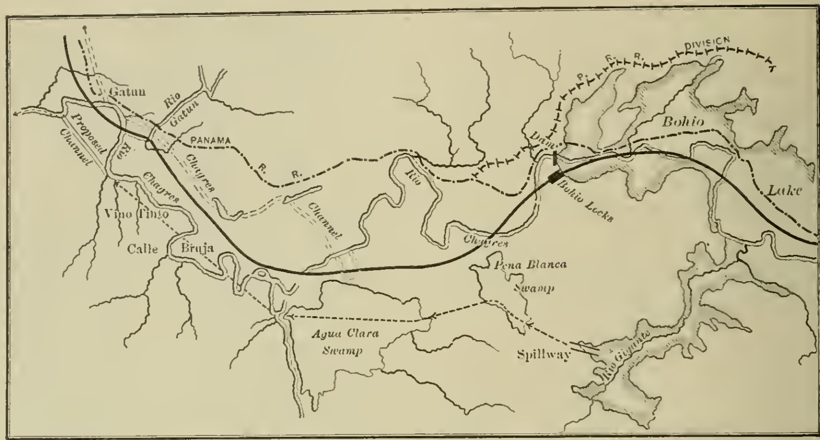
contents itself with a modest provision of $2,198,860. The problem at Greytown is admitted to be one of the most serious difficulties of the Nicaragua project; the Commission anticipates that quite two years will be required to make the necessary preparations and to construct an entrance and working harbour having a depth of 15 feet, and further that to maintain a depth of 35 feet, more or less constant dredging, costing $100,000 annually, will be essential. Nevertheless, the entire capital charges on account of this great undertaking are estimated at only 50 per cent. more than the expense of dredging the already navigable channel between Perico Island and La Boca wharf!

Among the illustrations to the present article will be found a longitudinal section of the Panama Canal, showing the plan for completion recommended by the second Walker Commission. In it I have also endeavored to indicate, as accurately as the limited size of the drawing would permit, the amount of excavation work already done, *i. e.*, 36,689,966 cubic yards, which the Commission regards as of value under its plan, and that (about two and a half times the quantity mentioned) which remains to be accomplished. The comparison appears to me interesting, as evidence of the present forward condition of the works and the not extravagant estimate of their monetary value framed by the American Commissioners.

It is to the lasting discredit of Ferdinand de Lesseps and his engineer coadjutors that, although they planned a sea-level canal, they never very seriously considered the necessity of protecting the latter and of assuring the safety of navigation against the violent floods through which they proposed their enterprise should pass. Yet it must have been obvious, even to them, that the lower the level the more pronounced would be the dangers, and that such expedients as they proposed were either absurdly inept or calculated to increase rather than modify the ever-present menace to the works. It was practically left to the International Technical Committee of 1896-98 to devise a comprehensive and efficient scheme for the control, and indeed utilisation, of the inconstant Chagres—the vital problem, more important by far than the great cutting through the Cordilleras, which called for complete solution before any ship-canal between Colon and Panama should ever have been attempted. The best of engineers is but a child when pitted against the forces of nature; he can conciliate them to his great advantage, but never defy them, and in frank recognition of this fact will be found the inherent strength of the Panama enterprise, as now understood.



PROFILE OF THE PROJECTED NICARAGUA CANAL—ATLANTIC AND PACIFIC SECTIONS.



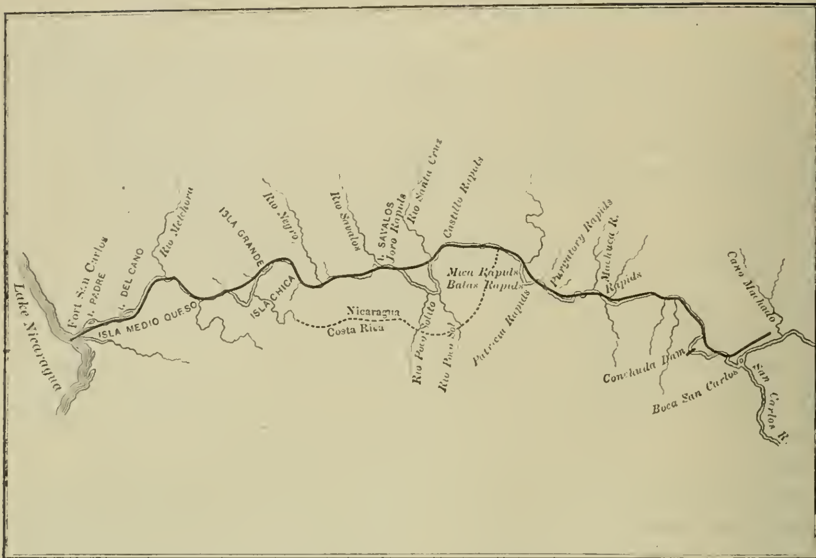
PANAMA CANAL. DISPOSAL OF FLOOD WATERS.

The scheme of the *Comité Technique* has been so frequently and fully described in the pages of this Review that there exists no necessity for lengthened allusion to it. With some modifications, it has been adopted by the Isthmian Canal Commission as the best possible plan applicable to the circumstances; and its promise of security is materially strengthened by alliance with a summit-level longer than appeared in the Technical Committee's high-level project and more elevated than that for which the same body avowed a preference. The members of the United States Commission very properly claim that simplicity is the marked feature of their plan, and I very cordially endorse that description without, however, for a moment admitting that the original was intricate. By the convenient, if costly, expedient of raising the height of the Bohio dam, the depth and area of the so-called Bohio Lake section will be so increased that the full flood discharge of the Rio Chagres may be received into it without the least risk of impeding navigation; and at the same time it will be possible to utilise to the best advantage the very favourable topographical conditions for the discharge of all waters in excess of canal requirements. The proposed dam at Alhajuela, on the upper Chagres, is, of course, no longer an indispensable adjunct to the system of flood control; but I am much inclined to think that its retention in the plan, for the purpose of moderating the more violent floods from the upper river, would be well-worth its additional cost.

Excepting the Bohio dam—a work of considerable magnitude and presenting many difficult features—the locks, the Obispo guard gates, and a spillway to regulate the height of the Pedro Miguel-Miraflores level, no important structures are called for on the Panama line. Away from it, however, are some subsidiary works, neither complex nor costly, which will prove of great utility to the efficient administration of the canal. They are designed as adjuncts to the automatic regulation of Lake Bohio, and appear no less practicable than simple. The water from the lake, after passing over the Gigante spillway, will flow across country about a mile to the Pena Blanca swamp, which is separated from the canal line by a sufficiently high bridge, and will thence be discharged, by an artificial channel, into the less elevated and larger morass of Agua Clara. Further on are other swamps, well-removed from the line of the canal and affording a wide area for the spread of flood waters, until the neighbourhood of Gatun is reached, and thence an artificial channel will be cut to the Chagres, through which the overflow from Lake Bohio and all tributaries below the lake on the west side of the canal will find its way to the sea. It should be added that for about five miles in the low-lying region about Gatun, the canal will require to be protected from overflow by levees. On the east side, for the purpose of diverting the Rio Gatuncillo, the channel built by the original French company as a Chagres diversion will be put into service.

It is but just, before referring to the Nicaragua project, that I should bear testimony to the admirable clearness with which the Isthmian Canal Commission has explained its salient features. At the same time I cannot but express serious doubts as to the adequacy of attention devoted not only to the great but also many of the minor problems of the route.

I much doubt if I exaggerate the difficulties which have to be encountered during the first twenty miles or so after leaving Greytown when I say that, excepting the heavy work in the Culebra section and the construction of the Bohio dam, the entire Panama canal might be built more easily and at no greater cost. For many miles of the distance mentioned, the Nicaragua canal line passes through a flat and swampy country, where the rainfall is abnormally heavy and practically continuous. The swamps communicate freely with the rivers in the neighbourhood, the flood levels frequently rise many feet above the level of the Caribbean Sea, and embankments will be required for long distances, not only to maintain the canal from within but also to exclude flood waters. The soil, moreover, is often so unsuitable even for the roughest of embankments that clay for their construction will have to be brought from the adjacent hills. At least two rivers will have to be diverted, and four wasteways are planned, each neces-

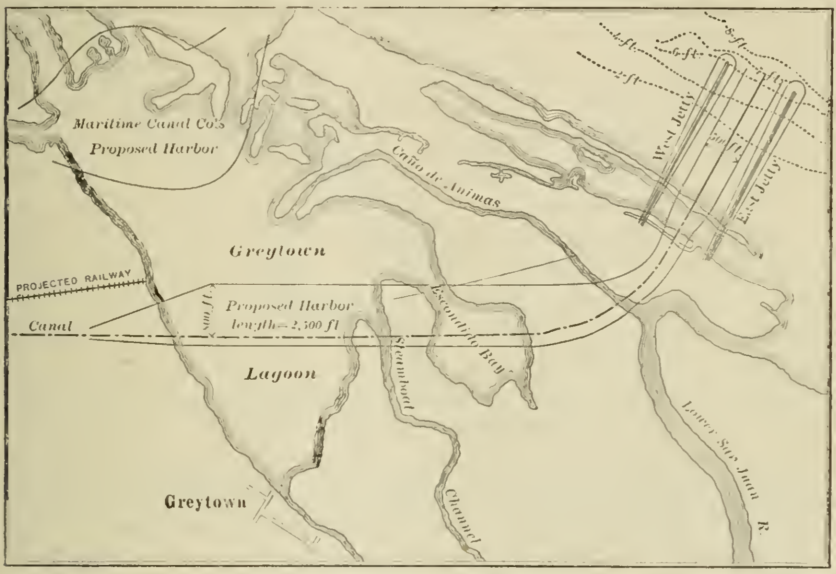


NICARAGUA CANAL. THE SAN JUAN RIVER CANALIZED.

sarily at a considerable distance from the canal line, for the purpose of protecting it from floods. It is not until Lock No. 4 is reached that these treacherous swamps can be eluded. Westward from Lock No. 2 are heavy cuttings through the Tamborcito, Tambor Grande, and San Francisco ridges, consisting largely of hard, basaltic rock; across Embankment Creek and the Machado River embankments will be required, for which considerable excavation will be needed, so that they may rest on firmer material than swamp; and beyond Lock No. 4 is a rough and hilly district where much deep cutting, through rock and clay, will be encountered. The total distance from the inner end of Greytown harbour to the junction with the San Juan river is 44 miles, and the estimated cost of constructing a canal across it—exclusive of the $19,258,572 allowed for the locks and their excavation—is $43,574,044. This sounds a large amount, but I venture to think that for this section of the work an appropriation at least 50 per cent. larger would not be by any means excessive.

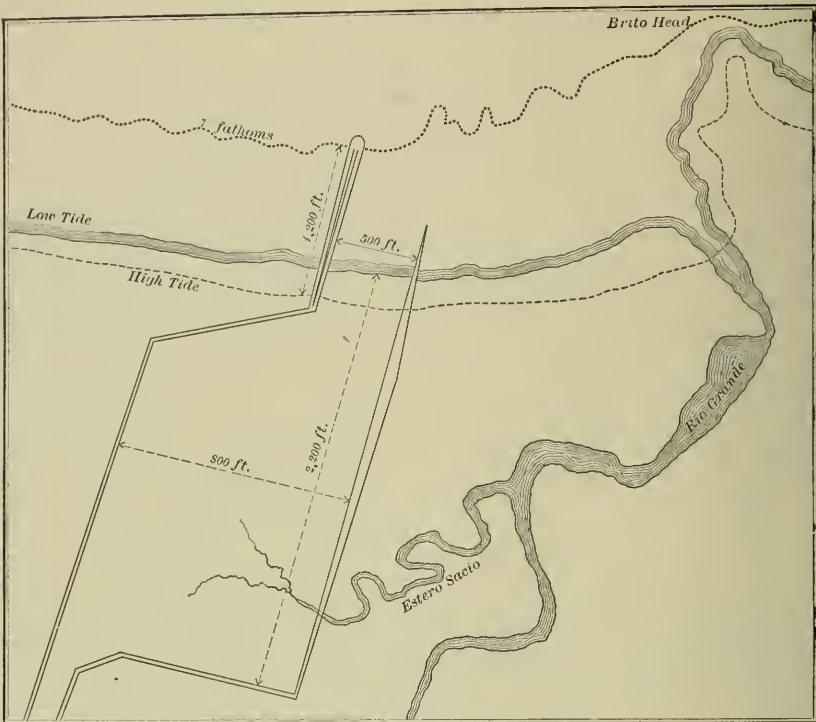
West of the Lake, the soil is invariably harder, and consequently more suited for canal construction; its adamantine virtues, indeed, are so pronounced that the necessary excavations are likely to prove unusually costly. The estimates of the Commission provide for a number of subsidiary works, including diversions of the Rios Grande and Las Lajas, a dam near Lock No. 5 to maintain the summit level, waste-ways, embankments, and the like, none, however, of very serious moment or involving difficult engineering.

The crux of the Nicaragua project is, of course, the regulation of the Lake level, a subject which had been almost studiously avoided prior to the labours of the Nicaragua Canal Commission. It would be unwise, in the limited space at my disposal, to attempt either a description or criticism of the scheme formulated by this body and adopted by its successor. The plan appears feasible and to be founded upon careful hydrographical observations, but all the data needful to make it even theoretically perfect are admittedly not yet to hand.



PROPOSED HARBOR AT GREYTOWN.

The sites of the proposed Conchuda dam and auxiliary waste-way seem to be most happily chosen, and the plans for these structures also appear in every respect satisfactory. Speaking generally, I do not hesitate to describe as most important and valuable that portion of the report of November last which deals with the problem of Lake regulation. There is, however, one very important point in connection therewith which appears to demand immediate explanation, and this I will endeavor briefly to express. For the purpose of regulating the Lake or summit level, the latter is to be extended for 55 miles to Lock No. 4, and to the Conchuda dam 3.3 miles down stream from the point where the canal leaves this arm of the Lake. There are, however, notable slopes in the various reaches of the River San Juan



THE PROPOSED HARBOUR AT BRITO.

which it is proposed to canalise; for instance, with the Lake at elevation 104, the fall in feet to the head of the Toro Rapids is 5.4, in the Toro Rapids the fall is 7.3, from the foot of these rapids to the foot of the Castillo Rapids 7.2, and thence to the foot of the Machuca Rapids 28.5. The surface level of the canal, therefore, at the last mentioned point would be 48.4 feet above the bed of the river under normal conditions, a circumstance which has raised in my mind the following question, not determinable by the reports of either the Nicaragua or Isthmian Canal Commissions, namely:—is the river so hemmed in on each side by high ground that no embankments will be needed to sustain the proposed canal?

It may be that this and all other questions of construction can be answered to the complete satisfaction of advocates of the Nicaragua project. Construction and relative cost, however, are not the only and most important points in the controversy; they are quite inconsiderable as compared with the questions of operation and serviceableness. As regards the first, the Isthmian Canal Commission offers us the not impressive information that it has estimated the annual cost of maintaining and operating the Panama Canal at $2,000,000, as against $3,300,000, the corresponding charges for Nicaragua. It has arrived at these figures by the comfortable, but certainly very inadequate, expedient of a percentage of the cost of construction, and the same rule has served it in connection with certain capital charges, ingeniously massed as "engineering, police, sanitation, and general contingencies." On account of these the Commission has added to the estimated cost of constructing the Nicaragua Canal and its railways, harbours, and other works, a sum of $31,644,090, or 20 per cent.; but for some occult and unexplained reason, in the case of Panama, the percentage is calculated only on the estimated cost of completion, without adding thereto any amount representing the work already accomplished. Estimates and their proper presentment are obviously weak points with the Commission; otherwise I should be tempted to ask why "police" and "sanitation" appear only as capital charges, and are quite ignored as items of general supervision.

It is proposed, and very properly so, to improve the course of the canalised San Juan by various cuts-off. These suggested rectifications of the channel are neither few nor far between, but it is very doubtful, even with their introduction, if this section of the route will commend itself to the shipping and insurance interests. Despite the improvements of the Isthmian Canal Commission, one half of this section still remains in curvature, four of the curves having radii of 6,876 feet, two of 5,927, six of 5,730, three of 5,289, two of 4,911 and four of 4,045! Curvature, as a matter of fact, is one of the weakest points of the Nicaragua route, as compared with Panama, or, indeed, any channel intended for use by large ocean-going steamers, and it seems very doubtful if further improvement is possible, except at almost prohibitive cost. On the other hand, the alignment of the Panama Canal is exceptionally good; twenty-one of the curves have radii ranging from 9,842 to 19,629 feet, four have radii of 8,202 feet, and three only fall below the limit of 6,500 feet. The following sum up the respective merits and demerits of the two canal lines in the matter of curvature:

	No. of Curves.	Length—Miles.	Total degrees of curve. °	′	″
Nicaragua	56	49.29	2,339	50	30
Panama	29	22.85	771	39	00

"The completion of the harbours as planned for both routes would yield but little advantage to either, but the balance of advantages, including those of maintenance and operation, is probably in favor of the Panama route." Thus wrote the Isthmian Canal Commission, in November last, concerning a matter which even the most enthusiastic supporters of the Nicaragua route regard with disquietude. The Commission is entitled to considerable credit, no doubt, for having planned, out of most unpromising material, harbours at Greytown and Brito; but the best of plans and the most sublime faith in their excellence will not, of themselves, construct and keep open harbours, especially where, as at Greytown, the forces of nature have united in ceaseless war against such an enterprise. By means of the proposed east jetty at Greytown, the westerly drift of sand may for a time be checked, and for quite a considerable period perhaps dredging may keep the entrance clear. How long the battle will last it is of course impossible to say, but the history of engineering is prolific of warnings as to its only too probable issue.

That a ship canal, of a sort, can be built over the Nicaragua route, I do not for a moment doubt; but I do very seriously question the possibility of constructing—within reasonable limits of time and expenditure—a water-way likely to be of service to the navy and commerce of the United States, to say nothing of those of other nations. Formerly, when many false impressions prevailed concerning the topography of the route and the advantages accruing from the presence of Lake Nicaragua and the river San Juan, some apologies could be offered for persistent advocacy of this route. Within recent days, however, the conditions of the controversy have vastly changed, and I, for one, fail to appreciate the "patriotism" which insists that it is the duty of the United States irrevocably to identify themselves with an adventure of dubious wisdom and utility, for no better reason than that in times past there existed many erroneous views upon the subject. The people of the Union will fall immeasurably in the opinion of all far-sighted and friendly nations, and prove false to every ideal in their history which has made them the industrial pioneers of the world, if now, standing at the parting of the ways, they choose the crooked path. The one road is full of promise of a triumphant realisation of perhaps the most grandiose enterprise ever planned by man; the other is abundant in menace to the national influence, prestige, and pride, and certain to engulf to no useful end many millions of well-earned dollars. I cannot believe that a practical, educated, progressive, and heretofore level-headed people will permit themselves longer to be blinded to a true appreciation of facts and all that the latter portend.

MONEY MAKING MANAGEMENT FOR WORKSHOP AND FACTORY.

By Charles U. Carpenter.

III.—THE ELEMENTS OF A WORKING SYSTEM.

In his first and second papers Mr. Carpenter dealt with the general principles of factory organization, and with a description of a remarkable example of a highly organized establishment. Before taking up each department of work in detail, he now briefly discusses the nature of these subdivisions, preparing the reader for the very full examination of each of these sections in the following articles. In this connection attention is called to the papers by Mr. Falconer upon the Factory Office, the first of which appears elsewhere in this issue. —The Editors.

THE struggle for commercial supremacy in this day of competition has forced upon the attention of the business world the all-important fact that in the adoption of up-to-date, efficient factory systems lie great possibilities of economies and a better product at lessened cost.

In seeking the reason for the lasting and commanding success of American business organizations of today, two facts will stand out prominently. One is that the organizations are founded upon principles that are in accord with modern progressive ideas and that tend to bring out the latent intelligence, loyalty and strength of all its members.

The other is that the important details of factory work are cared for by systems which are homogeneous, flexible and efficient; systems which leave nothing to chance, but which care for the smallest and the most important details of factory work alike.

The most effective means of increasing the volume of any business is the organization of the advertising and selling forces upon modern lines. The strongest support for the selling force and the best bulwark against competition is thorough organization of methods of production. Organization that will give new products, improvements of old products, more prompt deliveries and lower costs.

In the mind of the old-time manufacturer the word "system" is indissolubly linked with that horror of "extra clerks." It is the old question of the man holding the coin so close to the eye as to shut out entirely the greater and broader horizon of his commercial possibilities in both the expansion of his business and in factory economies.

He does not understand that the losses he is daily bearing are many times the amount that his extra clerks would cost him. In fact, his "extra clerks" would probably prove the best investment he could ever make. Many a man will place all conceivable safe-guards around his systems for handling and caring for his money and yet will be altogether careless of the manner in which his valuable stock, purchased by his money, is handled. Experience has shown that the opportunities for losses in the manufacturing end of the business are often as large as on the commercial side, and that the opportunities for economies in the former are often much greater than in the latter.

On a par with this old-time manufacturer with his horror of expenditure for clerical work, is that other unprogressive individual who says "Oh, that is too much red-tape for me. When I or my men want a thing we go get it in the quickest and easiest way we can. No red-tape, no records for me. Every one helps himself, and we get out the work somehow." The results are what might be expected. His "somehow" product is generally not good in quality, not delivered promptly, nor sufficiently low in cost to enable him to hold his own in the business world. A manufacturer ought to realize that he should be guided in his system of factory management by the same principles that he uses in checking up his bank account, seeing that he is credited with all deposits, and debited only with that which is properly chargeable to him, by the same common-sense that he uses in keeping the proper trace of his accounts. A man is showing the same lack of business judgment in refusing to admit the necessity for practical factory systems and a proper series of factory records, as he would were he to discard his book-keeping and trust to luck to come out "somehow" in his accounts. The "red-tape" is but common-sense applied to factory management. The writer is not a believer in "red-tape," but does insist that a proper regard for a few principles is absolutely necessary for the successful factory management.

It would be profitable to any manufacturer to consider seriously how far his systems are from being as efficient as they should be. This was taken up at some length in my former article and its great importance dwelt upon fully.

We hear much today about American products standing at the head in the markets of the world because of her automatic machinery and intelligent workmen. While this is true, still the writer asserts that investigation will show that, in the case of a vast majority of such products, the factories producing them are organized on modern lines. They know what their product costs them. It is produced without any unnecessary handling or expense, and every device of system and machinery is adopted to perfect their organization and product. It behooves the manufacturer of today to "look to his corners" and perfect his organization at every possible point or he will be left behind by a better organized competitor.

Factory Systems. The writer presents a series of systems which have proven to be of great efficiency and at the same time comparatively inexpensive. All "red-tape" is done away with, but the few fundamental principles and rules laid down must be followed out with uncompromising firmness. If these are properly adhered to and developed the important results herein outlined will be produced.

First, stock and stock tracing. A complete system should reduce the investment in stock and machinery to as low a point as possible and provide against all delays in the delivery of finished parts to assemblers, or finishers. This should be accomplished with a minimum of expense.

Second, costs. Providing accurate tabulated records of all costs, both of separate parts and of the finished product so as to form valuable records whereby the possibility of economies can be detected and the selling price fixed with exactitude.

Third, machining or producing. The product must be produced in the best manner possible at the lowest possible cost. It should be so finished in the main machining or producing departments as to eliminate all fitting, filing, or finishing in the assembling or finishing departments. The use of improved automatic and multiple machinery, jigs and gauges, should prevail to the greatest possible extent to insure uniform, interchangeable and a cheapened product.

Fourth, inspection. Probably no one of the highly important details of the factory systems is more neglected than this one. Inspection is absolutely necessary in order to secure the results above mentioned. It is also the only method by which proper check on the quality of the work can be secured and give assurance that the men will get paid only for that which is of the proper quality.

Fifth, scrappage. An inexpensive system can be devised that will prevent reckless extravagance in stock. The product handled by this system can be sold at a much higher price.

Sixth, piece-work. The great economies secured by proper system of piece-work are well understood. The system, however, should provide accurate checks on the workmen. In addition to the piece-work, records of the earnings and output of each man will be found to be very valuable.

Seventh, tools. Tool designing, methods of tool supply and tool making are of vital importance. The methods of up-to-date organizations can be suggested which will largely increase the output of the ordinary tool room.

Eighth, inventions. The progressive spirit of any firm may be gauged by its systems of inventing and designing new product for the market. This feature, often neglected, is of the highest importance for the future of any concern. Careful consideration should be given to the methods of securing ideas and of developing them; also, the thorough testing of new inventions before the tools are made and the product placed upon the market.

Naturally, the proof of any system is the manner in which it operates under severe conditions. A former article described fully the output and factory conditions of the National Cash Register Company where these ideas have been carried out to the fullest extent. Some of the most important of these data are here given to illustrate how severe these conditions are under which such a system has been developed. In the stock rooms are carried over 13,000 different kinds of stock; the stock tracer is continually handling over 19,000 different orders for stock, consisting of over thirty-million pieces. In one year the inspection and stock tracing department handled over two hundred million (200,000,000) pieces of stock. The piece-work system takes care of over 22,000 piece-work prices. Notwithstanding the fact that the machine room capacity is limited and great accuracy in the stock is required, no delays in the output, nor any difficulty in assembling are experienced.

Written orders. One rule in particular is necessary for any system. That is, *all orders must be in writing*. This must be adhered to strictly. Written orders are necessary for a number of reasons. First, they reduce the liability of error and misunderstanding to a minimum; second, they fix absolutely the responsibility of all acts upon those to whom it belongs; third, they promote accuracy and care in the preparation of orders. One factory has adopted an admirable plan to impress this rule upon the minds of all. Upon the stationery used throughout the factory are printed the words "*Verbal orders don't go.*"

Having thus outlined the departmental subdivision of the factory system, as organized for money-making operation, the next article will take up the subject of stock and stock-tracing in detail.

MODERN PRACTICE IN BOILER-MAKING SHOPS.

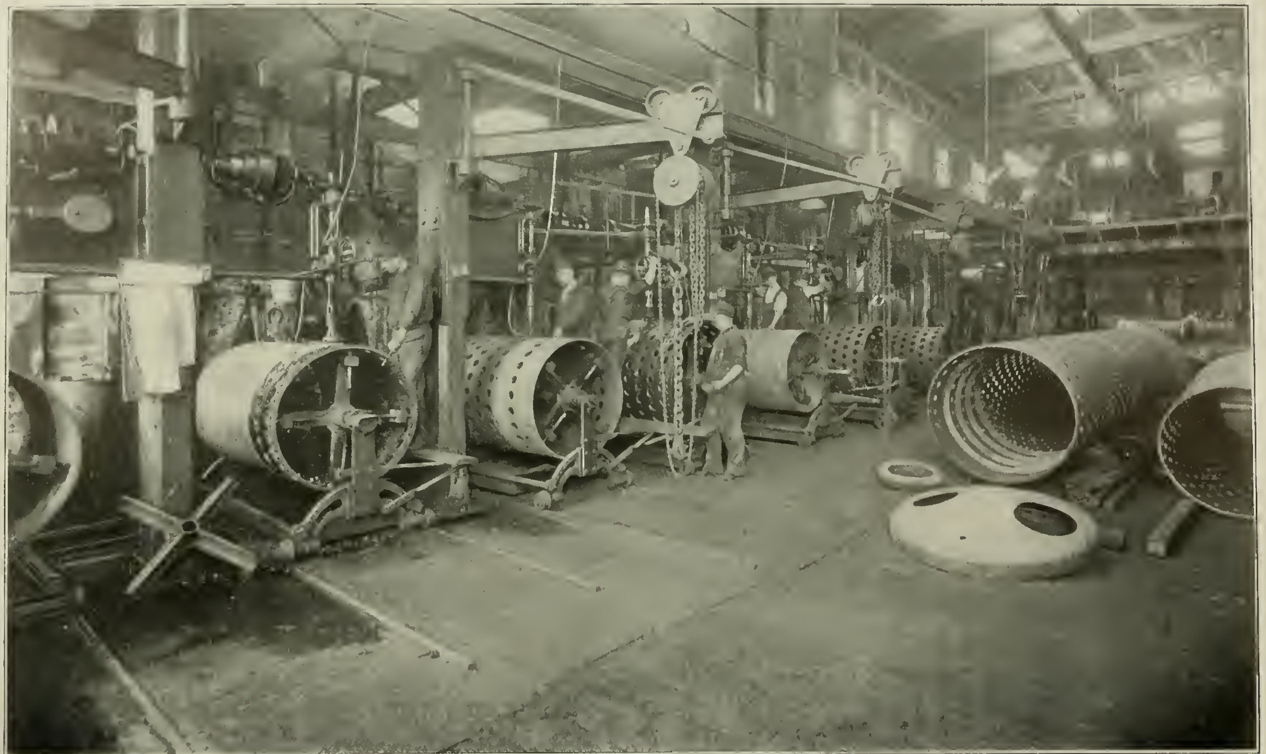
By Egbert P. Watson.

The transformation in the equipment of manufacturing establishments, concerning which much has been said in these pages already, has not been limited to the machine shop; the boiler-making department has also shared in it. Mr. Watson tells, out of his ripe experience, the transformation which has taken place in his own times, and the numerous illustrations show the extent to which both Europe and America have shared in this work.—THE EDITORS.

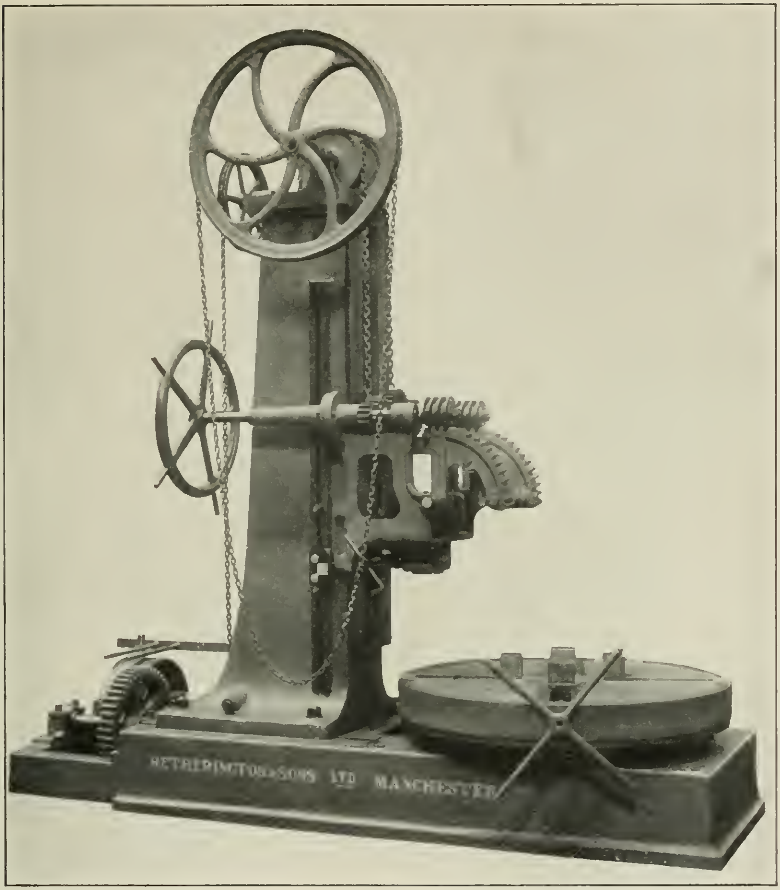
IT is not necessary to look back more than few years to recall the time when a steam boiler was made of almost "any old stuff," riveted up somehow, anyhow, so long as the rivets were spaced with apparent regularity and had good big heads on them. The chipping and caulking made the thin sheets look about an eighth of an inch thicker than they actually were, and the fittings and mountings of cast iron were so lavish in material that the buyer felt he was getting a good deal for his money. No one could see inside on the seams, even if it had occurred to him to look there, and discover the mischief wrought by drift-pins urged by heavy flogging hammers upon recalcitrant rivet-holes that simply would not let the rivets in, or find the liners and "dutchmen" that filled gaps where the plates would not come together; but all of these defects existed in cheap boilers, made to sell.

There were good boilers made in old times, be it understood; not all of them were of the class described above, but many were, chiefly those made for a small price. If they were reasonably steam-and-water-tight when done, that was all that was expected of them. If they were the reverse, a wheelbarrow load of manure helped them a good deal.

I will say here that there is no such thing as a cheap steam boiler; boilers are only relatively cheap, as compared with each other. For example, if by reason of larger capital, better shop equipment, and larger facilities generally, a firm of boiler makers should put fifty of one type through their works at once, such boilers could be sold for less than a boiler made to order could be. They are not inferior in quality of metal or workmanship, but they are of the same proportions all through—in grates, heating surface, and tube surface—for a given rating, so that if there is a defect of design the fault is common to all of the fifty, and if a steam user wants or thinks he wants some departures from certain dimensions, he can have them by getting a boiler made to or-



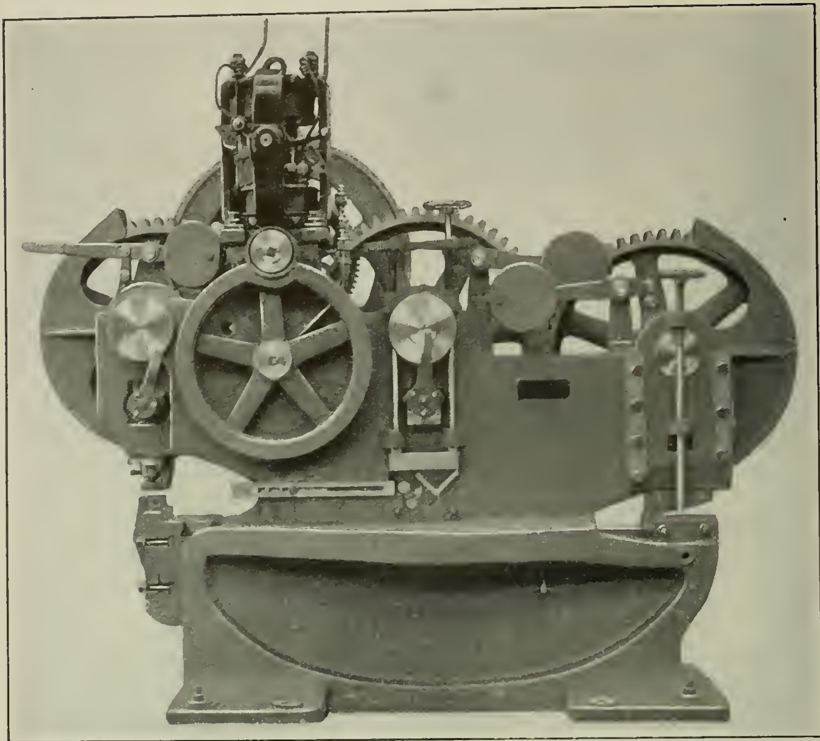
A BOILER-SHOP INTERIOR. CLONBROCK STEAM-BOILER COMPANY.



HEATON'S PATENT FLANGING MACHINE. JOHN HETHERINGTON & SONS, LTD., MANCHESTER.

der. This will necessarily cost more, but it is not relatively more expensive than the boilers built in lots, because the buyer gets (or thinks that he gets) more for his money, which comes to the same thing commercially. But as regards a cheap boiler built for a cheap buyer, the man who purchases it will always regret his want of foresight.

A modern boiler shop is far different from its congener of half a century ago, in that, for one thing, the methods of construction have been greatly simplified and improved tools are in more general use. These last have also reduced costs so much that an old-timer revisiting the shop would stare in amazement at what is now possible. It is not generally known that a boiler of forty horse power can be made and

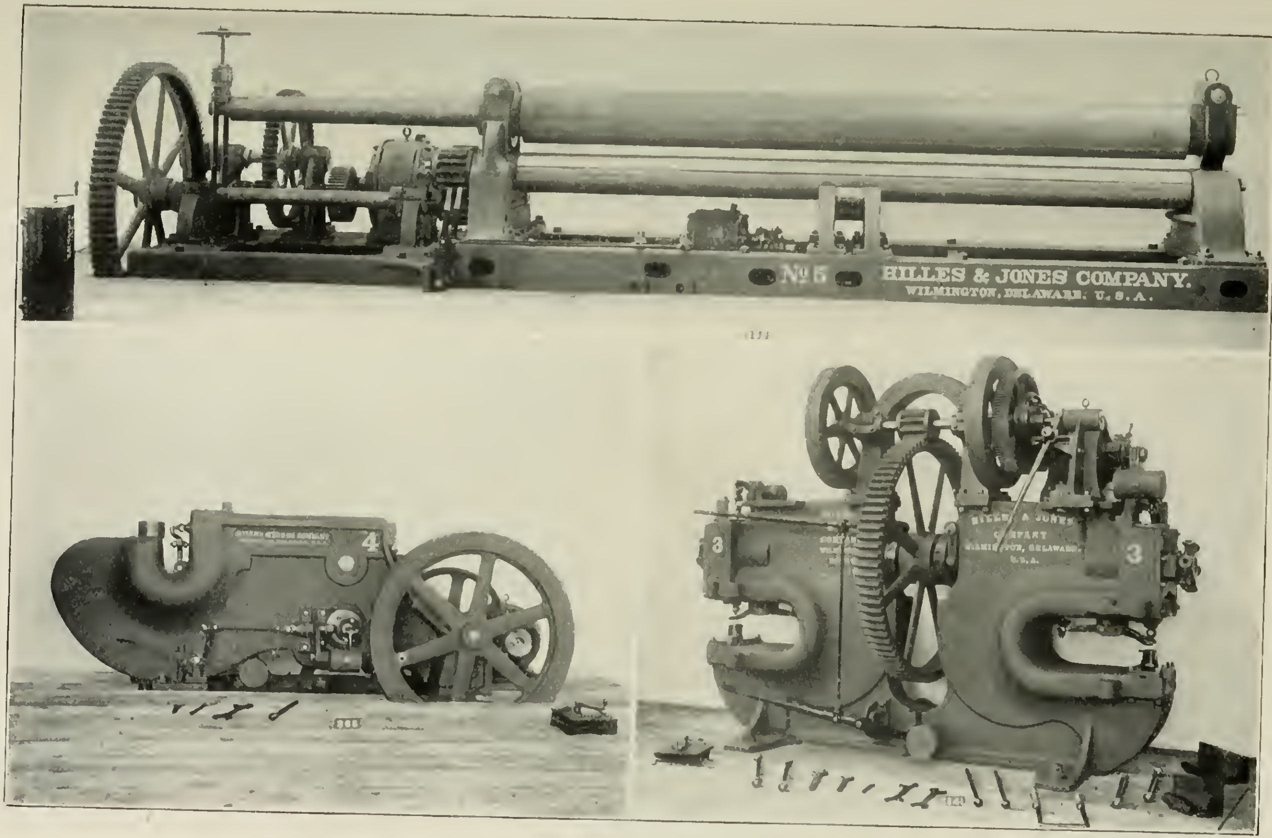


ELECTRICALLY DRIVEN SHEARING MACHINE. R. BECKER & CO., LONDON.

This machine is capable of shearing any length and width of plate, and is combined with a machine for cutting round, tee, or angle iron, and with a punching machine.

shipped in about eight hours. That is to say, if an order is put in by seven o'clock in the morning it can be on the way to its destination by three o'clock of the same day, ready for steam when set. This boiler will be taken from the flat sheets, rolled to dimensions, all rivets driven, tubes set and rolled, and the work made water and steam-tight within the time named; but it will be of the return-tubular type, where no smith work or flanging is required. This is quick work, and I know of one shop where it is done; doubtless there are others.

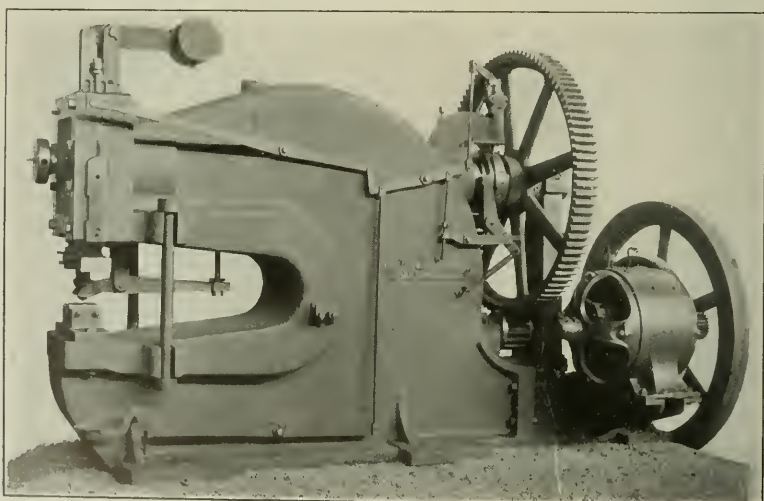
The old-time boiler shop which contained nothing but a punching press and a shear in more or less bad condition usually, (as to its blades, certainly,) and a few hand tools, would compare unfavorably with a modern shop of the same capacity, where all rivets are driven by power and seams chipped and caulked by the same agency. To see a little pneumatic machine upon work that will not go under the big machine, closing rivets with only one man at the heading, is itself a revelation.



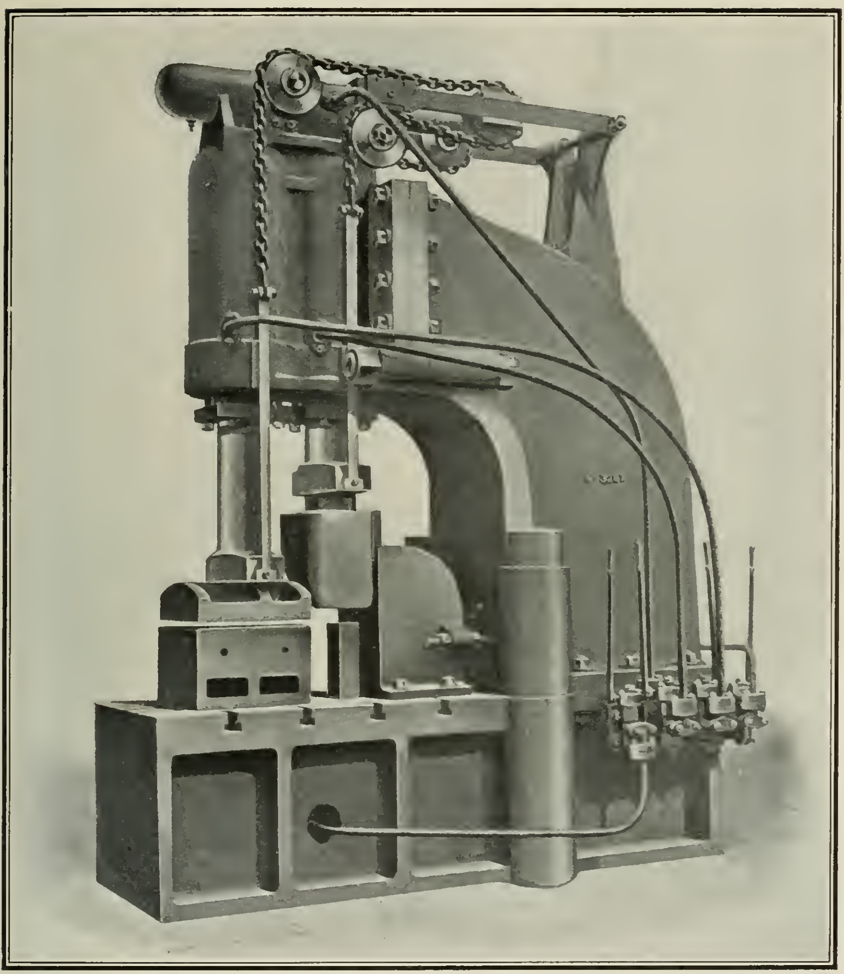
A GROUP OF CHARACTERISTIC BOILER SHOP TOOLS.

The top view shows an electric-driven plate-bending machine; the motor underneath is used for raising and lowering the top roll, either end being handled independently. Below on the left is a heavy horizontal flange punch, motor driven. On the right is an electric-driven double punching and shearing machine. Hilles & Jones Company.

RIVETING UP BUOYS WITH PORTABLE TYPE PNEUMATIC RIVETER.
Philadelphia Pneumatic Tool Company.



SINGLE BOILER PUNCH WITH DEEP THROAT. ELECTRIC DRIVEN.
Long & Allstatter Company.



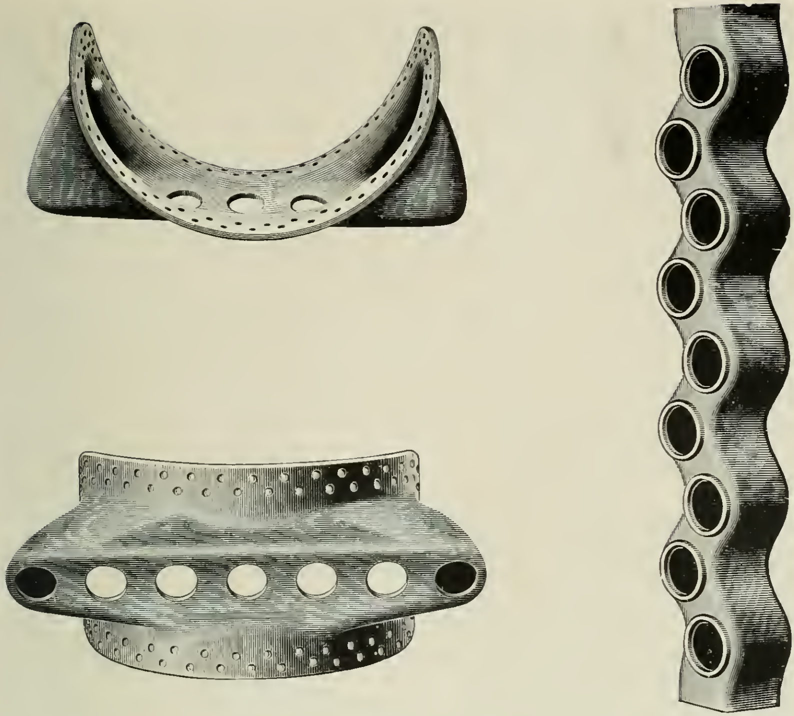
PROGRESSIVE BOILER END FLANGING MACHINE. CRAIG & DONALD, LTD., JOHNSTONE.
This machine is also used for flanging flues, steam dome ends, and similar work.

not only of the rapidity, but of the character of the work. All the heads are of the same height and external dimensions if the rivets are of the same length, and they are all "plugged" (that is, the body fills the rivet-hole) and need no caulking. What this means in the cost account no one but the boss boiler-maker who had to pay for handwork can appreciate. Besides the riveting these same pneumatic tools do other work, which when done by the old method was tediously slow. Some chippers and caulkers are quicker than others, but it puts an employer on pins and needles to see a "sojer" laboriously slugging away

FIXED-TYPE RIVETER AT WORK.
Bethlehem Foundry & Machine Company.

with hammer and chisel on a hurried job that should be in place, counting every stroke apparently, and making sure that he does not give too many for the pay he gets. Here is where the pneumatic tool comes to the rescue of the harassed boiler-maker, for one man goes around a seam, either caulking or chipping it, as a woman operates a sewing machine. There is no loafing with the pneumatic tool, for the man has perforce to keep up with it or willfully to spoil the job. It is literally a time-killer in the best sense of the word, for it walks over the work at a racing pace.

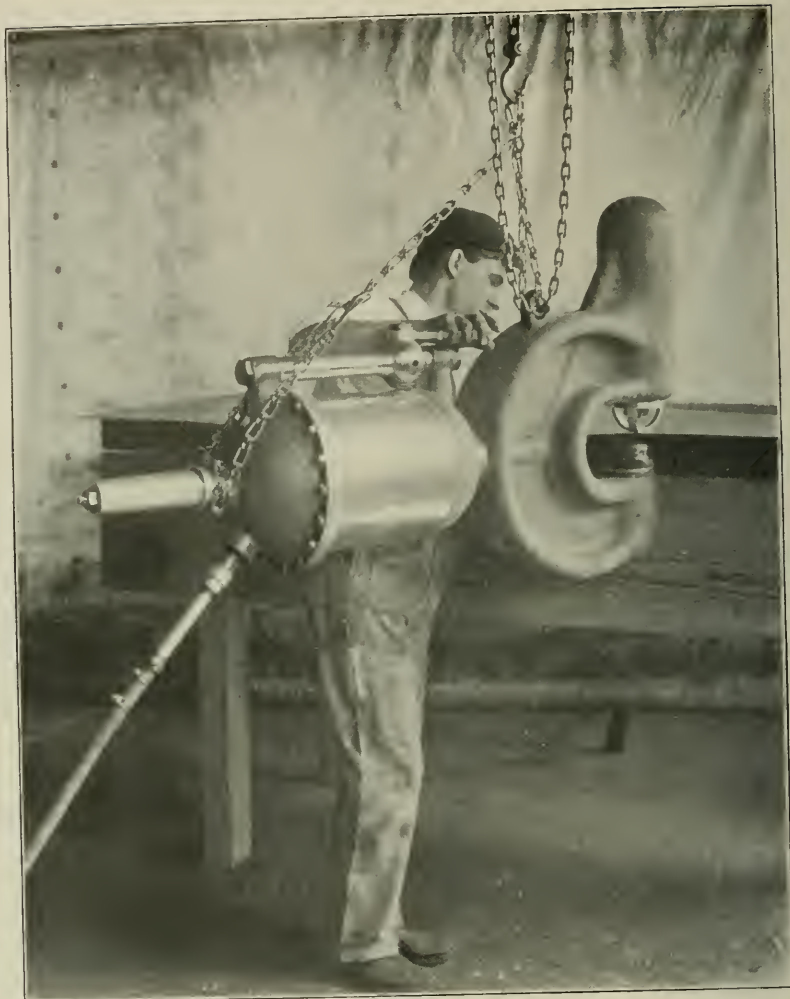
In old times the flanger was a great man—bigger than the layer-out—and it was a serious matter to lose him if he took a notion to change his base; but the flanger's task was a simple one to what it is in these days, for it was chiefly straight-away work, in no wise comparable to that done upon some kinds of modern boilers. The illustrations opposite, which represent steel plate flanged to the forms required for details of the Babcock & Wilcox boiler, illustrate the plasticity of modern steel boiler-plate, and the skill required for its manipulation. The header, on the right, is a square steel box, formed of one plate, the holes,



CONNECTIONS FOR BABCOCK & WILCOX BOILER.

These are examples of the results of the modern flanging method and materials.

of course being drilled. Imagine the consternation of the old-time flanger if required to produce these shapes! He would say it could not be done, and he would have been correct, too, for in his day, fifty years ago, there was no metal that would have stood the punishment required to shape it. Moreover, the sheets flanged years ago were not usually more than $^{5}/_{16}$ thick, rarely $\frac{3}{8}$; seldom, indeed, $\frac{1}{2}$ an inch thick; and to turn even these, if the shapes were at all out of the usual run, required an amount of discussion and pow-wow over the job that would discount an Indian council fire. Now, in these days, it would be a curious shape that would be given up as impracticable, whatever the thickness of the stock. The facility with which flanging or shaping of the details of steam boilers can be executed is rivaled only by drop-forging, which it very closely resembles in character. It has dispensed with castings to such an extent that there are none at all under strain in some modern boilers, and none anywhere except in the doors and fronts of stationary boilers. Even the dogs of hand-hole plates and man-holes are now made hollow in pressed steel, at a fraction of

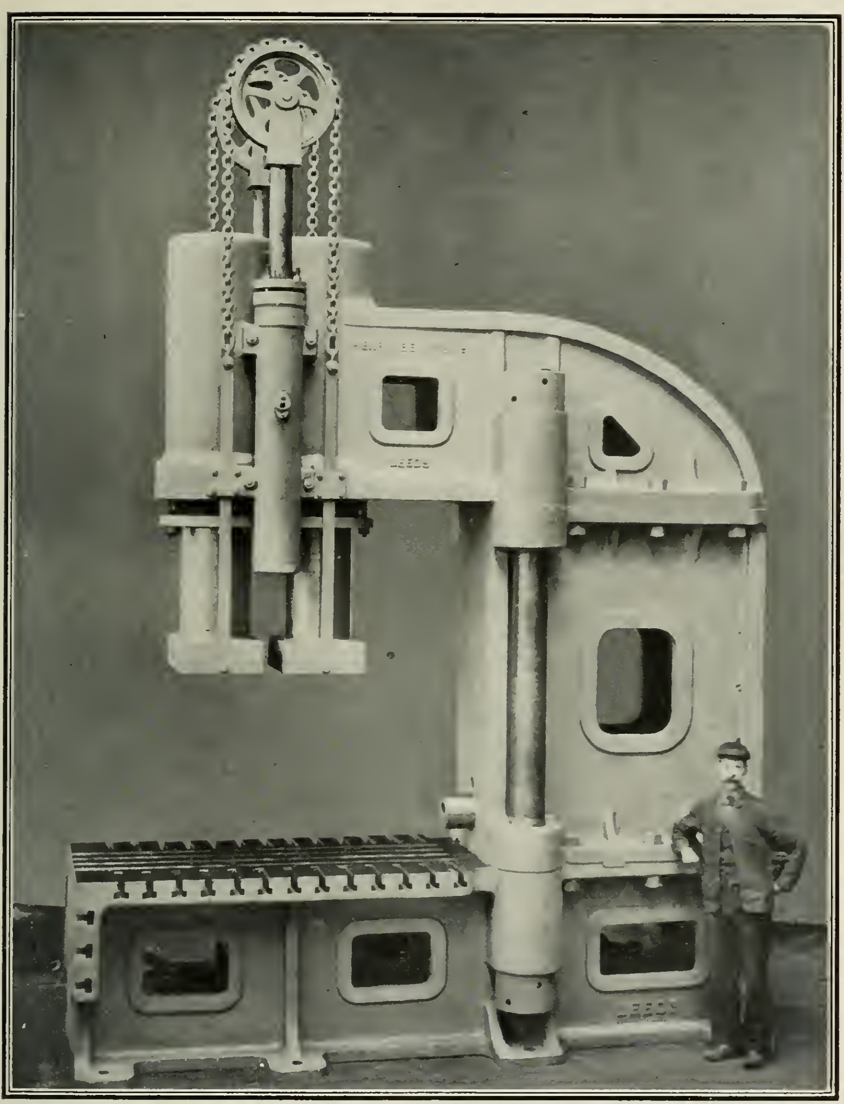


CASKEY PNEUMATIC PUNCH IN OPERATION.

The tool is also adapted to be used for riveting, with necessary changes in details of construction. F. F. Slocomb & Co., Wilmington, Del.

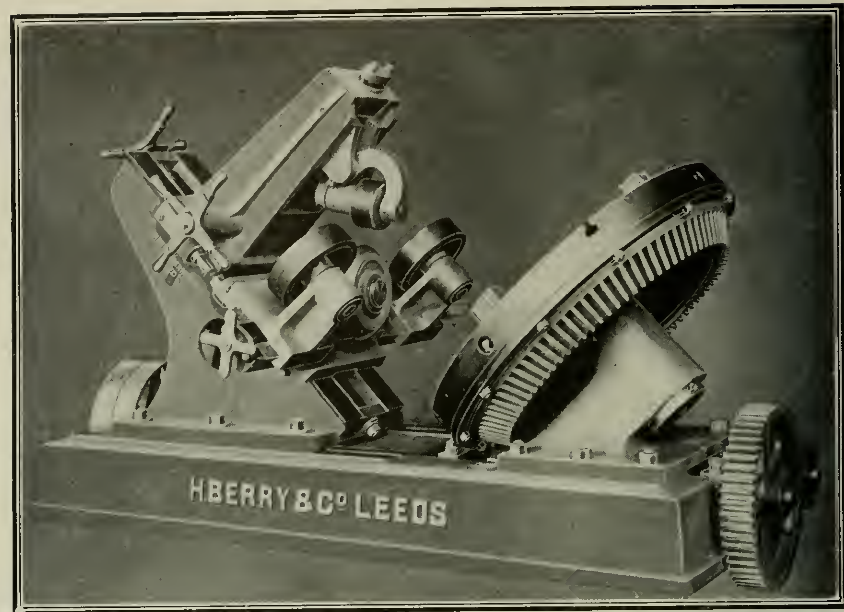
the cost of hand-forged dogs and of far greater strength than the cast-iron dogs in common use.

Hydraulic presses, in conjunction with dies or formers, (which are simply moulds of the shape required for any part of the boiler) are used for this work, although in some shops plain flanged heads of boilers and dished shapes are spun up, as it is called, in the same way that work is spun up in a lathe. Any thickness of metal is handled, up to



HYDRAULIC FLANGING PRESS. HENRY BERRY & CO., LTD., LEEDS.
A powerful machine made for the Leeds Forge Co.

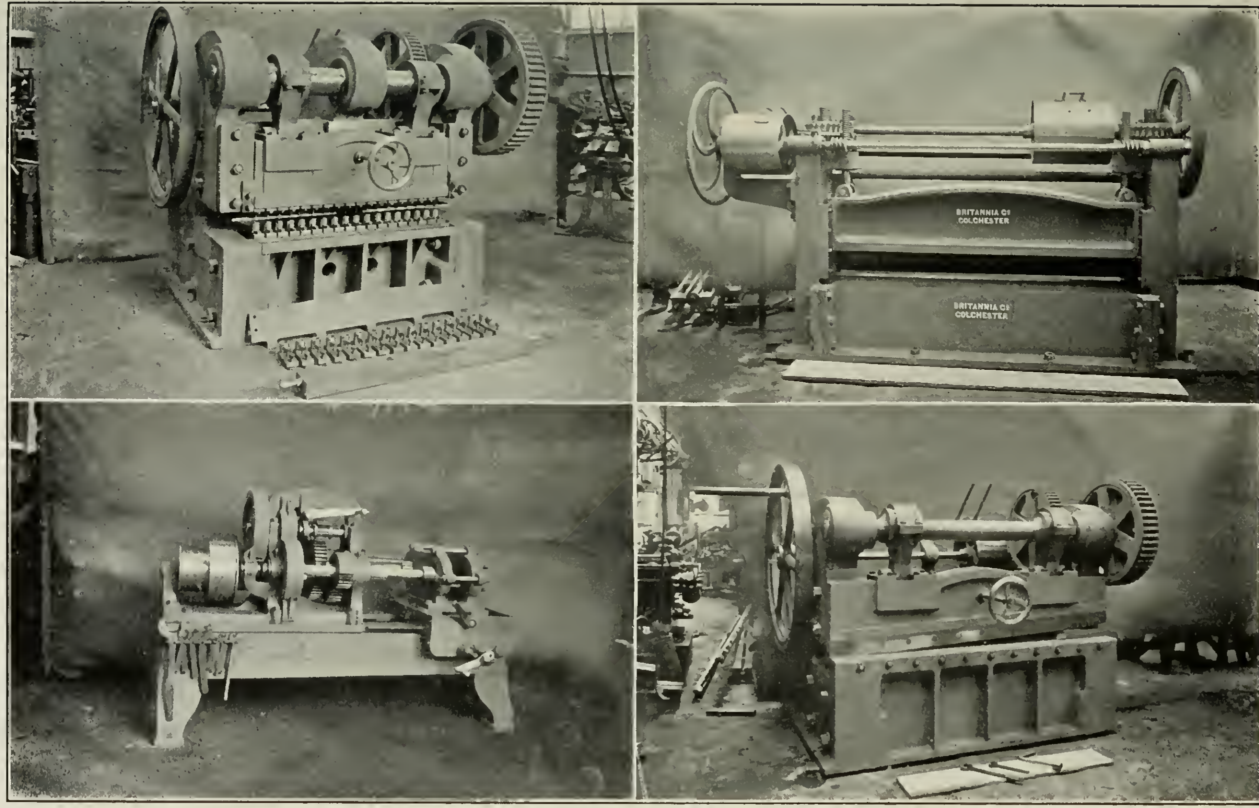
one inch and over, the heating being done in closed furnaces instead of open fires. The large steel mills now furnish flanged heads of all diameters, from $^3/_{16}$ of an inch thick and 12 inches diameter, up to 120 inches diameter by 1 inch thick, having flanges 5 inches deep; the beauty of the mill-flanged heads lies in their exactness to size, round-



ANGULAR FLUE FLANGING MACHINE. HENRY BERRY & CO., LTD., LEEDS.

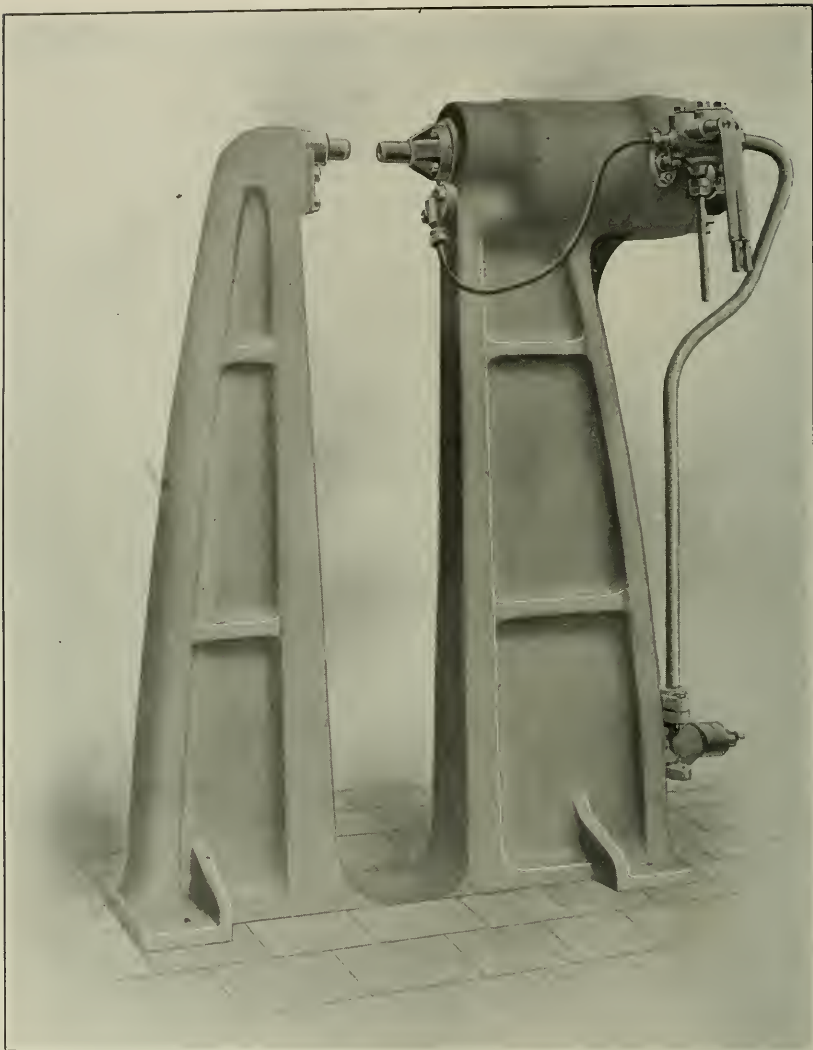
ness, and freedom from buckles, which last, in hand work, are a contingency by no means remote. The cost of the machine-flanged heads is but a fraction of that incurred by hand-work. In addition to the flanging, flue holes from 6 inches to 56 inches diameter can be placed where needed and flanged with great accuracy, so that practically the worst work the old-timer had to do is now done for him and the finished parts shipped ready for assembling. As an instance of the saving in expense to boiler makers by modern methods over hand work, steel plate saddles for man-holes, ready to rivet on the shell, with rivet holes *in situ*,—in fact the man-hole plate complete with the exception of the gasket only—can be had for $10, plus the cost of the plate which amounts to very little more; made by hand this detail would cost double that or more according to locality.

In laying out seams on plates, the old-time boiler maker had a lot of templets in the shape of strips of wood from ¼ of an inch thick upward, according to length, and about 3 inches wide. In these the pitch of the rivet-holes (distance from centre to centre) was laid off, after which holes were bored of the size of the rivets; in transferring this pattern to the plate the templet was laid on it and the holes located by a brass tube the size of the hole, armed with white lead, which left a circle on the plate. The boiler maker then centered the marks



A GROUP OF MODERN BOILER-MAKING TOOLS.

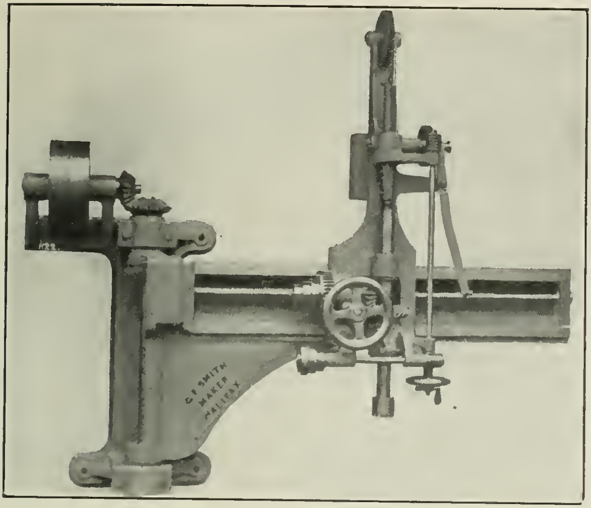
Above on the left is a multiple punching machine; on the right a plate flanging machine. Below on the left is a double spindle boring and tapping machine, and on the right a powerful plate shearing machine; all by the Britannia Company, Colchester.



HEAVY FIXED RIVETTER. HENRY BERRY & CO., LTD.

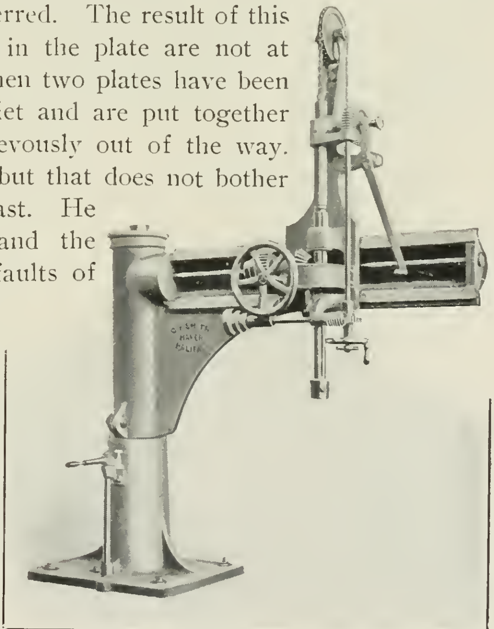
as accurately as he could with a tool, and the sheet was ready for the puncher, for no holes were drilled in old times—it cost too much.

Now it is a curious fact in boiler-making shops that the punching press is usually set in the darkest corner of the place; some modern boiler shops are as short-sighted in this particular as the old-timer was; but if there is anything that the puncher needs for accurate work, it is natural light—not artificial light— and plenty of it, for trouble

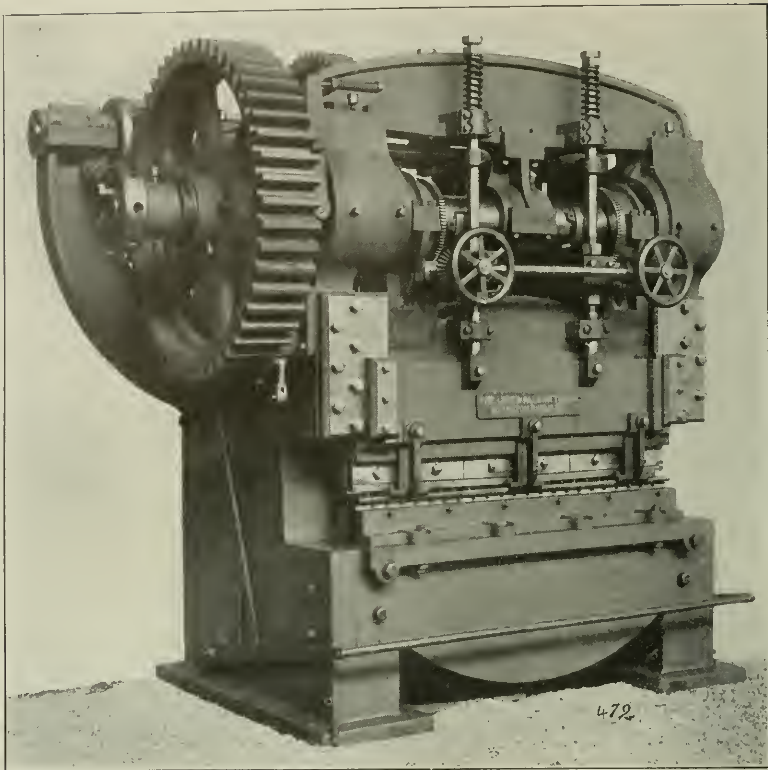


WALL RADIAL DRILLING MACHINE.
G. F. Smith, Halifax.

begins as soon as the press is started. It would seem to be the simplest thing in the world to cause a slow-moving punch to strike accurately in the centre of a big punch mark, but even with great care and a conscientious intention to do it on the part of the attendant, punches have a sort of moral delinquency, so to speak, and a determination that the hole shall be a trifle to one side or the other; and once started on their journey they cannot be deterred. The result of this is that the punched holes in the plate are not at all like the templet, and when two plates have been laid off by the same templet and are put together to be riveted they are grievously out of the way. The rivets will not go in, but that does not bother the average man in the least. He knows that his reamer and the drift-pin will correct the faults of the punch, but the less said about the holes themselves after these rude appliances have had their will of them, the better; oblong holes of varying diameters and sheets cracked as to the edges are frequent; but "out of sight out of mind" is a maxim that covers a multitude of sins in a boiler-



UNDER-DRIVE PILLAR RADIAL DRILL.
G. F. Smith, Halifax.

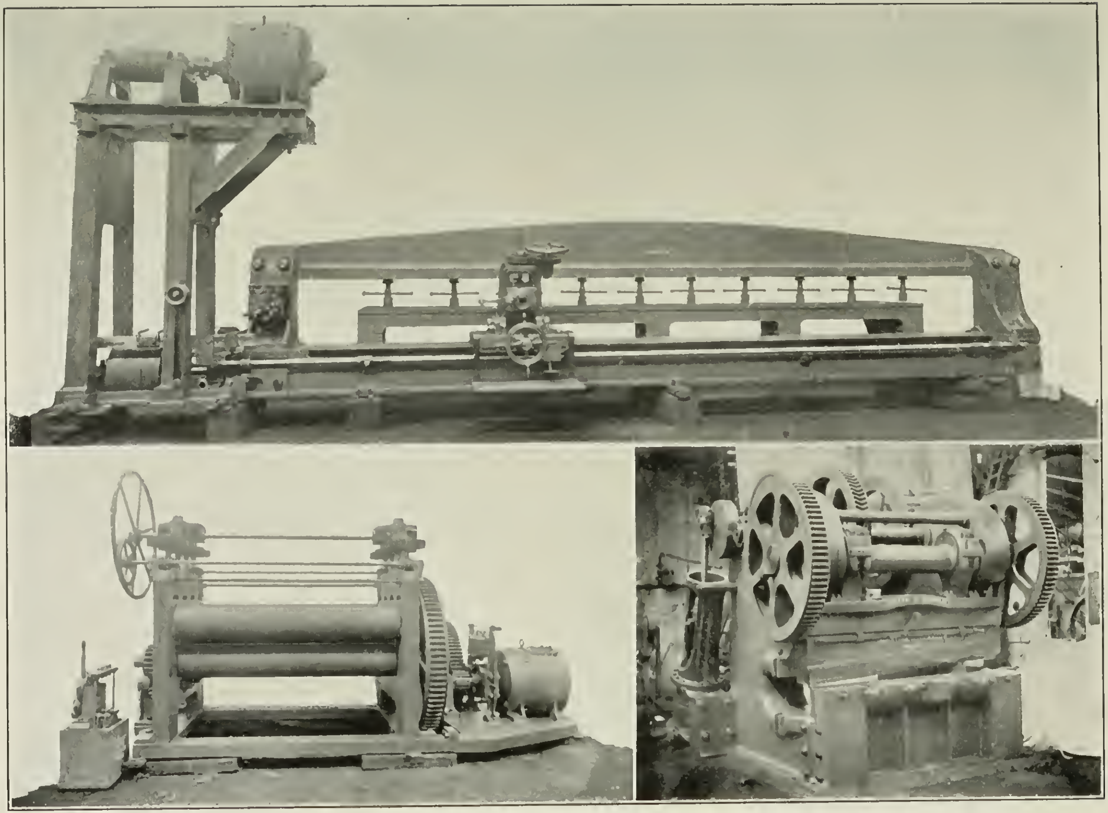


HEAVY DOUBLE-GEARED MULTIPLE PUNCH.

Long & Alstatter Company, Hamilton, Ohio.

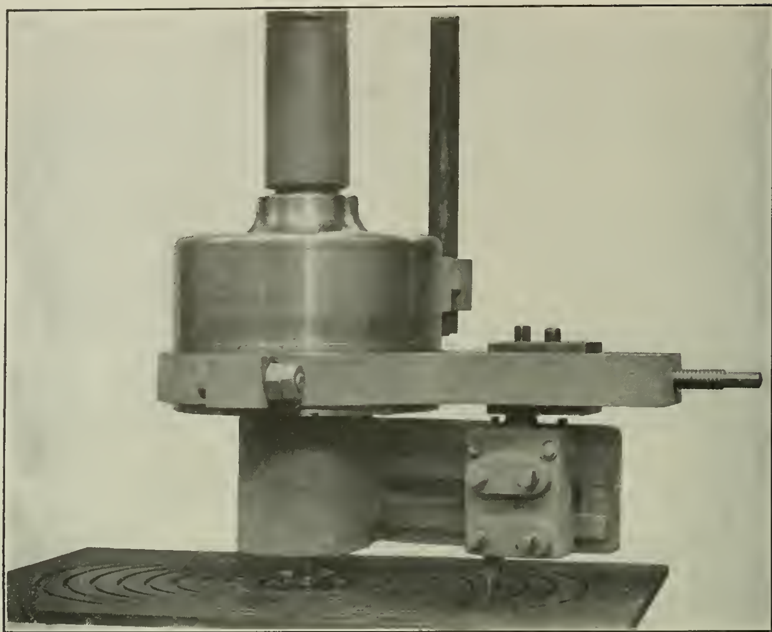
shop. The use of the drift-pin is prohibited in the best shops, and in fact, there is no longer any reason or occasion for it. The rivet holes in seams are now automatically punched and spaced by a special machine, which never errs either in pitch or locality of the hole, and the unfortunate helper, who formerly pretended to steady the long end of a sheet while the man at the punch guided it at the crucial moment, has lost his occupation, and with the loss has escaped the burning words and reproachful looks the man at the punch hurled at him when a hole was made in the wrong place; the fault was always charged to his account.

Besides the flanging and riveting machines in use in modern shops, there are a great many other special machines which reduce time and labor costs in a marked degree; hand-hole cutters for one, and punches that will stab an inch-and-a-half hole through wrought steel one inch



HEAVY BOILER-MAKING TOOLS.

The upper machine is a heavy plate planer operated by an electric motor; below on the right is a powerful plate shears, and on the left a set of flattening rolls; all by Craig & Donald, Johnstone.

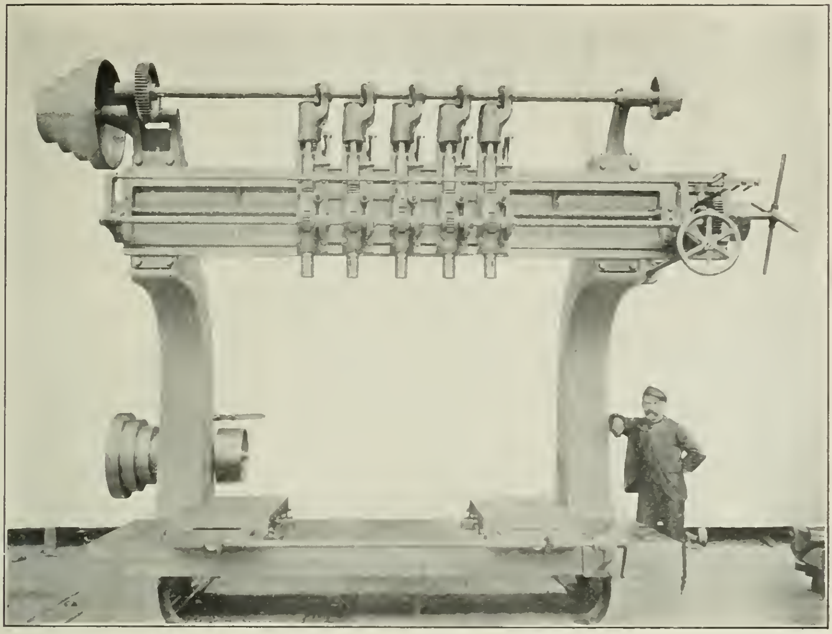


OVAL HOLE CUTTING MACHINE.

Adjustable by eccentric for various ovals and operated in connection with a drilling machine. John Hetherington & Sons, Ltd., Manchester.

thick; shears that will bite through bars four inches wide by one inch thick, and portable power riveters that both rivet and hold on in the most inaccessible parts of the boiler. In fact, a modern boiler shop is a first-class machine-shop, and the work done is really machining of the highest character. Especially is this true of sectional water-tube boilers, where the joints which have to be broken to clean tubes are all iron and iron, without the intervention of any adventitious aid or material to make them tight. The familiar tube-sheet cutters, or drillers of tube holes, are not new in application, but they have been much improved and are substantially changed from what they were fifty years ago, while air lifts, hydraulic lifts, chain blocks, and enormously powerful rolls in the modern boiler shop have wholly changed its aspect and operation.

All these things have also changed the character and quality of the assembling and construction of steam boilers of the best class, by which is meant those of first-quality plate and from strict specifications. These last are much more exacting than they were half a century ago; as a fact, there were none whatever extant then, every boiler being

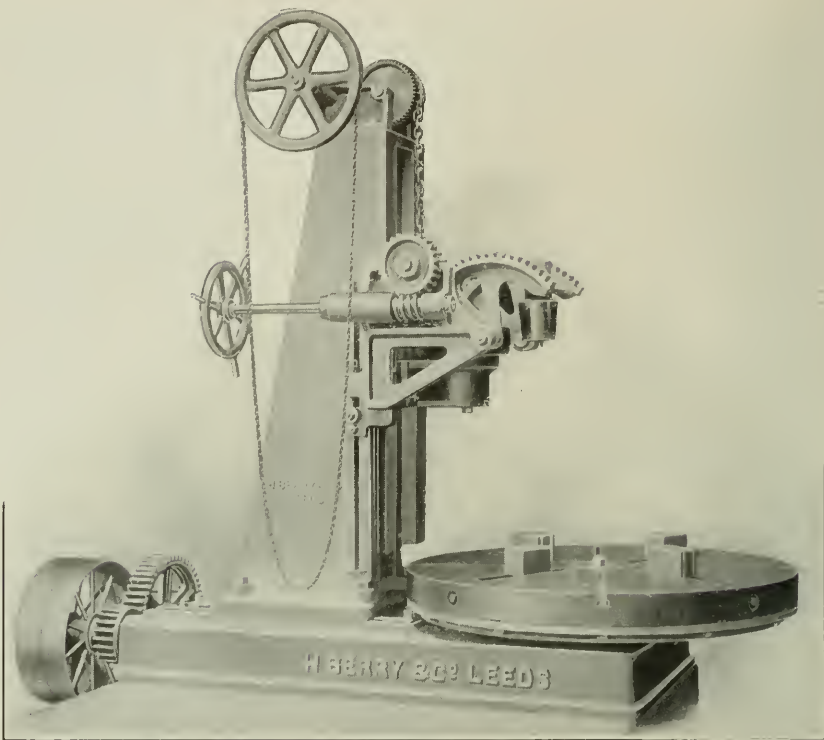


FIVE-SPINDLE DRILLING MACHINE.

A special tool, used in the construction of water-tube boilers. Noble & Lund, Felling-on-Tyne.

considered to fulfill its function and have a reason for its existence if it made steam in sufficient quantities for the engine attached to it. Factors of safety were ignored; this is the literal truth, in most all cases. The only test was a water and a steam test for tightness, the tensile strength of the plate itself being assumed, or, in other words, guessed at. I know of steam boilers 15 feet in diameter of shell by 18 feet long thickness of plate $^5/_{16}$ of an inch, which were run under forced draught for years at 50 pounds per square inch gauge pressure; this is the limit for steel plate of 60,000 pounds per square inch tensile strength with a safety factor of four only. These were iron boilers, of unknown tensile strength, but they never gave out, I am glad to say, for the reason that I was in charge of them; or, if this sounds slightly ambiguous, I will add that I am glad they did not give out. Many instances in the early steam history of the United States could be adduced, particularly in river boats, where the pressures far exceeded that just mentioned; some of them survived the stress and others did not.

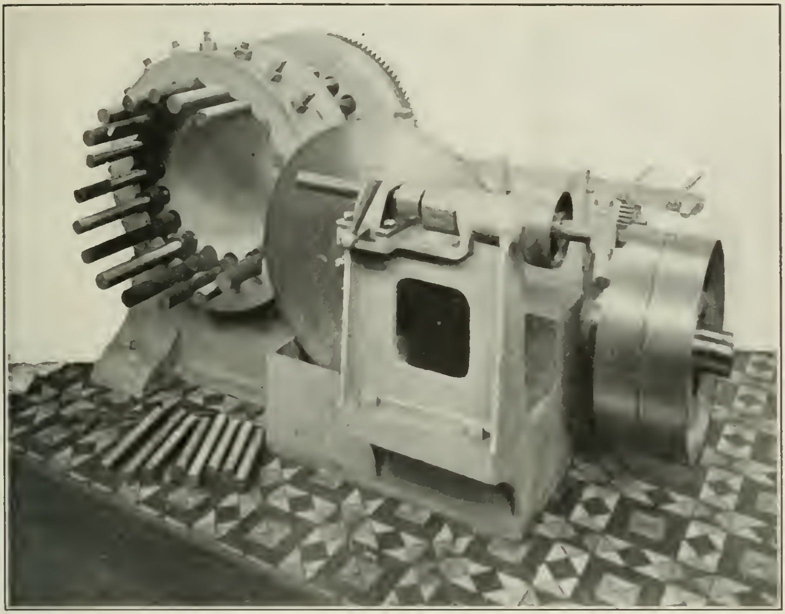
The very stringent rules of the Treasury Department for the steamboat inspection service of the United States as relates to the construc-



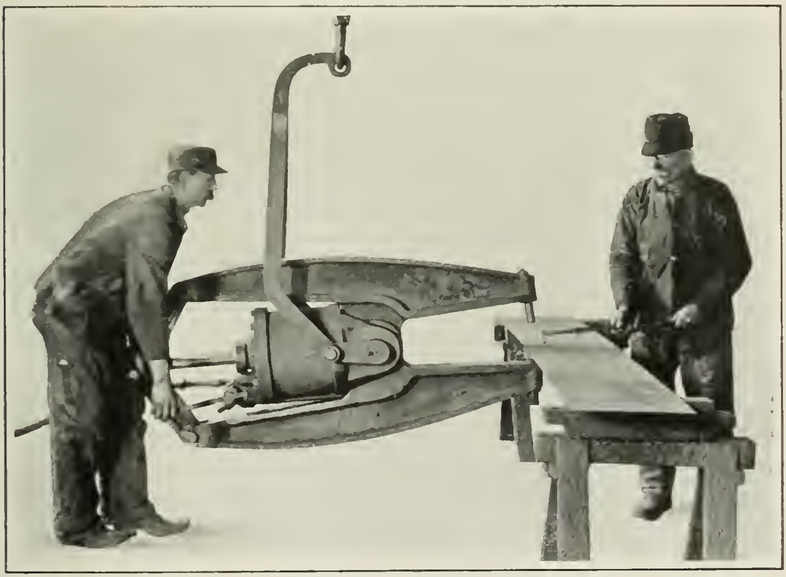
IMPROVED FLUE FLANGING MACHINE. HENRY BERRY & CO., LTD., LEEDS.

tion of marine boilers are strictly enforced by capable officers, and there is no influence of any sort whatever that can be brought to abate any of them. The thickness of metal for given pressures, as well as the quality of it in all that relates to tensile strength and elasticity, are set forth in the manual published by the government for constructors, and no departures or evasions are countenanced. All boilers used in steam vessels of whatever class must be approved as to their types and designs before they will be allowed to be used, a Board of Supervising Inspectors meeting in Washington each year for this and other business of their departments. No one can build a new type of boiler and call for inspection on it without this approval. The result to the traveling public is almost absolute immunity from disasters by failure of boilers, the actual explosions being very rare.

The construction of marine boilers of the shell type, Scotch boilers as they are termed, is carefully watched through every stage, and there are a good many processes to be gone through before such boilers are

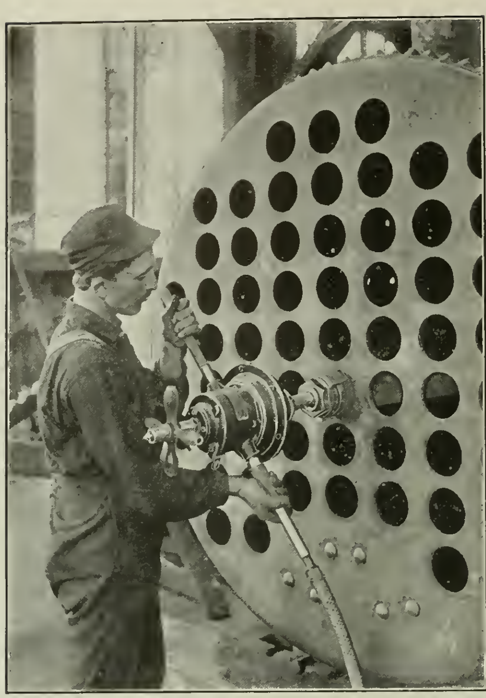


STAY CUTTING MACHINE. NOBLE & LUND, FELLING ON TYNE.



PNEUMATIC RIVETER "ALLIGATOR PATTERN."

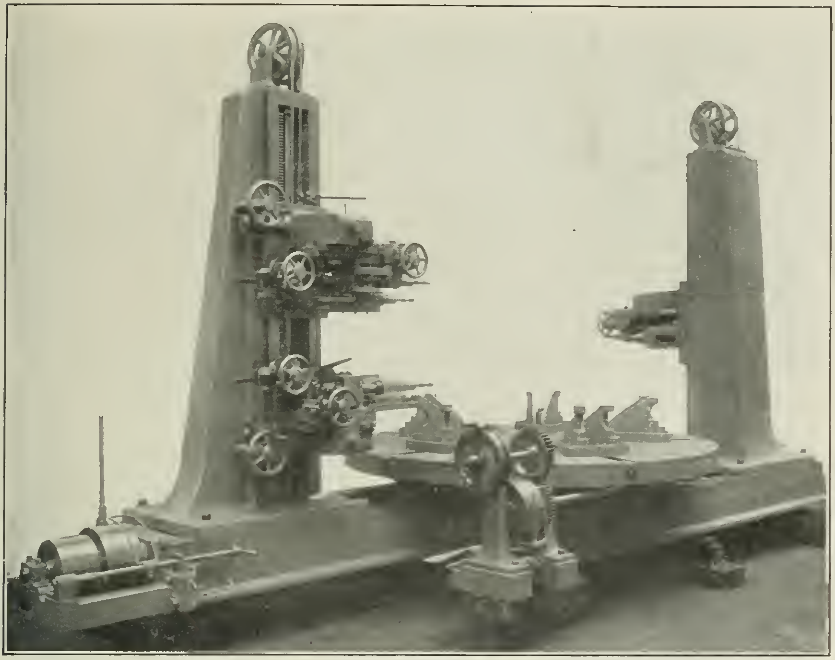
Capacity 300 rivets per hour with two men and two boy helpers. Bethlehem Foundry and Machine Co.



ROLLING IN 4½-INCH BOILER TUBES WITH PNEUMATIC TOOL.

Philadelphia Pneumatic Tool Company.

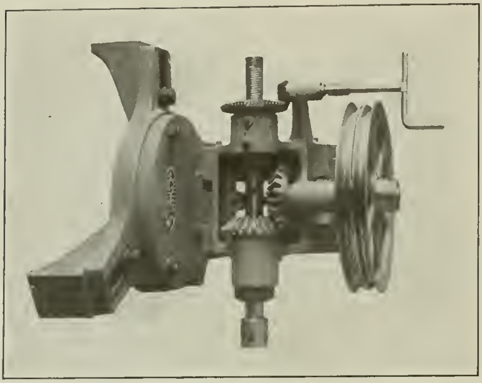
ready for steam. The shells of Scotch boilers are enormously thick, according to the pressure at which they are to be worked, the diameter and thickness of the shell regulating it. For 150 pounds gauge pressure, a Scotch boiler of 15 feet diameter would be made of $1^{17}/_{64}$ inch steel plate, weighing some 54 pounds per square foot. The rivets would be 1¼ inches in diameter, also of steel, and the horizontal seams would be secured by butt-straps of thickness equal to that of the plate. In boilers for government work the sheets are pickled in a bath of muriatic acid diluted with water, in order to remove the mill-scale, leaving the surface clean so that defects of any kind can be seen, and after being bent to the required diameter in rolls, have the heads fitted to them, all rivet-holes being subsequently drilled upon a special machine, so that there is no possibility of any of them being out of the way. When completed the parts are all taken down and the burs left by the drilling removed, as well as any scale or dirt which may have accumulated during the process; the surfaces where laps occur are thoroughly washed with lye to clean off any grease, so that positive



IMPROVED BOILER SHELL MULTIPLE DRILLING MACHINE.
John Hetherington & Sons, Manchester.

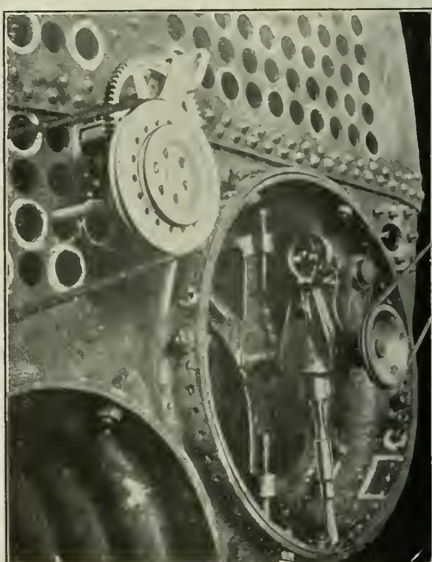
conjunction of the surfaces will be had when riveted finally. This practice as regards removing the grease is followed all through the manufacture, particularly in the tube-sheet holes and tubes themselves, an undiscoverable film of it militating against their being steam-and-water-tight under the great testing pressures to which they are subjected when completed. In the merchant service by Lloyd's and the Bureau Veritas rules this test pressure is double the working pressure, and it is needless to say that it is searching. Nothing but actual iron and iron contact all through and the very best workmanship will pass muster. I mentioned previously that the plates in a Scotch boiler of a certain diameter were 1 $^5/_{16}$ inches thick, but there are much thicker than this in use, those in one of the American line vessels having plate 1$^9/_{16}$ inches thick. The work of rolling these shells to dimension is one of the most difficult tasks in their manufacture, and the final caulking is done with sledges on the usual round-nose tool, instead of by hand-hammers. The rivets are 1½ inches diameter and a pressure of 135 tons is exerted on them when closed in place.

In connection with this subject of modern boiler making, I must



PORTABLE DRILLING MACHINE.
John Hetherington & Sons, Manchester.

advert to the exceedingly unsatisfactory condition of rating their power—an anomalous term, for a boiler cannot exert any power under any circumstances. It merely furnishes a means of power to other machines, yet boilers are sold wholly upon their horse power. A quarter of a century ago, at the Centennial Exposition, a standard was adopted which has been accepted in many contracts and specifications, but the engineering practice since that time has advanced, so that it requires very much less steam per horse-power hour than it did at the time of the Centennial. It is a pretty poor engine in these days of compound and triple-stage expansion that requires 30 pounds of water per hour per horse power, so that by the standard mentioned boiler-makers and purchasers are both handicapped; the boiler maker in furnishing a larger boiler than the engine needs, and the buyer in paying for it. It is not to be supposed that the boiler maker alone is to suffer for the want of a proper standard of rating. Just how he may incur obligations and liabilities which he should not is shown in a case of recent occurence. A commercial firm ordered a boiler of a certain nominal capacity, say 25 horse power, which was furnished and paid for promptly on presentation of the bill. This boiler was sent to the other side of the world, and after



BOILER FLUE DRILLING MACHINE AND PEDDIE'S TAPPING APPARATUS.
Showing these portable tools at work on a marine boiler. Smith & Coventry, Manchester.

HYDRAULIC PLATE PRESS. HENRY BERRY & CO., LTD., LEEDS.

nearly a year had elapsed, the boiler maker was notified by the agents of the commercial firm that payment had been refused them, for the reason that the boiler had been tried, (by "the best engineer" to be had) and would not develop more than 8 horse power. The agents therefore requested the boiler maker to refund the money paid, upon the ground that the boiler was not as represented. This the boiler maker declined to do, and demanded proof that the boiler would not do what it was sold for by citation of all the circumstances of the trial, which last had not been furnished. Now this boiler was not new in any respect, except in certain arrangements of the several surfaces, grate and heating, the proportions of which were those in general use; numbers of the boilers had been sold in various parts, so that there was no issue in the boiler-maker's mind as to his liability, and none concerning the action of the boiler, except mismanagement of some kind; the whole difference between the two parties to the contract turned upon what a boiler horse power really is.

In so far as the evaporation of 30 pounds of water per hour at 70 pounds gauge pressure, with feed at 100 degrees is concerned, it is not at all difficult to do it, even with a boiler that is not by any means what it should be in other respects. After the trial it may not come within 25 per cent. of its normal rating. New boilers, when everything is clean and the grates are in good condition, are very much better evaporators than they are after they are dirty all through, from mud-drum to dome.

This question of rating boilers has been raised time and again in discussions at meetings and in the technical papers, but it is still unsettled. It should not be difficult to arrive at some solution of the matter, but I have no suggestions to offer myself upon it. A commercial solution of the question is very difficult, for buyers do not know of any other term than horse power, and it would take about one hundred years to get one into general use. The question of boiler power could be very easily settled for boiler makers, or to their satisfaction, by fixing so many feet of heating surface and grate-surface, with a given height of stack, burning a certain number of pounds of coal per square foot of grate per hour, said proportions to constitute one horse power. This would leave the buyer to get the best evaporation that he could, let the same be more or less. I am afraid, however, that there would be as much argument after the adoption of this rating as before; the only benefit to the trade would be that boiler makers would not be in the controversy, so I leave the subject where I found it.

THE GROWTH OF ECONOMY IN MARINE ENGINEERING.

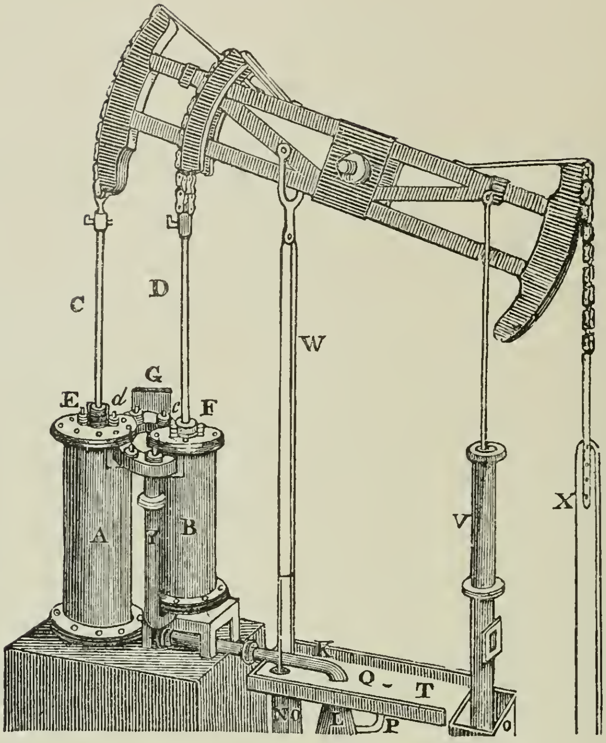
By Walter M. McFarland.

II.—THE INTRODUCTION OF HIGHER PRESSURES AND COMPOUND ENGINES.

In this, the second of Mr. McFarland's valuable articles, the subject is developed from the period of the simple engine to the advance in economy which followed the introduction of compounding; the work of such pioneers as Elder, Loring, Emery, Isherwood, and others being discussed. The following papers will deal with the introduction of triple expansion, and the succeeding improvements which have made the modern marine engine capable of developing a horse-power with one-tenth of the fuel demanded by the early engines and rendered present speeds and capacities possible.—The Editors.

IT is almost impossible to draw a sharp line separating one period in the growth of the steam engine from another; but for convenience this can be done roughly, and we might say that the simple-engine period extended to about 1865 and the compound-engine period from about 1865 to about 1885. The invention of the compound engine dates back almost to the time of Watt's patent, for a patent was granted to Jonathan Hornblower in 1781 for a compound or double-cylinder engine, and in 1804 Wolff also used a two-cylinder engine expanding the steam from six to nine times. As has often been pointed out, the compound-engine did not operate under satisfactory conditions with the low steam pressures then prevalent, and its actual introduction upon a commercially successful scale did not occur until eighty years after the time of Hornblower.

During the decade from 1860 to 1870 British engineers had been taking advantage of the higher steam pressures, which had become common, to re-introduce the compound engine, the foremost among them being John Elder of the firm of Randolph & Elder; still later this concern became the Fairfield Engine Works, which have built so many magnificent specimens of machinery. By the early 70's the use of the compound engine had become almost universal; steam pressures had risen to sixty pounds and rotational speeds had materially increased. In 1871 Mr. J. W. King, the engineer-in-chief of the American navy who succeeded Mr. Isherwood, made a visit to Europe and on his return urged most strongly the adoption of the compound engine for all naval vessels. In a later report printed in 1877, after he had spent



(*Hornblower's Engine.* **1781.**)

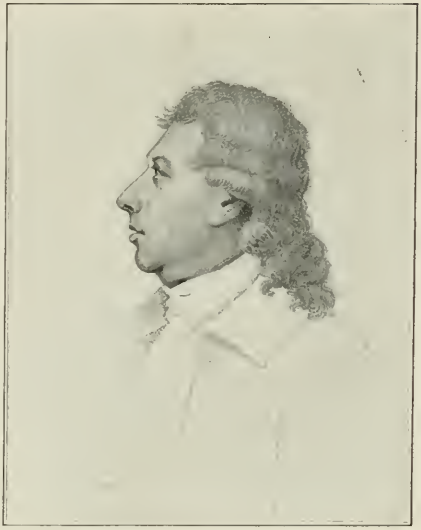
HORNBLOWER'S COMPOUND PUMPING ENGINE.

From Galloway's treatise on the steam engine, 1830. The construction of these engines was stopped by Watt, as they infringed his patent on the separate condenser.

more than a year in Europe, he again discusses the use of the compound engine and concludes by saying:

> "In the face of these facts, further discussion on the subject of adopting the compound engine for the vessels of our own navy is as useless as would be the discussion of the relative merits of the screw propeller and paddle wheel for ships of war."

The compound engines which were in use had demonstrated very thoroughly that they possessed a marked economy over the simple engines immediately preceding them, but in spite of this there was considerable opposition to the general introduction of the compound engine. This came from two sources. One was in naval circles and was represented by certain reactionary but influential executive officers who feared that the danger of boiler explosion would be greatly increased by the use of the higher pressures which were necessary with



JONATHAN HORNBLOWER.
Inventor of the Compound Engine.

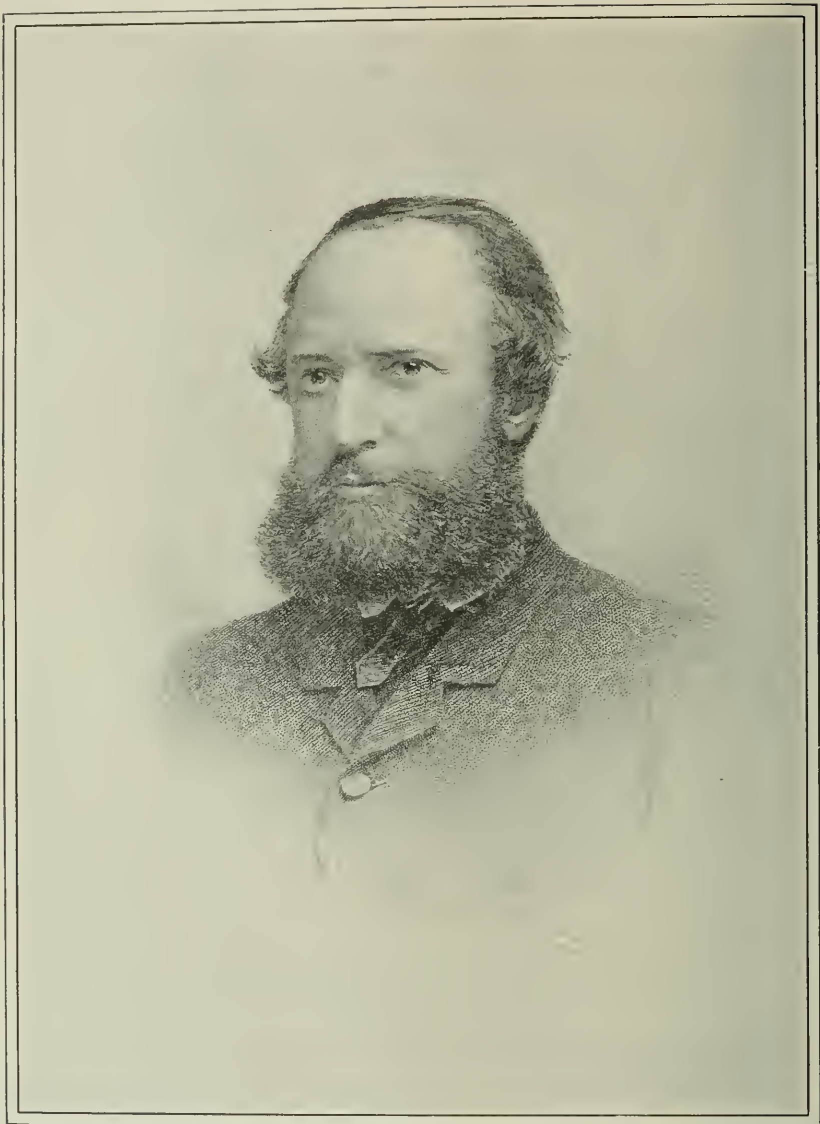
the compound engine. They forgot that with reliable material and proper design the high-pressure boiler was just as safe and worked with the same margin as the boiler of lower pressure. They also forgot that as far as damage due to the scalding effect of the steam is concerned, low-pressure steam was just as bad as high. As a matter of fact, it may be remarked incidentally that there is not a case on record of a well designed and carefully built high-pressure boiler ever having exploded. It has been surmised that some steamers which were lost at sea without anything being known as to the cause were blown up, but there is no ground for this belief, particularly as thousands of boilers have worn out without ever giving trouble on this score.

The other class of objectors, curiously enough, included engineers who made some pretension to scientific attainments, and some of them indeed were men of the very highest standing. They claimed that there was no virtue in the compound engine as such, and that there was no reason why a simple engine working with the same initial pressure and the same ratio of expansion should not give exactly the same economy as the compound engine. The great name of Professor Rankine was quoted as sustaining this view on account of a statement in his well known text book on the steam engine, which is as follows:

> "It is to be observed, then, as a general principle, that the energy exerted by a given portion of a fluid during a given series of changes of pressure and volume depends on that series of changes, and not on the number and arrangement of the cylinders in which those changes are undergone."

In 1870, however, two years before his death, Professor Rankine wrote a memoir of his friend John Elder, in which he expressed himself very clearly as to the importance of compounding as a means of preventing liquefaction, thus revising his former opinion.

Probably the most notable case of attempting to carry out the idea that the simple engine would give the same results as the compound



JOHN ELDER, 1824-1869.

To Mr. Elder is due the successful introduction of the marine compound engine, as well as many other details affecting steam economy in marine engineering, including steam jacketing, surface condensers, etc. He also advocated triple expansion, but died before its realisation. By courtesy of Mrs. John Elder.

was in the Allan line of steamers. The superintending engineer, believing firmly that the demand for compound engines was a fad, determined to make a crucial experiment. In two new vessels of that line, which were of about the same size, he had the machinery the same except that one was fitted with compound engines and the other with simple engines. Both used the same steam pressure (60 pounds) and the same ratio of expansion. Every care had been taken to make the machinery, as far as design and workmanship were concerned, the very best in both cases. The two ships were put on the line between Liverpool and Quebec, Canada, and the results as to economy of fuel were not greatly different. Unfortunately, however, there were unexpected difficulties in the operation of the simple engine consequent upon the serious shocks resulting from the rapidly varying pressures on the crank pins. So serious were these that not only the crank shaft but also the stationary parts of the engines began at an early day to show signs of weakness, and in a short time gave out altogether. As already stated, the superintending engineer was the designer of the machinery, and it was only after his personal efforts failed to keep the ship with simple engines running that he reluctantly decided to remove them and to substitute compound engines in their stead.

It will be noted that in the above case of the steamers of the Allan line the economy of the two methods of working is *said* to have been about the same. It seems very probable that, as the superintending engineer had staked his reputation on this result, this may have had some effect upon the figures which were reported. Other experiments made by engineers of reputation without any bias showed, as might have been expected from the Michigan experiments, that this is not the case, and we now know very thoroughly that after a certain very limited degree of expansion in a cylinder has been passed the losses consequent upon liquefaction due to the alternate heating and cooling of the cylinder walls overbalance any hypothetical gain due to expansion. In August, 1874, Messrs. Loring and Emery conducted a very interesting series of trials on the machinery of three revenue cutters whose hulls and boilers were alike but whose engines were different. One had a compound engine of the receiver type; the second a single-cylinder, but carried high-pressure steam with a considerable degree of expansion; while the third had a single-cylinder and carried steam of a lower pressure. The steam pressure for the compound and high-pressure was 67 pounds and for the low-pressure 32 pounds; the ratios of expansion were, for the compound engine, 6; for the high pressure, 3.5, and for the low pressure about 3. The results in steam per horse-

WILLIAM JOHN MACQUORN RANKINE, 1820-1872.

Regius Professor of Civil Engineering in the University of Glasgow; author of many important engineering works; one of the originators of the mechanical theory of heat, upon which all steam engine improvement is based. From the original portrait in the possession of the American Society of Mechanical Engineers.

power hour were, for the compound engine, 18.38; for the high-pressure, 23.9, and for the low-pressure, 26.9.

A very great advantage possessed by the compound engine, besides the increased economy, was the reduction of the stresses on the engine and the higher ratio of mean to maximum stress. The low-pressure cylinder is as large as would be required for a simple engine doing the same work with the same total ratio of expansion, but the maximum pressure which comes upon this large piston is only a fraction of the boiler pressure. This higher pressure comes upon the small piston, and the result is that, as each cylinder does about half the total work and as the maximum stresses are so much reduced, the sizes of piston rods, connecting rods, and similar parts are very much smaller than would have been necessary in simple engines which at the beginning of the stroke received the full boiler pressure.

An incident which occurred in connection with the introduction of compound engines in the American navy, and which was repeated when triple-expansion engines were introduced, makes it worth while to call attention to a curious circumstance in connection with reports of economy of marine engines. When it had been decided to adopt the compound engine a board of officers considered the question of a suitable size for certain vessels, and the bunker capacity which should be provided. The experience with compound engines at that time was almost wholly in the merchant service, and it was commonly reported that under ordinary conditions a horse power was obtained for about two pounds of coal. This was accepted as a fact and the bunker capacity based upon this idea. Experience with compound engines has shown that this estimate was very wide of the mark, and it would probably have been much safer to have used three pounds per horsepower as the basis. It is very doubtful if any marine compound engine in regular service ever got a horse power for less than two and one-half pounds of coal. The probability is that the coal expenditure was not carefully taken and was too low, and that the horse power used for the divisor was based on trial-trip records and was thus very much too high.

With the low steam pressure used in connection with simple engines, the boiler in general use was what was commonly called the "box boiler," because it had flat sides and was of a roughly cubical shape. Such boilers depended for their strength upon the bracing, and, even with low pressures, the braces formed such a network that it was difficult to gain access to the interior for cleaning and repairs. As steam pressures rose with the use of the compound engine, such a boiler would have been entirely inadmissible, and, as a result, the cylindrical boiler was introduced, whose cylindrical portion required no bracing. The correct road to economy had now been discovered, and consequently, as metallurgical processes developed and open-hearth steel of reliable quality was manufactured, it became possible to increase pressures and there was a steady progress along this line. At the same time there was improvement in workmanship, so that higher

COMMODORE CHARLES H. LORING, U. S. N.

Engineer-in-Chief, U. S. N., 1884-1887. Past-President American Society of Mechanical Engineers; associated with Mr. Charles E. Emery in important experimental researches in steam engineering.

rotational speeds were possible. Both of those were of benefit in reducing the cost of power.

As has already been mentioned, steam jacketing had been used to some extent, and with the general use of the compound engine the use of steam jackets became universal. The benefits derived were not always obtained, because care was not always taken to keep the jackets well drained by the use of efficient automatic traps. The economy to be derived from jacketing has not gone entirely unquestioned, and very interesting experiments have been made from time to time to test various questions in this connection—notably the proper steam pressure to use in the jackets of the different cylinders. It has sometimes been deemed advisable not to jacket the high-pressure cylinder, for the

CHARLES E. EMERY.

Mr. Emery's researches in steam engineering in association with Commodore C. H. Loring contributed most valuable data in connection with compounding and steam jacketing.

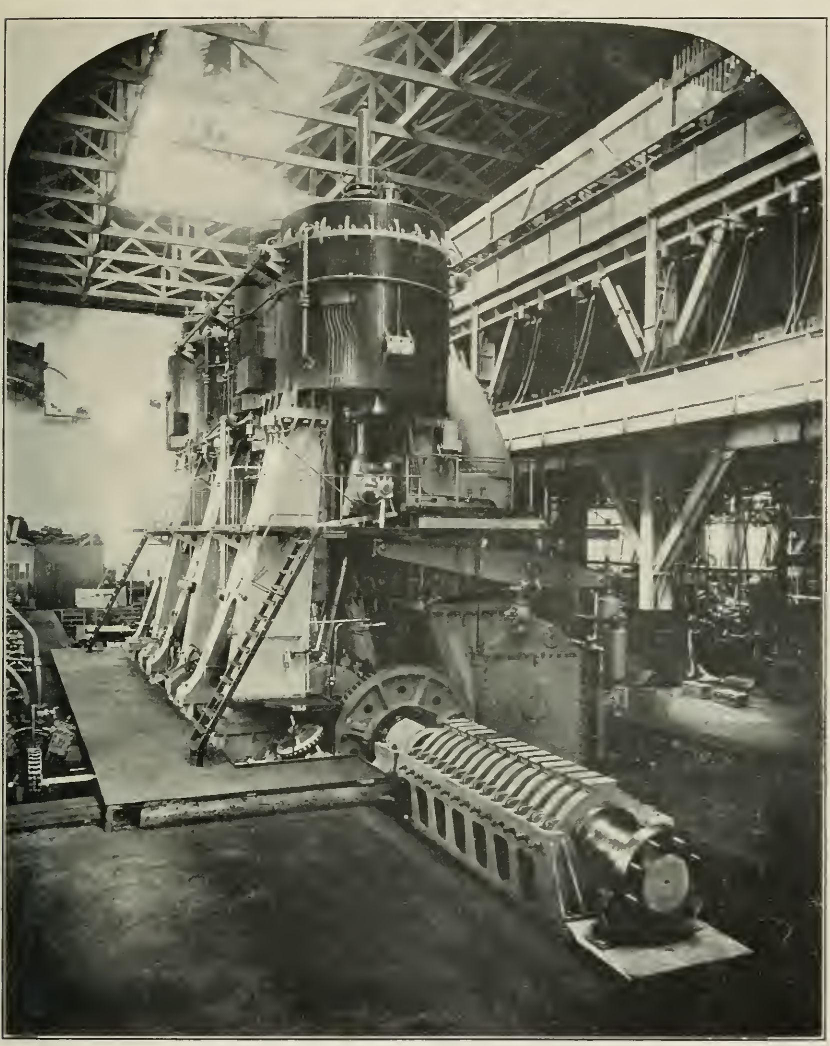
reason that a certain amount of moisture in the steam there has been considered beneficial; but the fact seems pretty well established that the jacket steam pressure should never be lower than the highest steam pressure in the cylinder to which the jacket is applied.

Two general types of the compound engine were used at first—the "tandem," in which the small cylinder was co-axial with the large one and usually placed above it (a vertical arrangement); several of the White Star steamers were built with pairs of these tandem engines; the other type was known as the "receiver compound engine," because there was an intermediate space between the two cylinders, which permitted placing their cranks at right angles when two cylinders or at 120 degrees when three were used, so as to make the engines much handier in manipulation. This latter type became the one universally used, and, except in war vessels, the cylinders were always vertical.

As has been stated, the low-pressure cylinder of a compound engine has to be of the same size as the simple engine with the same ratio of expansion, and it was soon found, as the sizes of engines increased, that the low-pressure cylinder when but one was used would be inordinately large. Some were, indeed, built with as great a diameter as ten feet. It became the rule, therefore, to divide the low-pressure stage of the expansion between two cylinders, which were usually placed one on each side of the high-pressure. This enabled the cranks to be set at angles of 120 degrees, which gave a very uniform crank effort.

In the early days of the compound engine, when the lesson that expansion could not economically be carried beyond very reasonable limits had not been thoroughly learned, it was the custom to fit what were called "cut-off valves" to both the high- and low-pressure cylinders. These were adjustable through a considerable range, the idea being to vary the power developed by the range of the cut-offs, while the steam pressure was kept at the maximum. Obviously this applied much more to the engines of naval vessels, which cruise at very varying speeds, than to the engines of merchant steamers which usually run at a constant speed. These special cut-off valves were rather complicated and required special eccentrics, and it is doubtful whether they were ever of great value. They were at first used in both naval and merchant vessels, because, apart from the desire to vary the ratio of expansion, it was impossible with a single slide valve to provide for a high ratio of expansion without badly deranging the exhaust and compression. The independent cut-off enabled the desired ratio of expansion to be obtained, while the exhaust and compression were attended to by the main valve. Experience finally showed that there was no real gain in economy in cutting off earlier in the high-pressure cylinder than about five-eighths, which could be done by the main valve, and when, as in naval vessels, it was desired to get a greater ratio of expansion for lower powers, it could be done by means of the link. A very simple means was found of arranging the suspension rod of the link so that whatever the degree of expansion in the ahead motion, when the link was thrown over for backing it would be in full gear.

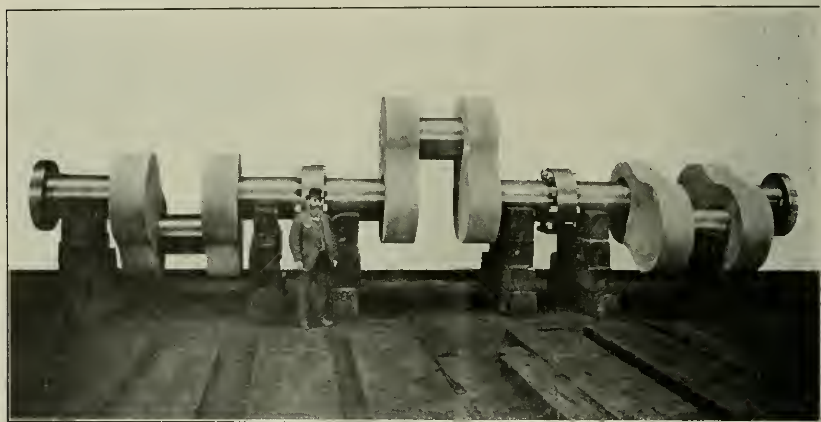
In the latter part of 1880, Chief Engineer Isherwood conducted a most interesting and valuable series of experiments with the com-



ENGINES OF THE SS. UMBRIA AND ETRURIA.

The last great compound engines for Atlantic liners. Built by John Elder & Co., Glasgow, for the Cunard Steamship Co. Cylinders: high-pressure 71 inches, low-pressure, two of 105 inches diameter; stroke 6 feet; 14,500 indicated horse power. By courtesy of the Fairfield Shipbuilding and Engineering Co.

pound engine of a Herreshoff yacht called the Leila, for the purpose of determining certain points in connection with the economy of compound engines when operated under different conditions, one of which was the distribution of power among the cylinders by varying the low-pressure cut-off without changing that of the high-pressure. Ordinarily, unless the cut-off in the low-pressure cylinder was somewhat earlier than that due to the link in full gear, the high-pressure cylinder would develop rather more than its share of the work. These experiments showed that not only could the distribution of power be varied among the cylinders, but that by the judicious use of the low-pressure cut-off the total horse power of the engine might be increased for the same steam consumption, or, in other words, that a slight gain in economy might result. It may be remarked incidentally that these experiments on the Leila showed one of the reasons why naval vessels in ordinary cruising can never be expected to give the same economy as merchant steamers, which work constantly under full power. The naval



CRANK SHAFT OF SS. UMBRIA AND ETRURIA.

Built up of Vickers' steel by the firm of John Elder & Co., and used on these, the last of the great compound engines, prior to the general introduction of the triple-expansion system. The shafts are 26 inches in diameter, and weigh 84 tons. By courtesy of the Fairfield Shipbuilding and Engineering Co.

engine must be designed for the maximum power which is required. The usual cruising speed is not much greater than half the speed corresponding to full power, with the result that the power of the engines for low speeds is about one-tenth that of full power. It is, therefore, utterly impracticable to attempt to get this low power by maintaining full boiler pressure and using a great ratio of expansion. The actual operation is to carry about two-thirds full pressure in the boilers and by throttling get an initial pressure in the cylinder which will allow a reasonable degree of expansion to be maintained. The Leila experiments showed, for example, that with a nearly constant degree of expansion, due to a cut-off a little earlier than half stroke in the high-pressure cylinder, the steam per horse-power hour, which, with a boiler pressure of 129 pounds, was 16.3 pounds, rose to 20.9 pounds when the steam pressure had been reduced to 55 pounds, and to 32.7 pounds when the steam pressure had been reduced to 21 pounds. It will be observed that these experiments are the inverse of the Michigan experiments, where the steam pressure was kept constant and the ratio of expansion varied. In the Leila experiments the ratio of expansion was kept practically constant and the steam pressure varied. The results, however, were the same. When the ratio of expansion became much greater than about one-twelfth of the boiler pressure there was a decided diminution in economy.

The Research Committee of the British Institution of Civil Engineers conducted an exceedingly valuable series of experiments on marine engines of different types to determine carefully their economy, and in 1888 and 1889 tested two compound-engine vessels. In one of them the boiler pressure was 80.5 pounds and the revolutions per minute 86.5. The coal per square foot of grate per hour was 26.1, and the coal per indicated horse power per hour 2.9. It is to be noted that a part of this high cost of power was due to the use of forced draft in the boiler, which reduced its economy. In 1888 they tested another compound engine, where the steam pressure was 56.8 pounds and the revolutions per minute 55.6. The coal per square foot of grate 19 pounds and the coal per indicated horse-power hour 2.66. The results of these cases are deserving of absolute respect, for the reasons that the trials were conducted by engineers of the highest standing with a thoroughly competent scientific staff, and the experiments lasted long enough to make sure that the results were really fair averages, and not, as is too often the case, unusually good results due to too short a trial and skilful jockeying.

It has been mentioned that forced draft was applied to the boilers of certain United States naval vessels during the civil war. It began to be used again in the 80's, this time in the English navy, and shortly afterwards in all other navies. There was a great demand for high speeds, and the boilers as then built took up so large a percentage of the room that to have continued to use natural draft alone would have made it impossible to put machinery in the ships to give the necessary high speeds. In the early stages of the use of forced draft it was confidently expected that an increase of power of at least fifty per cent. might be expected without trouble, but experience soon showed that when the boilers were driven to this extent there was trouble from leaky tubes. It was also found, as might have been expected, that the cost of power was materially increased. The reason, of course, was that the amount of heating surface which could be provided in cylindrical boilers of the ordinary type was not sufficiently great to absorb the heat when the coal per square foot of grate per hour was raised from about 16 to 18 pounds under natural draft to 40 to 45 pounds under forced draft. I shall discuss this question of the effect of forced draft on economy more fully under the next division of the subject—"The Triple Expansion Engine."

In discussing the question of economy in marine engineering the matter which has just been referred to is an important item because the weight of machinery is a very important element in the general economy, and, dismissing the great reduction in boiler weights for the moment, I may refer to what occurred to the engines about the same time that forced draft was reintroduced. The notable feature here was a great increase in the rotational speeds. This is sometimes spoken of as "increased piston speed," but when the increase consists in a greater stroke in the engine without any change in revolutions there is not a material decrease in weight. When the change consists in an increased speed of rotation, we not only have smaller cylinders but smaller moving parts and smaller shafts. It has already been intimated that a part of the increase in rotational speeds was due to better material and better workmanship, but the really vital element is one which has not hitherto been mentioned. This was a correct understanding of the design of the propellor.

As with so many other things, the history of the propeller shows a progress from a very crude form, where the instrument was designed simply to accomplish results without much regard to the cost, up to the stage where refinement of design and questions of economy are of much greater importance. It is an old story that in the early days of screw propulsion a very large number of blades was used, and it was due only to the happy accident of some of the blades of a certain propeller having been knocked off that it was found that so large a number was unnecessary. It came to be the settled practice along in the 70's to make the diameter of the propeller as large as would be fully immersed. This was the basis from which the other dimensions were determined. The pitch was a nearly constant multiple of the diameter, and then a certain portion of a full convolution (about three-tenths) was taken and divided into four blades whose corners were slightly rounded. Such a method of designing necessarily made the engines driving such propellers of relatively low rotational speed and consequently quite heavy. When the demand for higher speeds came, able engineers began to investigate the design of the propeller, and it was found that the method used had been entirely wrong. The propellers were altogether too large in diameter and had too much surface. It was finally discovered that, within reasonable limits, the design of the propeller is very elastic and that the engine speed might be determined to suit the conditions with respect to space and weight desired,with the assurance that a suitable propeller could be designed to give efficient results. We shall later on give a table showing the progress in economy of weights of machinery as well as of the cost of power, and it will be seen that in the high-speed engines, particularly those of torpedo boats, there has been an enormous reduction in the weight of the engines in spite of the fact that the modern engines work with a very much higher pressure than was used in the early days.

The Fairfield works which, under Elder, had been the leaders in the introduction of the compound engine, continued to build notable examples of them, and the largest and finest compound engines ever built were probably those in the Cunard steamers Umbria and Etruria, which work up to over 14,000 horse power. In them the steam pressure had risen to about 110 pounds. The high-pressure cylinder was 71 inches in diameter and each of the two low-pressure cylinders was 105 inches in diameter, the stroke of all pistons being 72 inches. Even when they were built, the next great change in the marine engine had commenced, so that steam pressures then jumped from 110 to 150 pounds.

The engineers who had led in the improvements which took place during the compound-engine period had good cause to feel proud of their work. While the next change which took place brought in a new name to designate the new engine, the change this time was one of degree and not one of kind, as had been the case in the change from the simple to the compound engine. The important features of high steam pressures, a moderate total expansion divided among the cylinders so as to prevent too great a temperature range in any stage of the expansion, high rotational speeds, the cylindrical boiler, forced draft, and the intelligent design of the propeller—all had been worked out. Progress during the next period consisted mainly in development and refinement of the principles which had been established during the compound period, as will be shown in the next article.

THE PLACE OF THE MECHANICAL LABORATORY IN THE EDUCATION OF THE ENGINEER.

By J. Boulvin.

There is probably no one subject to which the attention of the engineering world has been drawn more forcibly of late than the necessity of making technical education more practical in its nature, by the use of experiment in connection with instruction.

Professor Boulvin speaks with the authority of one of the ablest educators on the Continent of Europe, and both English and American engineers may profit by his experience.—The Editors.

ENGINEERING education is a subject upon which much excellent matter has been written, but one which is never exhausted. Ideas upon such a subject can never be absolutely fixed; in proportion as industrial processes are perfected and as new sources of wealth are exploited, in proportion also as science progresses, as the boundaries of the world are modified, as financial or commercial aggregations vary and in their turn exercise an influence upon production, it becomes impossible for the engineer to preserve a stationary position among these evolutionary surroundings.

No type of education can be established that will be responsive to all needs, because these vary with situation and time. All that can be expected is a statement of major principles, based upon a sound acquaintance with the subjects of education and the psychology of the student. In establishing a course of technical instruction it is needful also to take into account the nature of anterior or preparatory teaching; the authorities of an engineering institution have little or no influence upon the general methods of instruction in schools of primary or intermediate grade. It follows that a system recognized as excellent in France could not be applied with success in England or the United States, and *vice versa*.

It should be noted, however, that much general progress has been made in the establishment of mechanical laboratories.

I think I do not err in stating that the first installations of this kind were made less than a quarter-century ago. Before that the course of instruction for engineers consisted solely in the study of mathematics and in such sciences as physics, chemistry and mechanics. It was completed by the application of these sciences to the diverse branches of applied mechanics, such as hydraulics, strength of materials, machine designs, etc. The sole practical exercises were problems or plans of fixed structures or machines.

It is undoubtedly true that all fixed construction work is based upon the principles of the equilibrium of forces, and that by the theoretical method the design of a structure such as a frame-work may be fully determined. This is a branch of study that will ever remain fundamental and which, consequently, can never be neglected.

To solve correctly all the problems of this kind presenting themselves in construction the only incentive necessary is that furnished by numerous examples. Here experience has but little influence, for mechanics is a science of which the results are as positive as those of geometry; from its conclusions there can be no escape. It would be a dangerous illusion to fancy that one might pass by the study of theoretical mechanics, and the mathematical knowledge needed for its understanding and use.

In this connection it is worthy of remark that the mathematical training of engineers should be specialized with reference to their objective aims. Mathematicians will not fail to raise to this the objection that as there is only one kind of mathematics, maintaining that there can be no question of difference, save as to degree, between the training of an engineer and of a doctor of sciences. I think that this constitutes a positive error. The academician, who cultivates pure mathematics for its own sake rather than for its applications, may content himself with very general theories regardless of their applications. The student who can give his entire lifetime to mathematical investigations, has no need to follow out the ultimate results of all his studies; what he needs above all is a clear general view of the methods of the sciences, and of the profound relations that exist between them.

But with the engineering student, who works at his mathematics for its immediate utility, all is different; if he is not able to use his mathematical training from the moment of his entrance upon the technical side of his profession it will ever remain a useless tool in his hands, for he will never find time in his active career to perfect that knowledge sufficiently to use it with confidence. It results that his mathematical training should be at once less extensive and more profound than that of his fellow; more profound because he should be able to apply it without deceiving himself with errors in numerical examples. I constantly observe good students, coming from mathematical classes in which they have distinguished themselves, committing deplorable errors when they try to apply their mathematics to very simple physical or mechanical problems. Habitual combination of mathematical symbols has made them lose sight of the quantities the symbols represent, and they are not always enlightened by the absurdity of the solutions at which they arrive.

I believe that, as a general rule, the best results are obtained by curtailing the extent of mathematical courses and in requiring students to solve a larger number of numerical and practical problems; but by this I must not be understood to say that the time devoted to mathematics needs to be made shorter.

From various sides there has been recognition of the insufficiency of polytechnic instruction. In the case of fixed structures which must be sustained by the strength of their members, it is of course essential to know the stresses that will be developed in these members when the structures are erected; but it is also important to be informed of the capacity of the materials to bear these stresses securely. In the case of machines, and especially complex machines, such as those which accomplish the transformation of heat-energy into work, the hypotheses are always so far away from the facts that the deductions should be supported by experiment. The conversion of heat-energy into work rests upon the laws of thermodynamics, as immutable as those of gravitation; there is nothing arbitrary in Nature's processes; but the knowledge of the data necessary in applying these laws can be reached only by experiment.

We owe our knowledge of the properties of steam to experimental labours of which the importance and exactitude have never been surpassed. However extended the admirable researches of Regnault had been, that *savant* could never doubt that they would become insufficient at some time. Even to-day we are lacking in absolutely certain data for the properties of steam at very high pressures, and especially for superheated steam. Such researches must necessarily be of a very high class; it is not to be thought that they could be undertaken or repeated as a matter of course in all laboratories. Such a task demands the work of some physicist of high talent and reputation who can bring to the technology of the steam engine the fundamental data it is beginning to need.

In the study of steam engines the part of secondary or dependent phenomena is important. The conductivity of cylinder walls has an especially notable effect, yet it is still almost impossible to calculate it, notwithstanding the remarkable researches which have already been made, notably by the French engineer Nadal.

The state of our knowledge as regards the steam engine is, then, as follows: Theory teaches us several important facts which cannot be discarded without inviting serious errors; the study of its details has been carried far, steam distribution being notably a subject which can be taught so perfectly that a good student should be as much at home in it as would the late Mr. Corliss himself; but at the same time it is practically impossible to calculate with any certainty how much steam will be consumed by an engine working under given conditions. Experience alone can answer this question.

But it is not only the study of the engine which is found in this situation; in all the phenomena of applied mechanics there are unknown elements. It is the business of the engineering laboratory to search out laws as yet unknown, to verify those which are more or less uncertain, and to record by experiment the results of theories having a mechanical or physical bearing.

The mechanical laboratory presents itself thus as an auxiliary indispensable to theoretical study. The utility of this modern appendage of engineering schools is so evident, so incontestable, that it has been recognized in all countries endowed with technical courses of instruction. Like many modern ideas, the mechanical laboratory had its birth in the United States; it was almost immediately developed, though not so amply, in all parts of England, and more lately in Germany and other countries.

While the laboratory is indispensable for the fruitful study of applied mechanics, it should not be concluded that it can suffice for all, that it can be substituted for theoretical instruction, that the engineering student will hereafter pass all the time allotted to his instructions wearing overalls and amongst machines, for no idea could be more of a mistake.

Experiment has no inherent value if it is not susceptible of generalization. Whoever should have shown by experiment that the square constructed on the hypothenuse of a right triangle is equal to the sum of the squares constructed on the other two sides would not have advanced our knowledge, until the moment arrived in which he might have demonstrated that this property is true for all right triangles, whatever their size or form.

What is of importance to science is the interpretation of experiment, the generalization of conclusions that may be drawn from it, the culling from it of material that may be erected into more general or more exact theories. Hence laboratory work is not destined to invade the place in schools now given to sciences hitherto taught and thought indispensable; it will never be possible, in my opinion, to train a civil or mechanical engineer without a knowledge of mathematics, physics, and theoretical and applied mechanics, and the more complete this knowledge, the better will be the product. Laboratory researches are destined to give to the theories of applied mechanics the basis upon which they must rest. They, alone, can give this science its true significance.

This is a very important result, which might be partly attained if only the professor devoted himself to experiment. His teaching would gain in precision and authority, he would inspire more confidence than if he applied his instruction to experimental work done by others, frequently under different or unknown conditions.

But this is not enough; applied mechanics cannot be regarded as a science to be swallowed whole, which a young man can learn once for all in order that it may serve him through his entire career. Altogether different from the exact sciences of which algebra and geometry are types, it is in a continual state of transformation, a science that is never finished and that each engineer should himself help to bring up to date and modernize. The employment of new materials of construction for cylinders, and perhaps even a simple modification of the physical condition of surfaces exposed to steam, would doubtless sensibly alter their power of heat absorption or emission. The appearance of new lubricants or new alloys might modify the laws of friction. The result of these facts, quoted only as insignificant examples, is that the engineer should use, not only while at school, but all his life long, a faculty of vigilant observation. No success is possible for him unless he is accustomed to give the experimental side of his profession its full importance.

Doubtless the experiments which can be made at a school will always be limited in number; if one studies only the deduction to be drawn from them he will have a scanty equipment for encounter with the pitfalls that beset an engineer's career. But the real scope of such work is much wider. What he really should learn is the method of experimentation, that is, the art of making exact experiments, the necessity for employing apparatus, an appreciation of the importance of little things. Possessing these aptitudes he will be ready in his practical work to address himself to experiment whenever he needs it and to do this with a continually increasing ability.

Naturally, there arises the question as to what researches should be made in a mechanical laboratory to produce the greatest sum of usefulness. In principle there is no limitation to these researches save that set by the equipment of the laboratory itself. However, it is evident that the student, except for rare exceptions, can take up new and original research only with difficulty; the time he can pass in the laboratory serves only as an introduction to the fundamental experiments.

Thus, regarding strength of materials, the coefficients of elasticity of a number of specimens, chosen best to exhibit their differences, would be measured.

In the case of machinery the field is much more extensive; the steam boiler alone furnishes occasion for experience in the methods of testing combustibles, of studying steam production, and in consequence the importance of controlling the progress of combustion by gas analysis, of verifying the quality of the steam produced, etc. Delicate calorimetric operations and high temperature observations included in the course of these experiments are types of work eminently proper for the development of the student.

With steam engines, the determination of power by means of the indicator or by brakes, simultaneously with the measurement of the steam consumed and the heat lost, constitutes a programme of illimitable scope. If the engine is arranged to operate under different conditions, as a laboratory engine should be, the experiments may be made particularly interesting, since they permit the study of the influence of changes in the conditions of running. There is nothing more suggestive than the investigation of the results of such comparative tests, as exhibited in entropy diagrams. These tests can be repeated, one condition being changed at a time, for example, the pressure, the cut-off, the speed, etc.

The gas engine lends itself to the same class of researches, including the influence of the composition of the explosive mixture, of the degree of compression, of speed of running, of temperature of the cylinder, as well as of the method of ignition.

Pumps, fans, air or gas compressors, all give opportunities for varied experiments, either concerning their efficiencies or their working. Hydraulics, and the apparatus belonging to it, furnish other types of researches which can be carried on in a laboratory where a natural or artificial head of water is available.

Besides these experiments, so interesting from the educational point of view, there are others of much importance of a more theoretical nature; for example, I may cite those which may be made upon the flow of fluids in general, and of steam and water in particular. It is impossible to foresee exactly along what lines the prime movers of the future will develop. Many predictions made in this regard have failed and I shall not hazard one more, but it is certain that the increasingly frequent employment of superheating and the large place already taken by the steam turbine are facts wherein industry has outstripped science; it belongs now to the latter to furnish practicians the necessary data for the further knowledge of these applications.

By these small indications, for I cannot undertake in so limited an article to describe in detail all the desirable functions of the mechanical laboratory, it may be seen that the educational value of experiment is varied and extensive. The generation that follows us will hardly believe that schools without laboratories could have existed.

I do not think the research work of students can be expected to enrich science, considering the time spent upon their studies, which is generally three years in England and more frequently four years on the Continent of Europe. For the student, then, the experimental teaching must be considered as a sowing of seed to germinate later, and to aid him in accomplishing his end with greater profit both to himself and with benefit to the public.

The mission of the professor is to devote himself to research work of a more special and fundamental character, for, beside the obligations of teaching, it is his duty to aid in the advancement of science. This is important, and I may be permitted to indulge in some reflections:

The professor, I speak now of European countries, is too completely absorbed in the duties of instruction; there are many *savants* whose ingenious spirits have been stifled by the too prolonged labors of a fatiguing professorship. One can scarcely believe, unless he has been himself a professor, how depressing is the work of preparing lectures, correcting exercises, studying new projects, and above all the periodical examinations which are scholastic traditions. This work absolutely must be done with zeal and perseverance; the professor must set an example of care, of method and of correctness to his pupils, themselves at the age when these qualities are most often lacking.

These professional tasks absorb all a man's energies, and I know of more than one who looks joyfully upon the approach of vacation season, not that he may profit by his well-earned rest, but that he may work in peace at his personal researches.

This state of things cannot be true everywhere. The great American schools, notably, enjoy the privilege of being able to manage their own affairs; I like to think that they do it with much intelligence. And I exaggerate nothing in saying that in certain European countries where the technical schools are dependent upon the government, the life of a professor may be somewhat irreverently compared to that of a cab-horse; it is overburdened by the multitudinous detail of a teacher's duties.

Does it conform with the general interest and with good returns on the moneys invested in technical schools so to abuse the man upon whom rests so high a mission? Evidently not. There should be a remedy for this situation. It is needful that lessons be given, with all their retinue of exercises, examples and examinations; but this task ought not to be prolonged too far, it would be entirely reasonable to arrange, say, after twenty years of professorship to give the surplus work to a younger man as successor, for whom, incidentally, this preparation is necessary.

The professor would cease his daily and fatiguing teaching, at an age when he would be in full possession of all his scientific faculties, and consecrate himself thenceforth exclusively to theoretical and experimental research. He would do his work with the maturity acquired in the first stage of his career; he could then use the time that these researches would demand.

Experimental work of a purely scientific order can be done only by a professor, who has a wide view of the problems of which so many yet remain for solution. The domain that remains to be covered is vast, and it may be enlarged at any moment in an unforeseen manner. It would be rash to attempt to indicate what researches should be unundertaken at present, when new and fruitful openings are daily made by men of science. Thus, the thermometry of high temperatures has made a great step in advance by the invention of the thermo-electric pyrometers of Professors Callendar and Le Chatelier; many problems we would not have dared to face twenty years ago are susceptible of solution; the measurement of the variable temperature of the metal of engine cylinder walls at all depths has been conceived; the temperatures of explosion and of exhaust in gas engine cylinders have been measured. It is indubitable that before long, and by the use of these new instruments of research, we will come to a clear vision of the truth in phenomena long discussed, those that have given rise to so many suppositions and probably to so many errors.

The problem of engine regulation itself, old as it is, and one that might have been thought sufficiently solved, leaves the door open for new researches. Operation of polyphase electric generators has increased the requirements of regulation in prime movers to such a point as to necessitate a more complete study of the methods of operation of governors. It is no longer sufficient to take account of mean speeds as they might be registered by a tachometer, but to study the speed of the fly-wheel rim at each instant of its revolution by means of the isochronous vibrations of a tuning fork.

There is still another point of view from which the laboratory may be regarded, for it is frequently called to the assistance of industry; it is becoming more and more true that the latter can prosper only by an intimate accord with science; empiricism is disappearing before better research and more perfect products. The modern manufacturer, whether he be smelter or engine-maker, concerns himself with daily measurements for which his works are the proper laboratory; thus the engine-builder constantly measures and compares the efficiency of his output, for it must be kept at the salable standard. That which is not now a necessity in a new and rapidly expanding country is an accepted fact in lands where industry is an ancient foundation; an engine of any importance cannot be sold to-day in Germany, Austria, France, Belgium or Switzerland without a guarantee of its efficiency. This state of things will become general, a reason for satisfaction because it is only reasonable that the prices of things should be determined by their quality; in default of this basis of rational appreciation there are only the arbitrary claims and misleading statements of commercialism.

Outside of the current experimental work carried on by the personnel of works there are special researches which require costly instruments or exceptional aptitude and which, for these reasons, can be pursued only in a true laboratory. There is also a category of experiments which bear upon questions of public safety and which are indispensable to governments. Now when one sees steam boilers put under inspection and measures imposed upon the circulation of vehicles in streets and roads, it is natural to think that the administrations have the right to intervene in many cases where human life may be menaced.

I shall not discuss the question of whether it is preferable for the State to exercise its action in a preventive manner, that is, by imposing regulations. Many people are of the contrary opinion and these regulations may have objectionable features; not their least inconvenience is that they age rapidly, that they soon become out of accord with modern exigencies and that then they hinder progress. But if the preventive action of the state is not always exercised the same thing is not true of its repressive action, for the courts are called upon to pronounce in cases of accident to persons or injury to property. Should the case be the explosion of a receiver, the collapse of a structure, the breaking of a cable or a bridge, it is most often a question of material that is concerned. Almost invariably the inquiries to be made to establish responsibility are of an experimental character, which may be made with competence and impartiality in a mechanical laboratory. Experiments of this class are instructive for everybody, since they apply to materials such as are in actual use, submitted to the fatigues and stresses of their proper employment, and not placed in ideal or artificial conditions.

The laboratory can, then, be usefully consulted under many circumstances and it becomes thus an institution of public interest. Is it proper to attribute this last function to laboratories of technical schools, whose mission is already so important, or would it be better to build for this purpose special establishments directly under governmental authority? This is a question of occasion which cannot be answered in a general manner. If the laboratory has a sufficient personnel at its disposal there would be, perhaps, no great inconvenience in the execution of experiments demanded by particular occasions; there might even result certain advantages through the greater variety of researches and by the more frequent contact of the professors with industrial conditions.

However, we may conceive of a central laboratory in a country, established to respond to the demands of particular occasions, of municipalities, great railway companies, etc. This is almost precisely what has been done in Germany, where the Reichsanstalt at Berlin responds to these exigencies.

It is scarcely necessary to resume and to conclude. The *raison d'être* of mechanical laboratories is that they are destined to exercise a great influence upon production and upon the public wealth. This influence they exercise in three different ways, all concurring to the same end: First, by the better, more precise and more useful education they give young engineers, into whom they instil the necessity for experimentation and to whom they give a practical turn in thought and habit; again, by the opportunity they afford professors to give themselves over to the researches necessary for the advancement of science; finally, by the direct help they give to industry in undertaking the various investigations it demands of them.

To respond to these various demands the laboratory should necessarily be furnished with a varied and complete equipment, but the attention given the material side of things should not close our eyes to the qualities necessary in the men who will frequent it or guide its destinies. For the students there is requisite with sufficient theoretical instruction, a great desire to learn and an awakened curiosity; for the professor a great love of research nourished by profound scientific knowledge, and time to devote to it. Experience with existing laboratories demonstrates that these conditions are fulfilled to a high degree, for they have rapidly taken a large place in the profession of the modern engine, and this place will surely rise in importance.

THE FACTORY OFFICE.

CONSIDERED AS A PRODUCTIVE DEPARTMENT.

By Kenneth Falconer.

Mr. Falconer's timely contribution to our discussion of management problems makes a fitting addition to Mr. Carpenter's series of excellent papers publishing currently.

One of the chief difficulties in connection with a satisfactory system of shop-accounting is found to lie in the proper discrimination between the direct productive departments and those which must be considered as a part of the general expense account. Mr. Falconer shows how the factory office may be separated from the general system of accounting, and so be capable of inclusion in the productive shop work portion and distribution throughout the output in a manner similar to other shop costs.—The Editors.

IN view of the fact that clerical and accounting work is almost universally regarded as non-productive work, the application to it of the principles of economical production would at first sight appear impracticable, and a proposition to regard the factory office as a productive department of a manufacturing business would seem illogical and absurd.

A consideration, however, of the true objects of factory accounting, of the results expected from it, and of the valuable uses to which such results may be put, gives some weight to the claim that the output of the factory office may readily be one of the most valuable products of the concern—even though it has no marketable value.

Besides obtaining the correct cost of each and every article manufactured, a proper system of factory accounting should secure to the management full information as regards all the internal accounts of the business, whether such accounts represent assets or liabilities, receipts or expenditures, and such changes and fluctuations as these accounts may show from time to time. More important still, it should plainly indicate the causes of any such changes whenever they may become unusual or abnormal. This information should always be a matter of current work and not of past history, and should be so promptly secured and recorded in such manner as to facilitate comparison with past records of similar operations or transactions. Thus promptly secured and systematically recorded it will enable most valuable conclusions to be drawn from it, and judicious decisions based on it. The office of any manufacturing business attaining these results and turning out work of this kind is very far from a "non-productive department." Upon the management rests the responsibility of putting such results to the wisest use as truly as the responsibility of putting to the best use any part of the equipment or of selling to the best advantage the output of the shops.

In applying the principles of economical production to work of a clerical nature, a glance at what such principles involve and at the chief conditions which make for or against economy in the shops may show how best to apply similar principles and regulate corresponding conditions in the office.

In planning for the manufacture of any article the object sought is to obtain the desired product with the least possible expenditure of material, wages and time, the latter very possibly the most important item of the three. In the case of day work, the wage-cost itself is, of course, dependent on it, and of the many other factors affecting cost of production the majority vary more or less directly with it. On how wisely time is used, how little of it needlessly expended to say nothing of being lost or wasted, depends greatly the success of the shop as a productive concern.

The best use of time is largely dependent on a judicious apportioning of each job or class of work to the man or machine best suited to handling it, and this again is closely connected with the question of as far as possible, having all work done by the cheapest man or machine competent to perform it—the cheapest not necessarily meaning the lowest priced, but cheapest in view of rate of wages paid, time consumed, and quality of work done. Economical production and cheap production are entirely different things.

There are many other factors which tend for or against the efficiency of a shop, and consequently its cost of production. Some are more and some less prominent, but they nearly all hinge on the question of time. The more important of these, on account of their prominence, are usually pretty closely watched by those interested. Others, small in themselves, but which may yet have important results, often on account of their familiarity "pass unrecognized, or where not entirely ignored are apt to be so grossly underestimated as to be thought of very little account."*

In the factory office as in the shop, the "cost of production," (or ob-

* "Neglected Factors of Machine Shop Economies," by T. S. Bentley, in THE ENGINEERING MAGAZINE for January, 1902.

taining results) is largely a question of judicious supervision, and modern and complete equipment. In the former as in the latter there is great danger of overlooking or neglecting many matters whose importance is more real than apparent, and in the one as in the other time is the paramount consideration, most of the others being more or less important as they may affect it.

That is not a good foreman who neglects the supervision of his shop in its smallest detail to do mechanical work which can be done by a workman, but that perhaps is the mistake most frequently made by those in charge of what may be termed the technical accounting of a manufacturing or industrial concern. It must be remembered that "factory accounting" is not ordinary book-keeping, and that it is very much more than a branch of the science of accounts. While subject to the laws of accounting it is largely affected by consideration which the ordinary accountant never meets nor requires to study. The time is coming when it will be recognized as a profession in itself, partaking somewhat of the nature of both engineering and accounting.

If prevailing conditions justify the employment of a factory accountant they necessarily justify the employment of a sufficient staff to leave his time free for work which he alone can do, otherwise it is a clerk that is required. Though as a rule clerical work does not require such close supervision as mechanical, yet the clerical work of a factory office being so different from that of a commercial or mercantile office the rules usually prevailing in the latter must be modified to suit the former. I do not mean that the factory accountant should do no work, but I do claim he should do no routine work. His time may be and should be much better employed, even though he apparently does less actual work than any of his clerks.

If the conditions justify the making and filling of such a position as factory accountant, in order to obtain the best results it is quite as necessary he should have entire control of his department, as that a foreman should have full control of his men. This is a claim of which most managements fail to see the justice, virtually taking the stand that the factory office is part of the general office, instead of an entirely distinct department. Like the foreman of the shop, the factory accountant must study and know his staff—the capacity and temperament of each, and distribute the work accordingly, being careful as far as possible to have the services of each clerk employed on the most important work he is capable of doing. His clerks' brains are his productive plant, and it is far from economy to have a machine of high cost and value doing work which can be done equally as well and in the same length of time by one representing a smaller investment.

In the factory office, even more than in the shop, is the question of discipline as regards time a difficult one. In the latter men can be and usually are held pretty closely to their hours by a system of locking out for a part of the day and a consequent loss of pay. In the office such a plan is impossible, but, nevertheless, discipline and punctuality are quite as necessary as in the shop. In office work there always must be a certain amount of give and take, and fairly treated, the average clerk will be disposed to act fairly. As in the shop so in the office, except under exceptional circumstances, any advantage gained by working overtime is more apparent than real. When it is necessary, however, clerks will usually be ready and willing to put in the extra time, provided they know that the management see and realize that it is an extra effort that is being called for. Where clerical work is not kept up to date, nine times out of ten it is the fault of those in charge, not of the clerks, and in the majority of cases the cause is neglect of thought and care in distributing the work and planning the details. Where, when required by exceptional circumstances the staff refuse to make an extra effort, or do so unwillingly (and as a result ineffectively) it is either because the call for such extra services might by a little foresight have been avoided, or because they are asked and expected as a matter of course.

In these days a shop cannot turn out product at a cost low enough to meet competition unless fitted up with modern equipment. Similarly any factory office not supplied with modern appliances will be unable to procure and record the results looked for until the value to be obtained from such results is greatly decreased. A monthly statement of all details and results is valuable in direct proportion to the promptness with which it is prepared. Its value lessens greatly with each week or even day that elapses between the month to which it refers, and the date it is available for study or use. Comparisons of cost of manufacture to be of the greatest use should be obtainable as the work progresses, not as is often the case so long after completion that they have partially or completely lost interest and value. It is in this connection that a thorough knowledge of card and loose leaf systems is of use, and only those who have made a study of them can realize the great saving of time that may be effected by their use.

The lesser questions, light, heat, ventilation, &c., which Mr. Bentley points out in the article already quoted as affecting the question of economical work in the shop, also directly affect the cost of office work.

As a general rule it may be said that anything that tends to make a workman or a clerk more interested in his work—more comfortable in his surroundings, or more in harmony with his fellows, tends to lessen the cost of the workman's product, or of the results obtained by the clerk's labor, in other words to reduce the cost of production. Even in such a small matter as the location of the desks of the various employees, convenience should be studied, and as a result time saved. These and similar matters, admittedly small in themselves, may collectively affect the question of time, and therefore of cost of production to a greater extent than will readily be believed.

A factory office, looked to for important results,—expenses of operating it regarded as its cost of production,—the information and records it procures looked upon as its product,—is the fairest and most legitimate view to take when considering the question and the cost of factory accounting. That its product has no market value, and that its worth to the management cannot be expressed in figures does not disprove the claim that the factory office is a productive department.

HIGH TENSION ELECTRIC POWER TRANSMISSION.

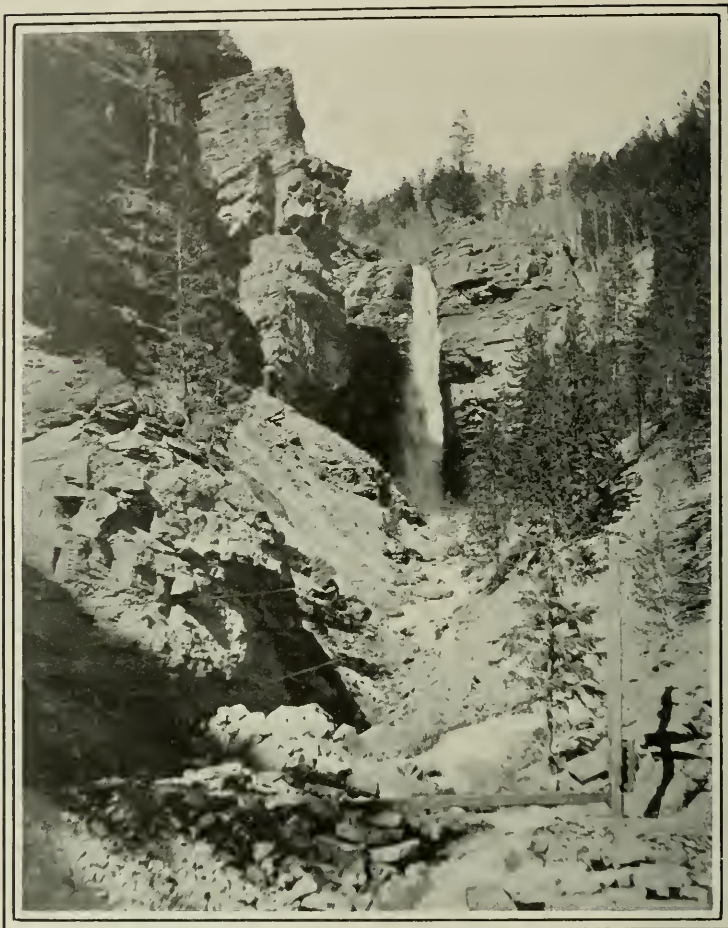
By George H. Gibson.

The use of electricity for the transmission of power has proved one of the most potent factors in the utilisation of the forces of nature for the benefit of mankind, and every improvement which extends the range of that transmission comes as an added resource to the wealth of those favored localities in which natural power is available. Mr. Gibson shows the progress which has been made in the electrical transmission of power during the past ten years, and the story cannot fail to be of interest to engineers and laymen alike. —THE EDITORS.

ENGINEERING has been defined as "the science of making money go the farthest." Considering another aspect of the subject, we may say that it is the science of making investments of money earn the most interest. Financial possibilities must always be important and determining factors when considering proposed engineering undertakings, and this applies with especial pertinency to the present subject.

When power is needed for manufacturing or other purposes the question usually arises whether it will be more economical to generate the power at the place where it is to be used or to transmit it from some distant and cheap source of energy. This question must be solved always upon the merits of the particular case, but in order to give the most satisfactory answer the very latest developments in the art of power transmission must be taken into consideration. The capitalist, and even the engineer who is not a specialist, is apt to base his calculations upon the successful practice of five or six years ago, rather than upon the demonstrated possibilities of to-day. It is the purpose of this article to exhibit, by citing some recent and successful installations, the latest progress in high-tension electric power transmission, and to draw attention to the ruling conditions in this branch of engineering.

It is now ten years since the historical Frankfort-Lauffen experiments, when 300 H. P. was transmitted more or less successfully over a distance of 100 miles by means of three-phase, alternating currents at 30,000 volts. Although these experiments were confirmed in the following year by the practical operation of a thirty-mile, 10,000 volt



DISTANT VIEW OF CONECT FALLS.
These falls furnish power to the Tomboy Mining and Milling Co., Pandora, near Telluride, California.

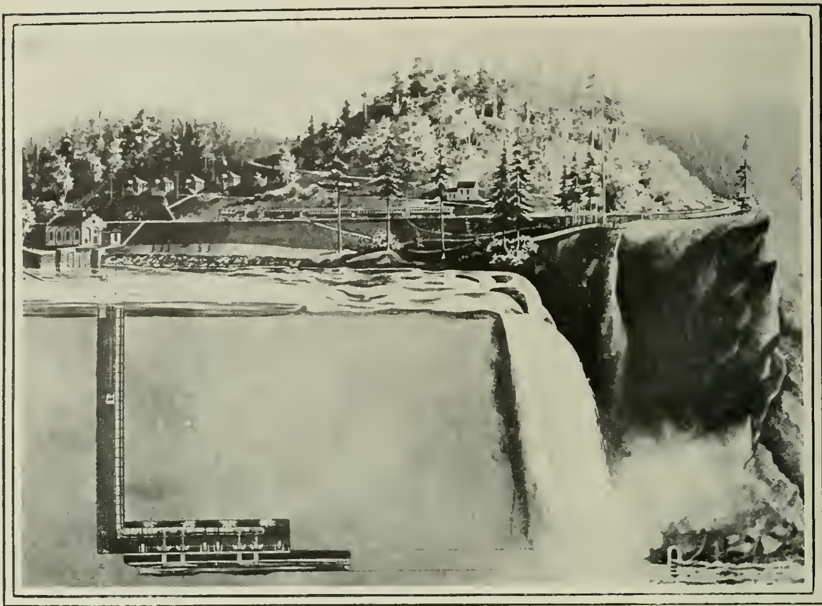
line at Pomona, California, subsequent progress in the application of high potentials was very slow, nor was this slowness entirely due to the natural hesitancy of capital in entering a new and unfamiliar field of investment. Early experience with high voltage currents inspired caution as well as respect. To handle a voltage capable of leaping a spark gap of several inches, and which would in time break down even the best insulation previously used successfully with lower voltages, required not only intelligence and care, but some rather costly experimenting.

But it may be safely said that the period of experimentation is over and high voltage undertakings may now be entered upon with entire confidence as far as the technical side of the question is concerned. In the words of a prominent engineer: "Apparatus as now constructed permits the use of 30,000 volts with practically no more risk of break-down than was involved in the use of 3,000 volts in 1890. This means that in ten years the increase in practical potential has multiplied the range of transmission by ten and the area of the territory within range of cheap water power by 100."

The voltage of transmission has been so much increased that the great loss of energy permitted in some of the earlier lines is now avoided and electric energy may be transmitted for 30, 40 and even 50 miles at an efficiency of 80 per cent., and without a prohibitive cost for copper. At 50,000 volts, 50,000 HP. may be transmitted with a loss of $^1/_5$ of 1 per cent. per mile and at a cost for conductor of only about $5,000 per mile. In fact for comparatively short distances, as 20 to 30 miles, the voltage which may be used is far above the requirements of the most economical transmission. The size of the wire in such instances, unless a very large amount of power is to be transmitted, is determined by the durability of the line from a mechanical standpoint rather than by considerations of loss of energy or cost of copper. It has been found that it is inadvisable to put up wire much smaller than about No. 6 B. & S. gauge, since smaller wires are liable to breakage.

BELMONT MILL, TOMBOY MINING AND MILLING CO., PANDORA, CALIFORNIA.

However, it is still true that there is a quite definite maximum limit to the distance over which power may be economically transmitted, even though the cost of the power may be practically nothing at the point of generation and coal may be very dear at the point of distribution. But this dis-



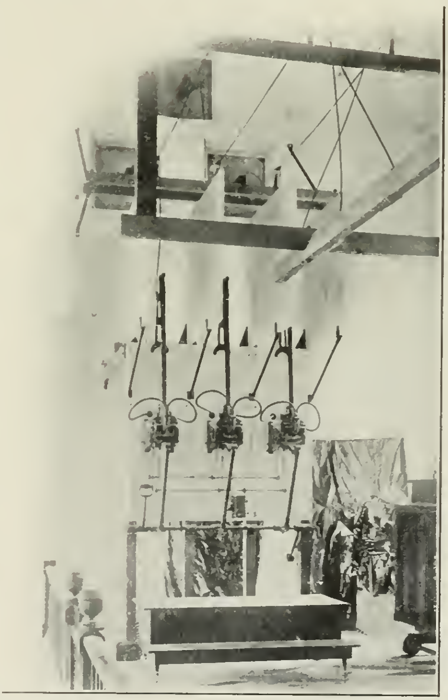
THE SNOQUALMIE FALLS POWER PLANT.
Sectional view, showing shaft, power house and tunnel.

tance is much greater than is usually supposed. The distance that may be covered by a transmitting line having a given weight of copper varies directly as the voltage employed. If we assume three miles per thousand volts and the loss of energy in the line at 16 per cent., the cost of the copper is about $20 per HP. This permits a range of transmission with a very good efficiency, both from a power and economic standpoint, of between 100 and 200 miles. Above this limit, however, there seems little prospect of passing. Three miles per 1,000 volts requires 50,000 volts to cover 150 miles, and 50,000 or 60,000 volts is at the present time the practical limit for the transmission of electric currents over bare aerial conductors. At higher voltages the air ceases to be a good insulator; it "breaks down" and acts more like an electrolytic conductor. This results in the passage of a very large amount of electricity through the air from one wire to another and a consequent loss of energy. It would be possible to build transformers and to manufacture insulators to withstand a much higher voltage, but the physical properties of air impose here a definite limit unless we enclose our wire in insulating tubes, a practicable form of which is yet to be devised.

Another point in this connection is that while it may be feasible and profitable to transmit a large amount of power over a long distance, it would be impracticable to attempt to transmit a small amount of power over the same line. This also follows from the physical and electrical properties of the materials we have to deal with. The charging current of a line designed to transmit 100 HP. is about as much as that of a 1,000 HP. line. This charging current, which becomes considerable with high voltages and long lines, transfers no energy but requires proportionately as much capacity in the generating station as the useful current transmitted. It also gives rise to loss in the line and affects to a considerable extent the voltage regulation.

We will now take up some of the recent and more noteworthy examples of high-tension power transmission. One of the most striking of these is the Snoqualmie Falls plant in the State of Washington, from which power is transmitted 31 miles to Seattle and 44 miles to Tacoma. The transmission is by three phase current at 30,000 volts over a line of aluminum. This was one of the first places where successful use was made of aluminum as an aerial conductor.

The generating station at Snoqualmie is located in a chamber excavated in the rocks below the Falls. It contains four 1,500 KW. three-phase Westinghouse alternators, which generate current at 1,000 volts. This is transformed in a station at the head of the penstock shaft to 30,000 volts, three-phase, by oil-insulated, air-cooled transformers. Between the transformers and the line is placed a full equipment of non-arcing metal lightning arresters. While machinery for only 6,000 HP. has been installed the water power may be developed to furnish 100,000 HP. the year round. The climatic conditions at Snoqualmie are rather excep-



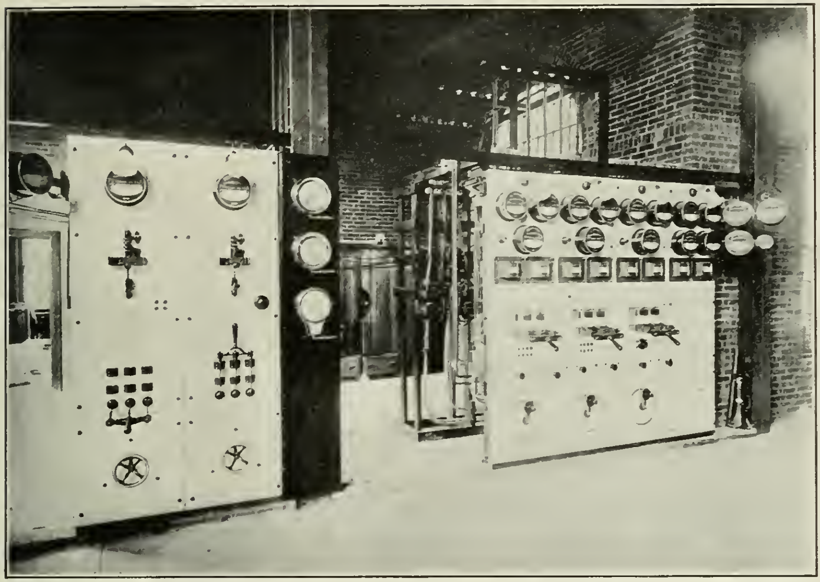
THREE HIGH-TENSION CIRCUIT BREAKERS.
Trade Dollar Consolidated Gold Mining Company, Swan Falls, Idaho.

tional. The catchment area is only about 600 square miles, but the average annual precipitation is nearly 90 ins. A large amount falling as snow during the winter months becomes available by melting during the months of drought, and it thus happens that the two months of greatest flow are November and June. The effective head on the turbines is 250 feet and the minimum flow of the river at present is 10,000 cubic feet per second. This, however, may be greatly increased by the construction of reservoirs in the catchment area. Tangential water wheels are used having ellipsoidal buckets and needle regulating nozzles.

This plant has been made the subject of some interesting experiments. The transmission lines to Seattle and Tacoma, which are double, were so connected up that the current passed from the Falls to Seattle, back to the Falls, to Tacoma and then back to the Falls again, making a total distance of 153 miles. The line was found to have a resistance of 241 ohms, and the resistance of the insulation from the wire to the ground was 7,000 ohms. One of the 1,500 KW. generators furnished the current sent over this circuit, and a similar machine was used as a synchronous motor at the receiving end. It was found possible to transmit a large amount of energy in this way with a loss of approximately only 13½ per cent. Tests made on open circuit to determine the charging current showed that the latter required in the generators a capacity of 112 KW.

The commercial success of this transmission scheme is well assured, both from a technical and financial standpoint. The towns of Seattle and Tacoma are rapidly growing, and have a population of nearly 120,000. There are also many neighboring towns in which current from this system is used for manufacturing and other purposes. The Company has decided to install three additional units of 3,000 KW. each and Mr. Charles H. Baker, president of the Snoqualmie Falls Power Co., has recently applied for a franchise to distribute power in Portland, 200 miles distant from Snoqualmie Falls.

A unique and interesting plant is that of the Compañia Explotadora de Fuerza Hidro-Eléctrica de San Ildefonso, consisting of five generating stations in the mountains 12 to 30 kilometers from the City of Mexico. The five stations contain 19 water wheels which are direct connected to the same number of 225 KW., 2-phase, 50 cycle Westinghouse alternators. The current is transformed from 440 volts, 2-phase, to 22,000 volts, 3-phase. The distribution in the City of Mexico is at 2,500 volts. The five stations are scattered over a considerable area of country, two of them being on one small mountain



THREE PHASE SWITCHBOARD, COLORADO ELECTRIC POWER COMPANY, CANYON CITY, COLORADO.

This plant supplies the Cripple Creek Mining district.

stream and three on another, but, nevertheless, the 19 alternators are operated in parallel. These plants will be reinforced by a 1,500 HP. steam plant at the receiving station and by storage batteries. The cost of coal in the City of Mexico is $22 per ton and upwards.

It has often been proposed to place electric generating plants near coal mines and distribute the energy to manufacturing districts by means of high-tension electric currents, but where there are reasonably good facilities for transportation it has usually been found more economical to ship the coal. However, there is one plant at least in the United States where this is not the case. The mines in the Cripple Creek District of Colorado are located in a country which is very difficult of access, and although there is coal to be had at no great distance, it is very difficult to transport it to the mines. Also, since there are many mines and it is more economical to conduct one large power station than a number of small ones, this was considered a good field for the electrical transmission and distribution of power. Another condition was that there was a scarcity of suitable water for steam boiler purposes in the Cripple Creek district.

The Colorado Electric Power Company was formed in 1897 to furnish power to the mines in the Cripple Creek district. The power

LUMBER CHUTE, FLUME, AND TRESTLE, MT. WHITNEY POWER CO.

station is located at Cañon City near the coal fields, where it is accessible to two railways and can also be supplied with coal by a down-hill wagon haul direct from the mines, which are owned by the company. The station is equipped with Hamilton-Corliss engines direct connected to Westinghouse 3-phase generators, delivering current at 500 volts and 30 cycles. These machines are rated at 470 KW. each. Three oil-insulated, self-cooling transformers raise the current to 20,000 volts for transmission over the 25 mile line to Cripple Creek and an additional transformer is kept in reserve. The line, which is over difficult mountain country, consists of three No. 3 bare copper wires arranged in triangle on glass insulators. Thirty-foot, white cedar poles are used and the standard length of span is 225 feet. At Cripple Creek the potential is reduced to 500 volts and the current is distributed to three-phase induction motors operating hoists, pumps, etc.

The Trade Dollar Mining Company, of Silver City, Idaho, has recently put into operation a large water-power plant at Swan Falls on the Snake River from which power is transmitted to the Company's mine 27 miles distant. The power house contains three Westinghouse belt driven generators operated from a jack-shaft, which is driven by four vertical turbines. The alternators are of 300 KW. each and deliver 3-phase current at 500 volts, which is stepped up to 22,000 volts for transmission.

POWER HOUSE, CANYON CITY, COLORADO.

The Mount Whitney Power Company in Tulare

THE FLUME OF THE MT. WHITNEY POWER PLANT.

Showing the manner in which the water is carried along the mountain side to the head of the pipe line.

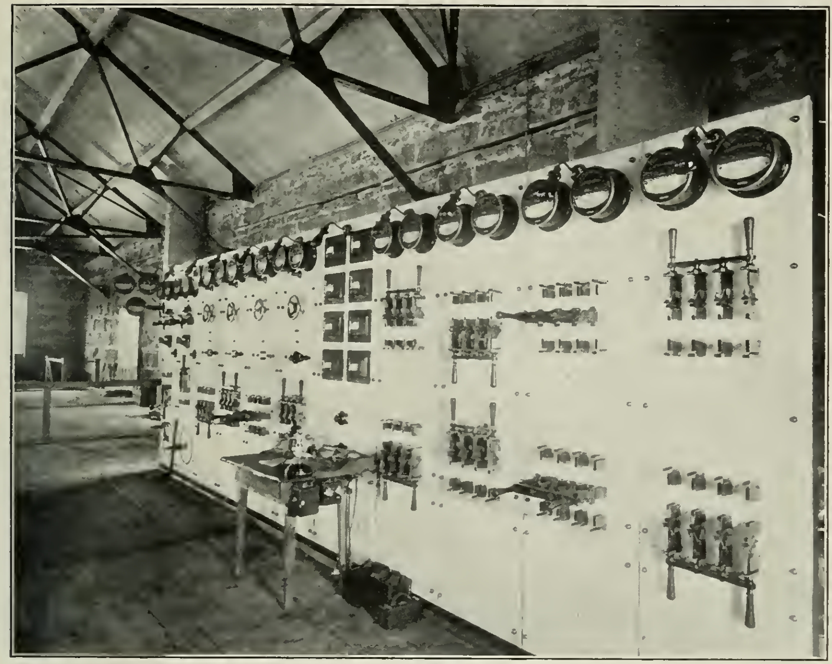
County, California, is notable as making use of the highest head of water utilized in any plant in this country or, perhaps, in the world. Water is taken from the Kaweah River by a granite dam, which can take the entire flow from the stream if necessary. The water is then conducted by a flume, provided with sand-boxes and settling basins, to a pipe line 3,300 feet in length. The latter has a total fall of 1,325 feet, and varies in diameter from 24 inches at the upper end to 19 inches near the water wheels. It is firmly anchored to the rocks and is provided with six air valves. The regulation of the wheels is accomplished by the use of deflecting hoods. There are three generating units consisting of 60 inch Pelton wheels of 700 HP. each, direct connected to as many Westinghouse generators of 450 KW. capacity. The latter run at a speed of 515 revolutions per minute and generate three-phase currents at 440 volts and 60 cycles. A cast steel fly wheel weighing 4,000 pounds is mounted on one end of the dynamo shaft, and the water wheel, which is carried by the other end of the same shaft, weighs 2,000 pounds. The voltage is raised from 440 to 17,300 volts in three oil-

THE PIPE LINE OF THE MT. WHITNEY POWER CO., CALIFORNIA.

This is a view looking down from the penstock along the pipe line to the power house.

insulated, self-cooling transformers of 500 KW. capacity each, with one spare. The transformers can be arranged in star connection to give 34,600 volts.

There are sub-stations at Visalia, Tulare, Porterville, Exeter and Lindsay, where the distribution is at 2,000 volts. A novel feature of the power distribution in this plant is the fact that interrupters are used on the lighting circuits. Current for lighting is sold to the consumer at flat rates and the interrupter causes the light to flicker when



THE ALTERNATING-CURRENT SWITCHBOARD, HELENA, MONTANA.

he has turned on more lamps than are covered by his contract. A large amount of power from this plant is used in irrigation work.

The Keswick Electric Power Company, of Shasta County, Cal., has recently constructed a power house containing three 750 KW. Westinghouse three-phase alternators, direct connected to impact water wheels. The current from these machines is raised to 20,000 volts for transmission to an ore smelting plant at Keswick and to Iron Mountain.

The Missouri River Power Company, of Helena, Montana, is now building a 70 mile, 50,000 volt line from their power house at Cañon Ferry to Butte, Montana. They are at present supplying power for electric railways and lighting at Helena over a 12,000 volt line. This company has constructed a dam 40 feet high and 500 feet long across the Missouri River, forming a lake 1½ mile wide and six miles in length, and making available a head of 32 feet. They have now in operation four 1,200 HP., 60 cycle Westinghouse generators direct connected to turbines. Six more units are being put in and the complete plant will have a capacity of 12,000 HP. The 50,000 volt transmission will be over two pole lines. The poles are spaced 50 to 100 feet apart and carry three wires arranged in a 78 inch equilateral

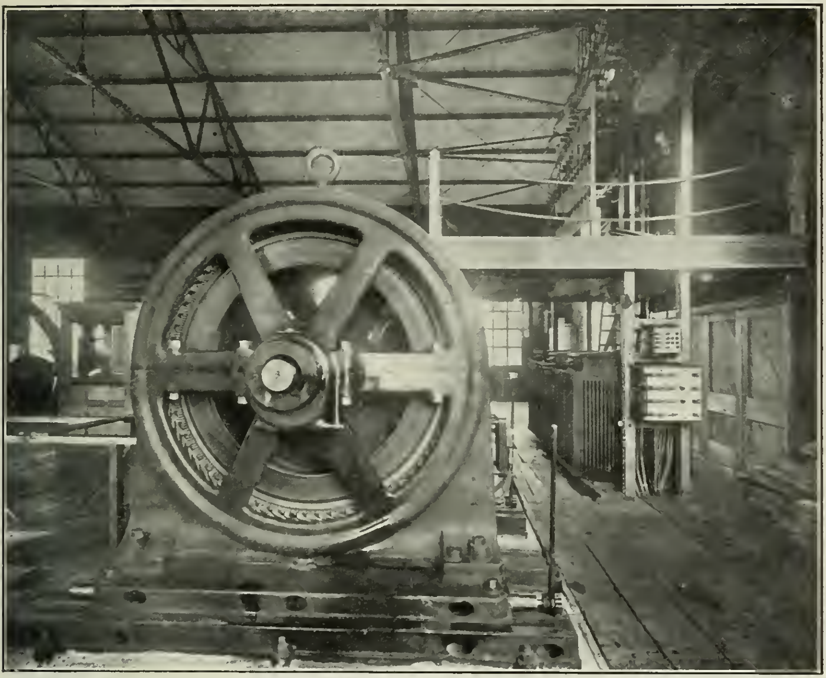
HIGH POTENTIAL TRANSFORMERS, HELENA, MONTANA..

Forming a part of the system in which a current of 50,000 volts is transformed to 2,200 volts. Missouri River Power Co.

triangle. At Butte the voltage will be reduced to 2,200 volts by six 950 KW., oil-insulated, water-cooled transformers.

The plant at Niagara transmitting to Buffalo is so well known that it is unnecessary to describe it here. It is pertinent to our present subject, however, to draw attention to the fact that the voltage at this plant has recently been increased from 11,000 to 22,000 volts, making it possible to transmit four times the energy over the same lines. Although this was intended when the plant was first installed it was thought best to gain experience with the lower voltage before adopting the higher for every day operation, the more so since the capacity of the lines was amply sufficient to transmit at the lower voltage all the power that could then be disposed of in Buffalo. However, the market for Niagara power has grown very rapidly, demanding the erection of a third transmission line and the above increase in voltage.

One of the most important uses of high-tension current at the present time is in suburban and interurban electric railway work. A notable example is furnished by the Union Traction Company, of Indiana, which operates a system of electric railways, including 153

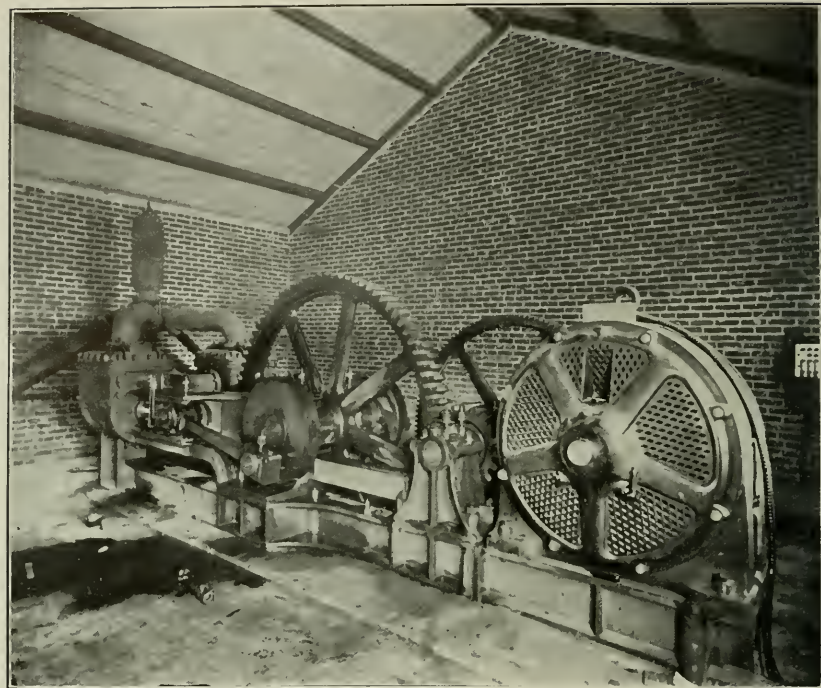


INDUCTION MOTOR, TRANSFORMERS AND HIGH POTENTIAL SWITCHBOARD, HELENA, MONTANA.

miles of track and serving 300,000 people, from one central power plant. This power plant is located at Anderson and distributes three-phase alternating current at 14,000 volts to eight sub-stations located along the railway lines running to Indianapolis, Marion and Muncie. These sub-stations are provided with transformers, rotary converters and storage batteries for furnishing direct current to the trolley lines. In addition there is a portable sub-station mounted upon a car which may be taken to any point to help out a local sub-station where the load is temporarily heavy.

Some interesting data have been obtained by the Union Traction Company, showing the cost of power at the bus-bars. In July, 1901, this amounted to $3,673.33 for 953,000 KW. hours, or $.00384 per KW.-hour. The road has been very successful and a number of extensions are contemplated.

It may be well to draw attention here to one or two general characteristics of these plants which we have omitted to mention. It will be noticed that in all cases a comparatively low number of alternations has been adopted. The reasons for this are that with a low frequency



INDUCTION MOTOR DRIVING PUMP, HELENA, MONT.

the self-induction and capacity effects of the line are correspondingly reduced; also, a low frequency is more suitable for the operation of motors and rotary converters. However, it should be remembered when designing a plant of this sort that the advantages of one frequency over another are only relative and that a small change in frequency one way or the other makes little difference; therefore, the engineer will do well to select a standard frequency, such as 25 or 60 cycles per second, in order that he may make use of the standard apparatus in the market. It will usually not be found advisable to go above 60 cycles, since that is high enough for most purposes and permits of the use of alternating-current arc-lamps. On the other hand, a frequency lower than 25 is unsuitable, since that is about the lowest at which incandescent lamps can be used without flickering.

Another characteristic of very high tension generating stations is that the current is generated at a comparatively low voltage, which is raised by the use of transformers. This is adopted in preference to generating a very high voltage directly, since high voltage generators are more costly to build than low voltage generators, are more vulnerable to lightning discharges, being directly connected to the line, and are much more dangerous to the station attendants. While it is perhaps sometimes advisable to build generators to operate at 6,000 volts, it will usually be found more economical and satisfactory to obtain the higher voltages by the use of step-up transformers.

In conclusion, we will point out the principal improvements to which is due the present perfection of high voltage practice. While no new fundamental facts have been discovered in this field in the last ten years, most of the practical and substantial advances have been made during that time. There has been a great gain in the knowledge of the general conditions to be met, together with perfection in the details of the apparatus. Perhaps the most important of the latter are improvements in insulators, better transformer design and insulation, the perfection of adequate and reliable apparatus for protection from lightning and superior generator design. Among other developments, which have contributed to the success in this field are the perfection of the induction motor, and the introduction of the rotary converter for transforming alternating to direct currents.

It is to be expected that, with the present low rates of interest and the knowledge which has now been gained in this line of work, there will be a great and wide-spread development in this branch of engineering. There are doubtless hundreds of places everywhere more or less similar to those enumerated above where high-tension electric transmission plants would be found most profitable and secure investments. As knowledge of the availability of this new agent in modern industry becomes more widely spread among capitalists and manufacturers, we shall witness the installation of transmission plants in many places where cheap water power is available.

THE POSSIBILITIES OF A NEW TRADES UNIONISM.

By Percy Longmuir.

There are always two sides to a question, and the truth is often found by the study of both. Trades Unions have their advocates and their opponents; Mr. Longmuir gives us his idea as to how both parties may find unity and harmony in a newer Trades Unionism, beneficial alike to employers and employed.—The Editors.

THE series of articles which recently appeared in the *Times* on the British Industrial Crisis have aroused much attention and have led to a fair amount of discussion. Accusations as to deliberate restriction of output, the universal adoption of the "ca' canny" policy, and hostility to labour-saving devices, have been leveled with more or less intensity against the unions. We have a series of word pictures graphically drawn of men eager and anxious to do a full day's work but restrained from so doing by the union officials. There may be truth in these statements, but it is well to remember also a further fact of daily experience, and that is that any average man, unionist or otherwise, no matter what his calling, needs a strong incentive in order to yield anything like maximum output, and the slightest relaxation of that incentive has a marked effect on the turnout. This is of course a mere truism, and in accordance with it we have the fact that any body of men engaged on work in which they have little interest and no feeling of responsibility, will shirk whatever they can, in short, adopt the "go easy" policy.

This spirit is not by any means confined to the ranks of trades unionists; even non-unionists take advantage of a foreman's absence. In passing it may be well to mention the fact that amongst non-unionists comparatively few are so from principle, the greater portion are so owing to the fact of their subscription having "run out" and as a consequence are suffering exclusion from the society. A natural result of this is that a large proportion of ne'er-do-wells, inefficient, topers, and the like swell the ranks of unorganized skilled labour. On the other hand, those non-unionists who are so from conviction form in the majority of cases a set of respectable intelligent workers, and in any consideration of non-unionists as a whole, it is well to bear in mind these two broad divisions.

The necessity of a motive or incentive for work has been mentioned and is quite as necessary in the case of an industrial worker as one whose work may be of a higher character. The tireless energy for which the British and American peoples are so justly famed can be exhibited to advantage only when those peoples realise their responsibility, or in other words when they realize the necessity for that energy being expended in any particular direction. Thus in certain times of National emergency, examples of which we have had of late both in the States and in Britain, a feeling of responsibility and an individual desire to share it has swept from end to end of the land.

"Then none was for a party,
Then all were for the State,
Then the great man helped the poor
And the poor man loved the great."

At these times of crisis the necessity for individual action is recognised and acted on collectively, and though such times may be of rare occurrence they form striking and noteworthy examples as to the capacity of a nation for simultaneous action.

The question naturally arises as to why this feeling of responsibility and the recognition of the need of individual action, of which we have occasional glimpses, can not be transferred from the national to the industrial arena, and immediately the answer suggests itself—"lack of motive." The apathy of the average worker to all progression is owing to his being unable to see the necessity for any advance, and his indifference to foreign competition is owing to the fact that the greater portion of the workers regard such competition as non-existent, or, to use a popular term, they regard it as a "bogey." Indolence never yet characterised a genuine British worker, and his present attitude of indifference and apathy towards advancing methods is the result of his environment rather than a deliberately assumed one of hostility. Some of these root causes have been already examined, and it does not require a very wide stretch of imagination to trace a relationship between this attitude of indifference and the general environment of the people adopting such attitude. If therefore this characteristic energy is to be maintained, it is evident that it must be fed and nourished in a congenial nursery and must be supplied with a motive warranting its full expenditure.

Modern industrial conditions, in which the personal element between employer and employee is necessarily absent, do not supply this motive; personal sympathy is missing and the relationship is simply one of work and pay. Therefore personal interest in the work on the part of the worker vanishes, and it becomes more or less monotonous drudgery. The two chief things looked for are the closing-down bell at night and the pay days. There is little interest manifested during the working portion of the day, and in many cases even less during leisure time, and it is this lack of vital interest that is the deadly thing of all industrial lives; herein lies the canker that is eating out the heart and sapping all initiative and enterprise. Fill these lives with interest, give them something to work for apart from pay day, and a new set of beings is created. The workers must have an interest and a stake in the work they produce; let them know something of its nature, of its quality, and of the conditions the completed work has to meet in actual practice. Not for one moment is it implied that they should be consulted as to method or conduct of work, for any given ship has only accommodation for one captain on any given voyage; but the crew of that ship know before commencing their voyage whether they be bound for Arctic or tropical seas, and make their personal preparations accordingly. So, too, let our industrial crews have an idea of their destination, and give them the chance of making preparation to carry themselves creditably through.

There are many associations at work whose object is to supply interest and give a motive to life generally. Such efforts, though incalculably good on the whole, fail to supply interest in the sense required by the workers. Any institution organised, managed, and supported by themselves is bound, by the very nature of the case, to succeed in far greater measure than any society primarily intended to benefit the workers by external means. As evidence of this there are the trades unions; and organisation amongst the workers in this direction has yielded vast results. This associated energy has been chiefly devoted to questions of wages and hours of labour.

Although these matters are very essential from a worker's point of view, there are nevertheless other matters of equal moment which might be profitably included in the scope of an association professedly formed to guard the real interests of the worker. What constitutes the real interest of the workers is naturally difficult to indicate, but any scheme should keep an eye on likely future requirements—in other words, the condition of the children, who in time to come will swell the ranks of industry, should be guarded equally with that of present-day workers. The unions are certainly well within their legitimate sphere in maintaining the living-wage doctrine; where they depart from that sphere is in the method of demanding it, in arbitrarily determining the amount of work to be done for it, and not only this, but also the manner in which the work shall be done. That paradox of high wages and low labour-cost is not understood as it should be in Britain. If the unions interfere as to methods of work they cripple present industry and at the same time ruin future industry, so taking away the bread from our own children. A union out of its sphere is a very big fish in shallow water, and when restrictions are placed on industry, they are so placed in most cases with comparatively little knowledge and less foresight. Some of this misapplied energy devoted to matters of more immediate concern to the workers would be productive of far greater good. The immense power wielded by a modern trade union is very evident. Why can not some share of this large force be directed to the workers' real benefit, in the shape of widening his interest and broadening his outlook?

Any scheme of this kind could be reduced to two essential features, namely, those of education and recreation. The education would not for one moment include anything of a routine or technical character; its chief aim would be to awaken and sustain interest pertaining to industrial lives. By giving reign to imagination we can suppose each trade union to be a kind of County Council, devising yearly courses of popular lectures, given preferably by members and followed by discussion, the feature of this course being variety of subject amply illustrated and each one treated in such a fashion as to be of direct interest to the hearers, whilst the advantage of discussion as an educative factor are apparent. Short courses of a more detailed character might be adopted to meet particular requirements, and these given by a specialist in the subject, still keeping to general rather than minute issues. The multitude of subjects which suggest themselves under this head make it impossible to give really representative ones, but any branch of economics so treated would be of immense benefit. A large field would lie in the direction of comparisons of this and other countries, particularly those countries which are our chief competitors. These comparisons would naturally branch out into the form of commercial and industrial contrasts and include examination of natural advantages. A few statistics, popularly treated by utilising the aid of suitable models and illustrative diagrams, could in a few and short lectures be made to yield a mine of information which would be of material assistance in aiding the formation of sound judgment. Scientific topics could follow, but general ones must necessarily take the first place owing to the fact that the immediate necessity lies in giving a grounding for the better estimation of cause and effect by industrial minds. The chief aim of the work taken up should be to place the worker, who has not had the advantage of early training and who has been cramped by narrowing circumstances, in a position in which he can form sounder judgments on any matter relative to his own conditions.

Such effort, so initiated by any union possessing "go" and aided by a judicious use of its disciplinary powers, would eventually crystallise into several sections of sufficient variety to meet individual or natural inclinations. One can readily imagine these ideals fructifying into sections devoted to a discussion of trade difficulties, to studies of comparative methods of work, and to discussions as to methods for maintaining the best output consistent with quality and low cost of production. The more energetic minds would naturally associate in a section devoted to new methods, to the encouragement of original ideas and the development of invention, one result of which would be the formation of a mutual protective section to assist members in obtaining patents and a just recognition of them.

The idea of a union discussing trade matters and new methods with an idea of familiarising members with them, and so paving the way for adoption in works practice, may seem visionary; but nevertheless there is no reason why such discussions should not be taken up by the men most immediately concerned. The professions have it; why not the industries? The necessity for full discussion of appropriate topics is equally as important in the latter as in the former case.

On the recreative side, this scheme would endeavour to fill with healthy vitalising interest time which, when pockets are empty, is often spent in a very aimless fashion. When pockets are not empty it is unfortunately, in many cases, spent in a worse than aimless manner.

No scheme of this nature would be put into operation without the exercise of much diligent caution and each individual member of a society would necessarily have to subject himself to more or less discipline. That this preliminary discipline could be attained there is not the slightest doubt, and if needful the end could be achieved by the collective union exercising but a small part of the power now expended on objects not always to the workers' real advantage.

The necessity of an incentive or spur to work has been already referred to and in the case of industrial workers what better incentive can they have than their own consciences—or rather, their own awakened intelligence? This arousal of dormant faculties, this reawakening to the responsibility of industry, to the keenness of other competitive nations, achieved through the aid of the workers' present organizations, would be of an extremely beneficial character to the industry of to-day and invaluable to industry of the future.

Such a training would in some slight measure patch up early lack of education; it would give an interest, a wider vision of life, and by aiding the individual to see a little further than the immediate present, assist in the formation of a juster estimate of actual life and produce a finer balance of industrial minds. Self help—not to quote Doctor Smiles—is undoubtedly the best; and such a scheme of self help as herein outlined would eventually overcome all opposition, trending to produce a spirit of reliance, a fair recognition of personal rights, and with it a due acknowledgment of the rights of others.

The effect of this spirit, judged collectively, would be found in wiser policies dominating the unions, a wider recognition of the necessities of industry, and whilst the present interests of the worker were guarded, a vigilant eye would ever be maintained as to his future requirements.

At present in far too many cases the gulf between capital and labour is regarded by the units comprising the latter half of the partnership as unbridgable—a sort of yawning chasm across which no connecting link can be thrown. This attitude may or may not be due to the capitalists themselves; but the fact remains that the majority of units comprising labour regard the units representing capital as natural enemies. In many cases when the capitalist does make an advance it is regarded by the recipients with suspicion if not absolute distrust. It is the same with new methods of organisation or management which do not appeal directly to the man's understanding, as for instance the "premium system;" they are regarded with suspicion or as a means of taking undue advantage. It has been shown that this attitude of opposition to capital or progress is not deliberately assumed, but is rather the result of crippling environment. With a wider outlook on the workers' part, this hostile attitude will gradually recede and ever increasing friendly relations be established. Capital and labour must be in amicable agreement and upon the strength and cordiality of this partnership will our successs in competitive industry depend. That there should be foreign competition is only consistent with the development of other countries, but if the two halves of our industrial partnership are in unison and hearty co-operation, competition then becomes but an incentive to fresh effort. This co-operation is not only possible, but feasible once the workers see the necessity for it; and that in turn or awaits arousal of their feeling of responsibility to themselves individually and to their industry as a whole.

What possibilities do not these thoughts open out! One direct issue is the formation of arbitration or conciliation boards equally composed of the representatives of "men" and "masters," each party having a full sense of responsibility and a just recognition of industrial necessities present and future. All differences rationally adjusted, fair and free discussion on either side, clearing away difficult points—opening the way for equitable agreement and adjustment. The strike or lockout then becomes buried in the archives of a mistaken past and though valuable as object lessons, are regarded with amazement by the disciples of the newer and awakened unionism. Evolution assisted by this combination of capital and labour, each based on a respect and knowledge of the other's requirements, moves steadily forward. Industrial and with it national progress is assured, the two essential factors moving onward in harmony.

Very briefly, then, this hypothetical attitude of the newer unionism, in addition to guarding the member's material wants as defined by a wages basis, is to take a certain moral charge and assist him to a better understanding of matters vital to his well-being—this endeavour being directed to raise the average level rather than that of the special (a genius can always take care of himself) resulting in an effectual guardianship of the workers' real interest and particularly that of the children who are to follow.

The practice of that which is ethically best we have defined in the words of Huxley:—"In the place of ruthless self assertion it demands self restrain; in the place of thrusting aside or treading down all competition, it requires that the individual shall not merely respect, but shall help his fellows; its influence is directed not so much to the survival of the fittest as to the fitting of as many as possible to survive."

Should any units of this mass show by special talent, aptitude, or inclination, a fitness to enter the lower branches of skilled industry and so work upwards, then give them every chance to do so, and not as is now the case, close every avenue of approach save one and crush every spark of ambition in men who may unfortunately have had no early chances.

And in the same spirit let the capitalist apply these words of Huxley and see that each of his workers worthy of the name ceives a wage sufficient to enable him at least to maintain self and nily in a state of physical efficiency or fitness.

EDITORIAL COMMENT

Regular readers of THE ENGINEERING MAGAZINE will recall the series of notable papers which appeared in these pages during the great strike in the British engineering industries in 1897-'98. That conflict was a very fierce one, and for many months the tide of public sympathy seemed to be with the workmen. But at length the Federation of Employers succeeded in convincing the newspaper editors and the public at large that it was not solely a question of granting an eight-hour day, or an advance in wages, but beyond that the Union insisted upon regulations which were both impracticable and unreasonable. The real issues in the contest were thus concisely stated by Sir Hiram Maxim, writing in these pages in November, 1897. Said he:

"The unionist, as a rule, is not a thinking man. It appears to his clouded intellect that there is a certain amount of work to be done, anyway, and that this quantity is fixed. Consequently, he looks upon work as something that ought to be nursed and made to go as far as possible. It appears to him that the more he gets per hour and the greater number of hours he can be employed upon a job, the greater the yield to his society. It never occurs to him for a moment that, if this were carried to extremes in either direction, the whole thing would be changed. For instance, if the cost of mechanical work should be increased twenty-five per cent. in England, the greater part of it would be driven into foreign countries; whereas, if it could be produced in England for twenty-five per cent. less than in other countries, there would be more than enough work for everyone who could be employed in England.

"Anything which serves to curtail or limit the output is not only detrimental to the country, but to the workman himself; and any society which encourages its members to nurse his job and make it last—that is, to dawdle, and to do it very slowly—not only does much to discourage the development of skillful mechanics, but also does great damage to the trade of his country."

It was the obvious truth embodied in this last paragraph which won a complete victory for the employers,—which defeated the workmen at every point. The very moment people were brought to see that the unions were driving trade out of the country by insisting upon regulations which were unreasonable, that moment public sympathy turned squarely to the employers.

It was a costly campaign, but in educational experience it was priceless in value, for it taught British employers that the true and sure way to gain public sympathy and effectively regulate the unions is to employ the cold logic of facts—to reason with the men rather than attempting to tyrannize over them; and, especially, to make public in temperate language the known conditions of world-wide competition.

* * *

Precisely similar methods were employed a year ago by American manufacturers, and again with notable success. Confronted by unreasonable and impracticable demands on the part of the union leaders, the employers united in self-defense, made public all the facts concerning each point at issue, and at once common sense and public sympathy were lined-up in defense of two essential principles of industrial liberty, namely: (1) that the proprietor must be free to manage his own business—precisely as the employee must be free to leave at will; and (2) that trade-union regulations which limit a workman's output or prohibit the use of improved methods and machinery, are indefensible and unjust, because they increase the cost of manufacture and drive work out of the country.

These valuable lessons so lately learned have put us well along the highway which leads to industrial peace. For obviously trades union leaders can not long withstand the cold logic of facts and known experience; and obviously, too, both the facts and the proper methods for using them are now within easy reach through the admirable organizations of employers which have been formed.

But if we are in a fair way to escape from the fallacy of "restricted production" through trades union regulations, we are still held firmly in the grip of that twin fallacy and folly—a belief in "over-production."

Over-production is assumed as a matter of course—because it is always talked about, especially in the newspapers; and everybody sees that manufacturers in all lines are constantly forming pools, combinations, and "trusts," the purpose of which is to restrict production and hold-up prices.

But the truth is that over-production is an absurdity. It never has occurred—never can occur! And the mere fact that so many manufacturers believe in the false theory, and act upon that belief, is precisely what makes the fallacy so mischievous and so damaging. Mr. G. H. Hull made all this perfectly clear in his admirable paper contributed to our last number,* and we again refer to it editorially because of the importance of a correct understanding of the subject. That article is, in fact, one which should be carefully read by every thinking man who is concerned with the production of raw materials and the great staples of manufacturing industry; and as evidence of the force of Mr. Hull's argument we submit the following brief extract :

Only a few years ago there were seasons when the receipts of fruit in all large cities were sometimes so great within a few days, that the fruit scarcely brought the amount of the freight. Very often large quantities went to decay for lack of demand. This in turn discouraged shipments, and then would succeed a season of great scarcity. It took experience and many years of loss to rectify this condition, but finally it was accomplished by the establishment of fruit exchanges and cold-storage warehouses, where fruits can be preserved in a perfect condition for months. The result is that prices of all such products are now more stable, the public is more regularly supplied, at all seasons, consumption has been enormously increased, and the profits of both producers and dealers are more uniform and remunerative. It was *Temporary surplus production* of fruit, before it was brought under intelligent control, which caused irregularity in the supply.

In our ignorance we called it over-production.

It was not over-production.

It was *temporary surplus production.*

By creating the modern systems of transportation, and by inaugurating the present system of cold storage, two long strides have been taken. Neither of these advances would have been possible but for the existence of one of nature's greatest gifts to man, *temporary surplus production.* Yet another long stride forward will be taken when the producers of staple commodities like coal, iron, steel, tin, copper, lead, and rubber, clearly understand that THE PRESENT SYSTEMS OF STORING THESE PRODUCTS ARE WHOLLY INADEQUATE.

Is it not good business to gather surplus products when they are plenty and cheap and hold them until they are scarce and high? Have any ten years passed in the recollection of men now living, in which the people of the foremost manufacturing nations have not suffered for the want of an adequate supply of some of the great staples—coal, iron, steel, tin, copper, rubber—which might have been stored up in times of dull trade? Has any one ever heard of useful manufactured products being destroyed for want of a market? Have they not all been consumed in time? Is not this proof that each one of the over-production claims put forth during the last two and a half centuries has been rank nonsense?

As man masters the art of dealing intelligently with the temporary surplus production of each article, we hear no more of over-production in connection with that article.

And the deduction from this reasoning gives us Mr. Carnegie's simple and notably successful rule of manufacturing upon the largest possible scale, and selling at a price so low that it is certain to capture orders; in other words, stimulate demand through low prices !

* The Mischievous Fallacy of Overproduction, THE ENGINEERING MAGAZINE, March, 1902.

Engineers in the British Navy.

We reviewed, a few months ago, in these columns, that portion of the report of the Engineer-in-Chief of the United States Navy which referred to the non-success of the personnel bill and to the importance of taking decisive action as to the proper manning of the engineering department. The United States Navy is not the only one which is defective, to use a mild term, in this respect. In a recent paper, presented before the North East Coast Institution of Engineers and Shipbuilders by Mr. D. B. Morison, we have a report on the memorandum submitted to the First Lord of the Admiralty with reference to the present unsatisfactory condition of the engineer branch of H. M. Navy, and this, together with a previous paper upon the same subject by Mr. Morison forms interesting if not very satisfactory reading.

The present condition of the engineer branch of the navy is certainly most unsatisfactory, not only to the engineers themselves, but to all who have the welfare and even the safety of the empire at heart, both within the navy and without. This was clearly shown by the reception which was given by the "ruler of the king's navee" to an important deputation of members of Parliament and representatives of engineering institutions who attempted to present the facts of the situation to those who have the authority and power to correct the existing evils.

The whole state of the case may easily be laid before the general reader. The executive branch of the navy consists of the official descendants of the officers of the old days of Britain's naval glory, before the days of steamships, auxiliary machinery, electricity, water-tube boilers and other mechanical contrivances. These gentlemen, being of a conservative turn of mind, are unwilling to admit that there has been any real change or advance in the *matériel* of naval warfare, and regard the idea of the engineers, by whom these new fangled mechanical devices are handled, that they should have any executive authority, as utterly preposterous. Since the admiralty is equipped with executive officers only, no engineers being given place thereon, it has been found practically impossible to give the engineer branch any real command over the work which they alone are qualified to handle.

It sounds like a situation from a comic opera, and if it were not so serious it might become altogether laughable. It is far too serious, however, to excite any feelings but those of dire apprehension among those who are really qualified to judge. The widespread imperial position of Britain is too vulnerable, and the dependence of her people for existence upon sea-borne food stuffs is too great to render these questions anything but most important to every thinking citizen. Especially is it important that this subject should be agitated and discussed now, while there is time to train men for the work, to rid the service of incompetent or unsuitable men, to place the navy in fit condition to be what it should be, the mainstay of the existence of the British Empire.

Let every thinking Englishman recall the dark and gloomy forebodings with which every heart was filled during the reverses in the early days of the war in the Transvaal. Then let him think again and compare the state of the British army for that task with the present state of the British navy for a contest with any other first-class power. He can obtain the facts for this consideration fully and faithfully presented in Mr. Morison's paper, and he can find there also the apathy and indifference with which the danger call was received by those in high authority by whom in truth the danger should first have been perceived.

Far more important is the state of the navy personnel than was, or is, the condition of the army. The loss of the Transvaal would indeed have been a disaster, but how incomparably greater would be the disasters following the successive breakdown of vessel after vessel in time of war, not with a minor South African State, but with a European power; breakdowns due not to the superiority or capacity of the enemy, but to the undermanning of ships, to the incompetency of those placed in unexpected charge of machinery, to the fatuous condition of unpreparedness, of jealousy, of discouragement existing to-day.

The engineers of Britain are second to none in the entire world. The development of the modern fighting machines upon which the existence of the empire depends, is due to the ability and genius of British engineers. The whole defense of the land could safely be placed in the hands of British engineers, controlling and operating British warships, but the control should not be delayed too long or it may be too late. It is only a question as to which nation will take the first step in the realisation of the transformation in naval warfare which is already upon us. We may be able to imagine in some small degree the indignation of the feudal knight who after a life of training for warfare according to the methods of his fathers found that the introduction of "villainous saltpetre" had made the veriest peasant his superior. The transformation in warfare wrought by the introduction of firearms is small, however, compared to that which is impending in the introduction of fighting by engineers and engineering methods alone. Conservatism will not serve in the warfare which is practically here already. It is the nation which keeps itself constantly in the forefront with the latest mechanisms, the most skilful engineers, the most modern workshops, the most complete and fully organized methods, which will sweep aside in its irresistible advance the whole flock of conservative martinets who are incapable of seeing or thinking except with the methods of a past which is none the less useless because it is but yesterday.

The Overcrowding of Cities.

A THOUGHTFUL paper upon the vital subject of municipal overcrowding was recently read before the Society of Arts by Mr. W. L. Madgen, and some of his suggestions are so eminently sensible that they may well be reviewed and emphasised.

Confining his remarks to London, Mr. Madgen well says that one of the first things to strike the visitor to the metropolis is the apparently hopeless entanglement and obstruction of traffic. The great city is so congested at certain localities and at certain hours that progress is only intermittently possible, and then with great waste of time, energy and temper.

It is apparent upon inspection of the problem that there are present two elements to be considered; one being the best method of providing for the requirements of the present and the immediate future, while the other is control of the growth which is progressing yearly at an accelerating rate. It is this second feature, the rate of growth, to which Mr. Madgen especially devotes himself, and with reason. It is to small benefit that improved methods of transit are furnished, more and cheaper houses built, increased water supply provided, if the influx in population continues to exceed the capacity of such improvements. The remedy therefore, may be found in the operation of prevention, at least partially.

Workmen, receiving but moderate wages, must live near their places of employment, and if those places of employment are in the metropolis, there the workmen must be crowded, often in unsanitary quarters, and rarely, if ever, with such comfort as might be obtained elsewhere. For many industries, however, London is by no means an ideal situation. The causes of its growth are two: its advantages as a seaport; and, the fact that it is the seat of government and the court residence. Neither of these facts need render it a desirable place for manufacturing purposes.

"It is fairly certain that no manufacturer about to commence business at the present day, would fix upon London as a suitable position. He would choose rather a district in which land was cheap, and in which he could obtain cheap power for his machinery and transport for his goods. He should not in future be limited to the colliery districts, or to the main lines of railway. Light railways, serving as feeders to the main lines, and the supply of electrical energy over large areas from main power stations, could provide for both these requirements, giving the manufacturer ample assurance that his works could be run cheaply, and that the raw material and manufactured products could be efficiently handled. By such means, electrical science is capable of opening up thousands of square miles in England for manufacturing purposes, the native population of which has been languishing under the chronic complaint of agricultural depression."

The remedy, then, for the overcrowding of the metropolis is to render it more desirable for manufacturing industries to establish themselves in smaller towns, scattered over the kingdom, and this can be done by providing cheap power and cheap and convenient transport. This transport would not only enable the merchandise to be handled to advantage, but would also make life sufficiently attractive, by providing access to neighboring cities, to overcome the desire of many to escape from the dullness of the small town by crowding to the metropolis. When, however, the engineer has planned a system of power generation and transmission, and a scheme for interurban transport, all perfectly feasible and successful from an engineering standpoint, he finds that obstacles wholly of a political nature prevent their execution. Boundaries, fixed ages ago, for the purpose of local administration, under conditions altogether different from those which now obtain, are permitted to interfere with the development of plans of the greatest public importance.

"When personal enterprise seeks to further the modern system of electric power distribution, or light railway construction, it widens its plans to include groups of towns, so that the population of the whole district gets the benefit of a comprehensive scheme, contrived in such a manner as to effect the utmost economy and utility. Yet such schemes, manifestly of national importance, which bear an intimate relation to this overcrowding question which we are discussing, almost invariably meet with bitter and strenuous opposition from the aldermen and councillors of the several towns, who demand that the large area which has attracted the attention of the advanced electrical engineer shall be parcelled out into a number of small local monopolies worked on antiquated lines. Each town must have its own toy generating station, and its own little train-line shuttling from one street corner to another, and an enterprise which has projected a network of light railways connecting, perhaps, half a score of towns, and a comprehensive scheme of cheap power supply, is obstructed on the ground that the boundaries, which were fixed simply with reference to the maintenance of order and the control of public health, are equally well fitted for traction and power schemes.

If these restriction can be removed, the question of the overcrowding of the great cities may be solved, not by making them more attractive to newcomers by providing increased facilities, but by rendering a great number of small towns more suitable for manufactures and trade, thus drawing away from the great cities much of the population with which they are now congested.

Mr. Madgen discusses this idea at length, and formulates the conditions under which, in his opinion, the task of adapting the small town to the requirements of industrial sites, and consequent increase of population. The whole question appears to be the apparently simple one of permitting the engineer to do his rightful share of work in benefitting the community and by relieving him of the shackles of obsolete limitations.

The Development of the Gas Engine.

When Mr. Dugald Clerk has anything to say about the gas engine, there is certain to be interested attention; since his large experience, especially with the early history of internal combustion motors, renders him especially well qualified to speak. For this reason his recent paper before the Institution of Engineers and Shipbuilders in Scotland, published in the *Transactions* of the Institution demands attention and comment.

Before discussing the detailed construction and operation of the gas engine, Mr. Clerk describes very clearly the true nature of the explosion as it occurs in such engines, showing its difference from the explosion produced by gunpowder, cordite, or other solid explosives. In a gunpowder or cordite explosion a chemical change is effected, whereby a solid or semi-solid substance evolves large volumes of gases; that is, the solid substance, after chemical decomposition, produces gases which, when cooled, are hundreds of times the volume of the original solid powder. In addition to this evolution of gas, great heat is produced by the chemical action, and so very high pressures are obtained. The substances as producing pressures within a gun are quite unsuitable for obtaining controllable motive power, and, although attempts have been made to actuate engines by gunpowder and gun cotton, yet all such attempts have been failures. A gaseous explosion is a much more controllable phenomenon than a powder explosion. In gaseous explosions the action is much simpler. There is no change of state during the reaction from solid to gas; on the contrary, in all ordinary gaseous explosions the volume of the gases formed by combustion, reduced to standard temperature and pressure, is less than their original volume before combustion. In the gaseous explosion the increase of pressure is due wholly to the increase of temperature of the gases entering into the chemical action.

In order to obtain experimental data concerning the explosions of mixtures of air and gas in closed cylinders Mr. Clerk used an apparatus consisting essentially of a cylindrical vessel, upon which was placed an indicator, differing from a steam engine indicator in that the reciprocating drum was replaced by a revolving one, the rate of revolution being regulated by a revolving fan, connected to the gear train and weight by which the rotation was produced. By starting the drum in revolution, and causing an explosion to take place in the cylinder, a diagram was produced showing the pressure at every instant of time for the especial gas mixture under test A study of numerous diagrams produced by this apparatus showed in no case higher pressures than about 100 pounds per square inch. The nature of the curves also showed that a gaseous explosion is a strictly controllable phenomenon, quite unlike the explosion of gunpowder or gun cotton.

After describing the early, non-compression engines, Mr. Clerk refers to the statement by Mr. Beau de Rochas, in 1862, of the true operative cycle of the modern gas engine, followed by its practical application at the hands of Dr. N. A. Otto. As an indication of the success of this principle it is stated that there is not less than half a million horse power at work in Great Britain and probably 300,000 horse power on the Continent. Including American engines, and the large engines recently built for use with furnace gas, the gas power of the world at present is at least a million horse power.

The earlier engines employed the flame ignition, using a slide valve with opening for the communication of the flame with the interior of the cylinder, together with a relighting flame, the whole being only partially satisfactory. The degree of compression was also moderate, usually about 30 pounds above atmospheric pressure.

It was soon realized that higher degrees of compression would conduce to greater economy, but it was necessary to devise some more satisfactory method of ignition before the pressure of compression could be increased. This requirement was met in two ways, first by the introduction of the "hot tube" ignition in England by Watson, and in Germany by Daimler, and then by a return to the use of the electric spark, which latter had been employed in the old non-compression engines of Hugon and of Lenoir. With these modifications came a diminution of the relative volume of the compression space and a consequent increase of the compression, engines of the Otto type now using a compression of 90 to 120 pounds per square inch above the atmosphere. The proportions of the valves and ports have also been modified so as to minimize the throttling of the charge during the inlet period and the back pressure of the exhaust gases during the discharge. These various improvements have raised the thermal efficiency from 16 per cent. in 1882 to 25 per cent. in 1894, and some recent tests of large engines have shown an efficiency of 30 per cent.

When liquid hydrocarbons are used instead of gas, the principal modifications required are those involved in the conversion of the fuel from the liquid to the gaseous state. In the earlier forms of oil engines, and in those used in motor cars, very light inflammable oils of the gasoline or petrol kind are consumed. Here the problem of vapourizing the oil is comparatively simple. It is only necessary to draw air over a surface saturated with one of these light oils, or throw a jet of light oil into an air current, to produce a mixture of inflammable vapour and air which, when taken into the cylinder, readily supplies the place of coal gas, and gives explosions under compression closely resembling those obtained with coal gas.

Light petrol is too dangerous for use in large quantities within buildings in towns, or even in the country, and, accordingly, heavy oil engines have been produced, and are sold in considerable numbers. Heavy oils are those which have a flashing point above the Parliamentary standard of 73 degrees Fah. Such engines may be divided into three distinct classes:—

(1.) Engines in which the oil is subjected to a spraying operation before vapourization;

(2.) Engines in which the oil is injected into the cylinder, and vapourized within the cylinder; and

(3.) Engines in which the oil is vapourized in a device external to the cylinder, and introduced into the cylinder, in a state of vapour.

Mr. Clerk is a full believer in the future of the internal combustion engine, including both gas and oil engines.

So far as economy of heat is concerned, both have considerably surpassed the best steam engines: but much remains to be done before they equal the steam engine in frequency of impulses, lightness of machinery, and absolute steadiness of governing; in power of control, for instance, where reversal is required. As yet, the application of gas and oil to any but fixed engines, has been very limited; but ultimately, I have no doubt, gas and oil engines will be used with great advantage for propelling ships, and for driving locomotives.

Referring to the lines along which future developments may be expected, Mr. Clerk inclines to the belief that it will be in the direction of a combustion rather than an explosion motor. Says he:

"In 1887, I had an experimental combustion engine of my design running in Birmingham, giving about 7 H. P., at 150 revolutions, with great smoothness; and since that time I have continued experimenting in that line. Other inventors have also experimented in the combustion engine line, including Herr Diesel; and there is good hope for believing that in time a constant pressure gas engine will be produced which can be as easily handled for marine purposes as a steam engine. At present, of courase, there is no possibility of reversing or cutting off power impulse in the way done in steam engines. Apart, however, from the engine, further work requires to be done in connection with gas producers before marine gas engines become commercially feasible. Both in Germany and this country several inventors are at work upon gas producers intended to use ordinary steam coal, which would produce gas on board ship, without gas-holders, and supply the gas direct to marine or other engines. One great point is to get rid of the present gas-holder. Several inventors have made this attempt. Perhaps the first engine of this kind to be run in public was that of Mr. Benier; but recently I inspected at the little suburb of Heusy, near Verviers, a gas plant supplying two 80-horse Otto cycle engines, in which no gas-holder was employed.

"In my view the gas engine affords to the engineer and inventor an enormous field of work, likely to result in a very considerable revolution, certainly in land engine work as well as marine work. A gas engine with an efficient gas producer would easily give 1 I. H. P. on half-a-pound of coal per hour, as against 1¼ to 1½ lbs. for the best steam engine now in use; that is, power for marine propulsion could be obtained at less than half the present cost.

"Many engineers are now at work on the subject, and when the problem is further solved, it will aid much in meeting the fuel difficulty, which must face this country at a comparatively early date. My view is that the nineteenth century was the century of the steam engine; and that the twentieth century will be the century of the gas engine. Steam will ultimately be displaced almost entirely by gas engines."

The Uganda Railway.

A DESCRIPTION of the route and construction works of the Uganda railway was given in the July, 1901, issue of THE ENGINEERING MAGAZINE by Mr. F. W. Emett. and now we have the very interesting account of Commander B. Whitehouse, R. N. before the Society of Arts, describing a journey from Mombasa, on the Indian Ocean to the shores of the Victoria Nyanza over the railway. A most interesting feature of the occasion of the reading of the paper was that the chair was occupied by Sir Henry M. Stanley, who, nearly thirty years ago traversed this region against all the obstacles which have now been permanently overcome.

Work was begun on the railway in December, 1895, and the first locomotive reached the shores of the lake in December, 1901, and in these six years the journey from the sea to the great lake has been cut down from a dangerous expedition of eight months' duration to a speedy and comfortable trip of two-and-a-half days.

The difficulties of the work can only be hinted at here. The route climbs to a height of 7,900 feet at mile 355 at the Kikuyu escarpment, then descends to 6,000 feet at lake Ementeita, again ascending to 8, 320 feet at mile 490 on the Mau ranges, descending to the lake at a level of 3,726 feet above the sea at mile 582 over a route for most of the last 100 miles that previous to September, 1898, no European had ever trodden.

"Never before has a railway been built under such extraordinary conditions or caused such radical changes in the country through which it has passed. Till other railways are constructed the whole of the trade of that part of Central Africa must come to it. The way the country has been opened up by it is very marked; rupees are in constant use where previously only beads, cloth, and wire were asked for. The journey from Mombasa to Port Florence, on the opening of the whole line, will take two and a half days, and another day can be allowed for the steamer journey of 148 miles to Mengo, the capital of Uganda—three-and-a-half days instead of about seventy by the old caravan route All the privations, delays, and trouble of the caravan road are things of the past, and travelers now pass through the country in a first-class sleeping carriage at a charge of three pence per mile, with rates for their goods that compare most favourably with some of the other railways in Africa. Cable messages can be sent from any station on the railway, and a telegraph line has been laid into Uganda from Port Florence."

In addition to the actual work necessary for the construction of the railway, the whole of the coast line of the British half of the Victoria Nyanza, with all the islands that are known to exist in it, has been surveyed, under the superintendence of the chief engineer of the railway; the early and incorrect information concerning the coast being thus reversed.

The result of all this work can now clearly be foreseen. The slave trade is practically abolished, the whole magnificent country, with its possibilities of rubber, tobacco, coffee, and other tropical products, is thrown open to the commerce of Europe and Asia, while the great lake may now be equipped with steamboats, and rendered a most important means of communication between all points on its shores.

The whole work shows once more the tremendous power which the engineer plays in the exploitation of the world. Savagery and barbarism recede before the advance of the locomotive, where the progress of military forces would be most stubbornly opposed. In the case of Africa there is little doubt that the land can be opened up far better by the construction of railways from various points on the coast into the interior than by one great longitudinal railway, such as has been discussed from the Cape to Cairo. Africa has the sea on either side, the best and readiest highway for communication and transport, no railway is needed for that service. It is the interior which should be penetrated by many railways, each reaching to its seaport and enabling the heart of the continent to be dark no longer, but brought into enlightening communication with the sea which connects all parts of the world with each other.

The Imperial Cable.

With the construction of the British Pacific cable, there is undertaken not only the largest piece of submarine cable work yet attempted, but there is also inaugurated a new departure in politics. These features are both emphatically brought out in an article upon the Imperial cable, in a recent issue of *The Engineer,* from which we make some abstracts.

The political idea lies in the fact that it involves cable communication across the Pacific, made for strategic as well as commercial purposes, and owned by the state, or rather states, concerned—that is to say, Britain, Canada, New Zealand and Australia. Through the existing Atlantic cables landing on Canadian soil, such as those of the Anglo-American Telegraph Company and the Commercial Cable Company, it will connect the mother country with Canada, Fiji, and other South Sea islands, Australia, and New Zealand. All the stations will be under the British flag, and independent of any foreign control.

The original idea of Sir Sandford Fleming was to lay a cable by the northern, or great circle route by way of the Aleutian and Kurile Islands to Japan, this being not only the shortest route, but also the most feasible because of its subdivision into several short lengths. The great advantages of this route are well known, and have been fully set forth in the exhaustive paper of Mr. Harrington Emerson, in The Engineering Magazine for November, 1899, but evidently this route does not comply with the requirement that all the stations should be under the British flag. The selected route, therefore, is from Vancouver to Fanning Island, Fiji, and Norfolk Island, with branches from there to Australia and New Zealand.

The great question concerning the cable is that of profit and loss. It is estimated that the cost for making and laying will be about £1,500,000, and that £150,000 a year will be required for maintenance and operation, as well as interest and a sinking fund for redemption after fifty years. The earning power of such a cable depends largely upon the speed at which it can be worked, and this again depends on the length and the section of the core. These questions are discussed at length in the paper, and while no definite dimensions are given, it was recommended by the committee that something between the suggestion of Lord Kelvin of 552 pounds of copper and 368 pounds of gutta percha per nautical mile, and the Anglo-American Company's cable of 650 pounds of copper and 400 pounds of gutta percha should be used. Such a cable would have a speed of about seven or eight paying words per minute, and it is expected that in a few years the business would become profitable, even at a reduced rate of 2s. a word.

Unusual secrecy is preserved regarding this National and Imperial cable, but it is understood that the Vancouver-Fanning section, the most novel and interesting from an engineering point of view, is very similar to the Anglo-American cable of 1894. Every drum of the core is submitted to a hydraulic pressure equal to that of the sea bottom, and severely tested with powerful alternating currents, to break down latent flaws or faults. The core is defended from the teredo by brass tape, and sheathed with steel wire of great strength. The southern sections are to be laid during the present year, and the whole is to be completed by the end of the year.

It is a question whether the advantages of an all-British cable are likely to be realised. The mere possession of the landing territory adds but little to the safety of the cable in time of war, and indeed it is stated that it "may be necessary to fortify the stations and patrol the line with fast police cruisers," so that the mere possession of the landings is admitted to be insufficient to protect and maintain communication.

As a matter of fact, a cable landing in the territory of several nations and owned jointly by several governments, appears to be less liable to interruption than one under a single ownership, and if this is admitted there is no good reason for abandoning the otherwise superior northern great-circle route. Government despatches can always maintain their secrecy by use of special codes, and no inconvenience is experienced in this respect on the existing Atlantic cables, while the greater speed and lower cost of the shorter lengths of the northern route appear to outweigh the sentimental points which have been advanced for the all-British line. It is quite certain that, should both be constructed, the cheaper route would be able to control the commercial business, so that the Imperial route would practically become a private government line, and would have to look to the government for its maintenance. Such a duplication of cables is not to be expected immediately, but if the precedent of the Atlantic is to be taken as a guide there will doubtless be more than one cable across the Pacific in the not distant future, and in such case the operation of competition can only be prevented by the institution of some form of monopoly.

Electric Shock.

At a recent meeting of the Institution of Electrical Engineers, three papers were read on the general topic of "Electric Shock," in which various aspects of the subject were discussed.

Major-General C. E. Webber's paper gave, first, a general account of the physiological action of electric shock, with the views of many experimenters, and then went on to review British legislation on protection against electrical accidents, and, particularly, "the events which led up to the inclusion of electrical generating and transforming stations in factory legislation."

Mr. A. P. Trotter occupied himself entirely with "Electric Shocks at Five Hundred Volts," the pressure which is most usual in electric traction, and which therefore has a special interest. He divided his subject into three parts: (1) The physiological and electrical conditions; (2) the dangers connected with trolley wires; (3) the dangers of third rails of electric railways.

"The physiological sensation does not depend directly on the actual current, but on the current density. With four or five square inches of contact between dry metal and bare skin, (for example, grasping a trolley wire), a steady continuous current of 1 or 2 milliampères is hardly perceptible, from 3 to 8 easily supportable, above 10 is painful and above 35 almost unendurable. More than about 14 milliampères of steady continuous current at the finger tip, making a poor contact of about one-sixth of a square inch, is unendurable, but 35 milliampères from boot to boot, nearly the whole of the soles of the feet being in contact, is much less painful.

"The dangers of electric shocks at 500 volts have been much misunderstood, greatly exaggerated and little investigated. The pressure of 500 volts has been deliberately chosen by electrical engineers because it is not dangerous under ordinary conditions."

The conclusions to be drawn from the many experiences cited by the author are that with *dry* shoes and clothes there is slight probability of receiving a dangerous shock from accidental contact with trolley wires or third rails carrying a current at a pressure of 500 volts, but with wet clothing and in wet weather there is danger of getting at least a very disagreeable shock, and in a few cases, prolonged contact with conductors at 500 volts has caused death.

Mr. F. B. Aspinall discusses a number of points, his questions and the gist of his conclusions being as follows: 1. Is every one equally susceptible to an electric shock? Not only are different people differently affected, but the same person under different conditions does not experience the same sensations.

2. Is a person suffering from disease more likely to be fatally injured by an electric shock than a person in good health? This will depend upon the disease.

3. Does the physiological condition one is in at the time a shock is received make any difference? A man when drunk is less likely to be fatally injured, and a person when asleep is peculiarly unsusceptible to shock so that condition appears to have a decided influence.

4. Does the path which the current takes through the body have any effect as regards the shock proving fatal? The path has a great effect, the left side being the more vulnerable.

5. Does the question of contact made, and whether burning takes place or not, have any effect upon a person's chance of being killed? The question of more or less good and large contact is the most important of all, and largely determines the result of a shock. When there is severe burning, there is less probability of a fatal termination.

6. Can a person receive a fatal shock without giving the "cry," and also can he speak after receiving a fatal shock? Yes, to both questions.

7. Is an alternating or a direct current shock more likely to prove fatal? The danger from shock is the same with both, but more burning takes place with direct current.

8. Cannot the doctors give us a more certain method of ascertaining whether a man is dead or not? The present methods are unsatisfactory.

9. Cannot something more be done to help those who receive a shock? Artificial respiration should always be induced, but first the body should be held for a few seconds head downwards at an angle of 45 degrees, thus flushing the brain and stimulating its action, which is the treatment used for collapse from chloroform.

Superheated Steam for Locomotives.

ALTHOUGH the advantages due to the use of superheated steam have been known for a long time, there has been little attempt to introduce superheaters in locomotive engines, probably because of the dislike to the addition of further complications. At the present time, however, when every attempt possible is being made to increase the capacity of locomotives without overstepping the limitations of the loading gauge, superheating for locomotives is being seriously considered.

In a paper presented recently before the Verein deutscher Ingenieure, and published in the *Zeitschrift* of the society, Herr Garbe discusses the Schmidt superheating device for locomotives, and shows how the economy in fuel, or the increased capacity for the same fuel consumption due to superheating may be obtained.

The Schmidt apparatus for superheating is ingenious, and readily understood. Instead of filling the barrel of the boiler below the water-line entirely with small tubes, there is placed in the lowermost portion a flue about 12 inches in diameter, running from the fire box straight through to the smoke box. In the smoke box is placed the superheater, this being composed of small bent tubes, forming a nest below, just where the hot gases from the above-mentioned flue are delivered, and curving up around both sides of the smoke box to the steam-pipe connections above. This portion of the smoke box is separated from the central part, into which the small tubes discharge their smoke and gases, but both portions discharge into the chimney above. Suitable dampers serve to control the amount of draft through the large flue, so that no heat is wasted, the amount passing through being regulated according to the temperature of the chimney gases.

By this construction it is possible to superheat the steam much higher than would be the case if only the waste gases were used, while at the same time no heat is lost, since the flue itself furnishes valuable steam generating surface in the boiler, and also a proper adjustment of the dampers prevents an excessively high temperature in the chimney. In order to obtain the best results the steam should be heated to at least 300° C., or, for pressures of 10 to 12 atmospheres, to a temperature of about 100° C. above that of saturated steam. Two important results are obtained by this degree of superheating: the steam is increased in volume about 25 per cent., and the wasteful drop in pressure at the point of admission into the cylinder is obviated, when the link motion is set so as to give the best point of cut-off.

It is unnecessary to rehearse here the often-repeated advantages of superheating, since it is now generally admitted to be the most effective remedy for the losses due to cylinder condensation. In stationary practice a fuel economy of 20 to 25 per cent. has been obtained by the use of superheated steam in properly designed engines, and if it is to be employed with success in locomotives, the experience obtained in stationary practice may be recalled to advantage. The cylinders should be proportionately larger for the same power development, and every precaution should be taken to avoid trouble from unequal expansion, due to the higher temperatures of working. In the engines described by Herr Garbe, piston valves are employed, and these may be all right, if suitable packing is used.

The American design of casting the cylinder in one piece with the whole arrangement of steam passages, etc., forming half of the front saddle for the boiler, would be almost certain to cause very unequal strains upon the working parts, due to warping. The piston packing, and stuffing boxes would have to be fitted altogether with metallic rings, and all the precautions involved in high temperatures and consequent lubricating difficulties should be taken. Doubtless all these points can be provided for, and with intelligent design, all trouble avoided.

An increase of 20 to 25 per cent. in the capacity of the locomotive boiler would be most welcome, since pressures and speeds have been well worked in the effort to increase the capacity without increasing dimensions. The locomotive of the future will doubtless be both compound and superheating, the latter rendering higher expansion ratios possible, without corresponding losses by cylinder condensation.

The Berlin Electric Elevated and Underground Railway.

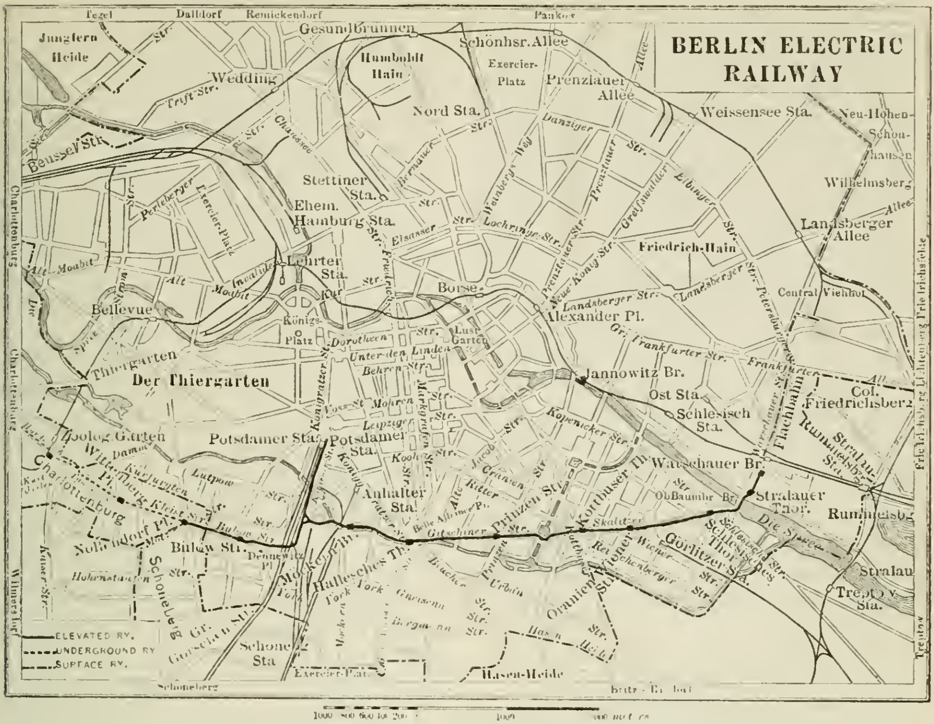
The growth of Berlin in the last quarter-century has been little short of marvellous, rivalling that of the most progressive American cities, and with the increase in population there has been an even greater development in the intraurban movement on the existing "Ringbahn," street railways and omnibuses. During the years from 1895 to 1899, for instance, while the number of inhabitants increased 13.4 per cent., the city passenger traffic increased 52 per cent., or nearly four times as much. This growth has naturally been accompanied by a demand for increased rapid transit facilities, and various projects for new city railways have been brought forward. The need for an east to west line across the southern part of the city has been most pressing and plans for such a road have been discussed for more than twenty years. From the beginning, this project was fathered by the Siemens & Halske Company and the actual construction work has now been carried out by them in connection with an Elevated Railway Company, formed to finance the undertaking, under a ninety-year franchise, the city reserving the right to buy the road after thirty years.

The first sod was turned in September, 1896, and the road has now been opened for traffic in the early part of the present year. The line extends from the Warschauer Bridge, close by the Warschauer Street railway station, on the east, to the Zoological Garden on the west, a distance of about 9 kilometres (5.5 miles), with a spur, 1 kilometer long, branching north from near the middle of the line to the Potsdamer Place, as shown on the accompanying map taken from the *Elektrotechnische Zeitschrift,* to which and to the *Zeitschrift des Vereines Deutscher Ingenieure* and *Stahl und Eisen* we are indebted for our data. There are thirteen stations, including the last-mentioned one, with an average interval of 900 meters. The underground section of the road comprises about 1400 meters at the western end, from Nollendorf Place to the Zoological Garden, and nearly 400 meters at Potsdamer Place. All the rest is elevated, but at the Warschauer Bridge the road makes connection with a surface line which runs 2 kilometers further to the city stock yards.

The heaviest grade, 1 in 32, is at Nollendorf Place, where the line changes from elevated to underground. Elsewhere the grade does not exceed 1 in 38, and the sharpest curve has a radius of 80 meters.

In order to avoid grade crossings at the "connecting triangle," where the spur to Potsdamer Place branches off, the "up" and "down" tracks are carried at different levels, but all elevated. This rather complicated, but very neat piece of engineering work does a great deal to insure the safe and speedy operation of trains.

The elevated structure is principally of steel, with about one kilometer of masonry viaduct at the Warschauer Bridge end and at the "connecting triangle." The steel construction, in general, consists of light trusses combined with plate and angle columns. The alternate trusses are rigidly connected to the columns, the lower chords ending in curves, which run into the spreading upper portions of the columns, and the other trusses are freely suspended in order to allow for expansion and contraction. The clear height of this part of the structure above the street varies from 3.2 to 5 meters and the trusses have spans of from 15 to 21 meters. Most of the columns are vertical, but in Bülow Street they are inclined outward so as to give a wide enough passage way underneath the structure. There are special constructions at various places along the line, with some highly ornamental features in stone and steel, and in general a great deal of attention has been paid to the looks of the road and to the necessity for making it harmonize with its surroundings.



MAP OF THE ELECTRIC RAILWAY SYSTEM OF BERLIN.

The elevated structure runs through the middle of streets and along the northern bank of the Landwehr Canal. It crosses the Spree River, the Canal and several main railway lines, and in one or two places it cuts through buildings. There is a water-tight flooring of sheet iron covered with gravel or asphalt to prevent drippings and to deaden noise.

The underground portion of the road runs through the middle of the street, right under the pavement. The tunnel is 6.24 metres wide and 3.33 meters high, with concrete floor and sides. The roof consists of transverse concrete arches, between steel beams, which rest on the side walls and on longitudinal girders supported on a line of square columns in the center of the tunnel.

The road throughout is two-track standard gauge. The distance between track centers is 3 meters on the elevated portion and 3.24 meters in the tunnels.

The third-rails, carrying the working current, are between the tracks on the elevated sections and on the outside of the tracks in the tunnels, and in the latter they lie a little higher than on the elevated track, in order to automatically switch on the current for lighting the cars.

Continuous current, at a pressure of 750 volts, is taken from the third rail by contact shoes, of which there are four on each car, two on either side, and the cars are heated, as well as driven and lighted, by electricity.

At present the trains consist of two motor cars, with a trailer between them, but as the traffic increases, another trailer can be attached, or two of these train units can be combined. All the cars have two four-wheel bogie trucks and are 12 meters long over all, and differ only in their interior arrangement. The motor cars are third-class, the trailer, second-class.

The motor cars will ultimately have four motors, one on each axle, but at present they need only three. The motors are four-pole and are powerful enough to give the train a speed of 50 kilometers an hour.

The train is controlled on the multiple-unit system from the motorman's compartment in the front end of the first car. There is a corresponding compartment in the rear end of the last car, to be used when the train is going in the opposite direction.

Each motor car has seats for 39 persons and standing room for 27, while the trailers have 44 seats and standing room for 30. There are two sliding doors on either side of each car, one to be used on entering, the other on leaving.

The trains run under a 2½ or 5 minute headway, at an average speed of 25 kilometers an hour. The stops at stations take 15 or 20 seconds apiece, and the distance from one end of the line to the other is covered in about 20 minutes.

The current is generated at a power station situated near the middle of the line, by three 800 kilowatt direct-current machines. There is also a storage battery large enough to take the place of one of the dynamos for a full hour, and for shorter intervals its output is even greater. This plant will be enlarged from time to time, as the increase in traffic demands.

The Luxembourg Arch.

For a long time the great masonry arch at Cabin John, on the Washington Aqueduct in Virginia, has held the supremacy for size, and it is only very recently that its 220 feet span has even been approached in magnitude. It is true that there had been in existence the arch of Barnabo Visconti, over the Adda, at Trezzo, of 76.5 meters span, (251 feet) built in 1377, but this was destroyed in 1416, and until now its dimensions have not been again attempted.

Since the experiments upon full sized arches by the Austrian Society of Engineers and Architects in 1895, the laws governing the distribution of pressure in masonry arches have been more fully understood, and the result has been to create a renewed interest in large-span arches. The great railway arch at Jaremcze, by Huss, with its span of 65 metres, (213 feet) nearly approached the size of the Cabin John bridge, and as the latter carries only an aqueduct, and an ordinary footway, the stresses are decidedly less than those of railway service.

Now, however, we have the recently completed arch at Luxembourg, exceeding in span, not only the bridges at Jaremcze and Cabin John, but having even a greater span than the mediæval bridge at Trezzo. With a clear span of 84.65 metres, (277.65 feet) this new arch stands more than 50 feet greater span than Cabin John, and 26 feet larger than the former bridge over the Adda. From a fully illustrated account in a recent issue of *Le Génie Civil* we abstract an account of this important structure.

The City of Luxembourg is situated upon a rocky plateau, surrounded on three sides by valleys of 40 to 50 metres in depth, in which flow the Alzette and its small tributary, the Pétrusse. The slopes of these valleys, especially on the side toward the town, are very steep, so that in former times, especially after the construction of the works by Vauban, in the reign of Louis XIV, it was considered one of the strongest fortified cities in Europe.

In 1859 the introduction of railways into the Grand Duchy of Luxembourg brought up the question of the location of the terminal station, and in order that the strategic importance of the city might not be impaired the station was not permitted upon the plateau, but was built beyond the valley, nearly a mile from the city. Access was had to the station by means of a viaduct of many arches, but the limited width of this viaduct (8 metres) and the demands of increasing traffic have led to its replacement by the new bridge with its great arch. The design which was accepted for the work was that of M. Sejourné, already well known for his construction of the arches of Lavaur (61.5 metres), of Castelet (41 metres), and of Antoinette (50 metres).

Apart from its great span, the Luxembourg arch presents some most interesting features. The width of the roadway was planned to be 16 metres (52½ feet), but instead of making the arch of this width, M. Sejourné designed two parallel arch rings, each of 5 metres width, and with a space of 6 metres between them; the two arches being covered with a platform of reinforced concrete. The spandrels of the arches are left open, with light masonry piers to carry the weight of the floor down to the arch ring, there being a conspicuous absence of any solid backing, formerly considered so necessary to the stability of a masonry arch. The advantages of this double construction are apparent. In the first place the total quantity of masonry required is reduced by more than one-third. In the second place the centring need be only 5 metres wide, instead of 16 metres, since one arch can be completed entire, and the centring then shifted for the second arch. A notable economy in timber and labour is thus effected. Furthermore the completion of one arch greatly facilitates the work upon the second. With these come numerous minor advantages which appear upon an examination of the work.

A few of the dimensions of the masonry arch are given, and reference should be made to the original paper for further details, including drawings of the entire structure. The span, as given above, is 84.65 metres (277.6 ft.), and the rise is 31 metres, (101.7 ft.) the depth of the arch being 2.16 metres (7.09 ft.) at the springings, and 1.44 metres (4.72 ft.) at the key. The material used is a local limestone, having a crushing resistance, under test, of 1,200 to 1,500 kilogrammes per square centimetre, (17,000 to 21,000 pounds per square inch).

The first of the great arches was completed on July 24, 1901, and the centreing was struck on October 26, when the key sunk only 6 millimetres. The construction of the second arch is now under way.

Progress in Aeronautics.

We have already referred in these columns at various times to the attempts which have been made to solve the problem of aerial navigation by the means of aeroplanes, dirigible balloons, and their various modifications.

Naturally the greater part of recent attention has been directed towards the experiments of M. Santos-Dumont, but these form a portion only of the effort which has been directed of late to the subject. We now have a general review of recent progress in aeronautics, contributed to the *Mémoires* of the Société des Ingénieurs Civils de France, by M. Armengaud, Jeune, from which we make such abstracts as will serve to give a general idea of the present state of the art.

M. Armengaud naturally devotes his attention almost entirely to the subject of dirigible balloons, and while giving full credit to M. Santos-Dumont for his success, shows that it is the natural outcome of the general development of the science of applied mechanics, and especially of the development of the light and powerful motors which have met the demand for automobile vehicles.

It was in 1884 that MM. Renard and Krebs succeeded in demonstrating that a dirigible balloon was a mechanical possibility, and their balloon "La France" must be considered as the pioneer in this direction. At the same time it was impossible at that time to produce a motor sufficiently light and powerful to enable headway to be made against anything but the lightest winds, but enough was done to indicate the lines along which future progress might be expected.

A brief description of the general dimensions and construction of the Santos-Dumont No. 6, with which the successful trial was made, may be given here. The balloon itself was a cylinder of 6 metres in diameter terminating in two cones, the total length being 33 metres, and the displacement being 622 cubic metres. This is equivalent to 800 kilogrammes of air, against which there was to be charged the weight of the balloon, 120 kilogrammes; of the motor, 98 kilogrammes; of the hydrogen itself, 120 kilogrammes; of the aeronaut, 50 kilogrammes, and of various accessories; there being left an unopposed buoyancy of 150 kilogrammes. The balloon was made of the finest white Japanese silk, this being very close mesh. and rendered impermeable by means of five coatings of linseed oil. Within this main gas reservoir there was placed a secondary balloon of 60 cubic metres capacity, this being capable of distension or contraction by the admission or discharge of air, thus maintaining the outer main balloon in its proper shape.

The motive power and propelling machinery were carried on a sort of trussed girder which was attached to the balloon by a system of wires similar to those used in the piano-forte. The rudder, which was of triangular form. was attached to the rear, behind the propeller, and braced and stayed to the frameworks and the balloon by wires. One of the novelties of the apparatus consisted of the use of two reservoirs of very thin brass, containing 45 litres, or about 100 pounds, of water, which might be discharged at will, forming a more controllable ballast than the usual sand bags.

The motor, upon which the principal success of the apparatus depends, was constructed by M. Buchet, and contains no especial features differing from the well-known machines of Daimler, de Dion, Panhard, Mors, and others, for automobile service.

We have already reviewed at length the result of the trial of October 19, as well as the trace of the route by M. Armengaud, and hence we may here rather discuss the general conditions which govern the design of light motors for aeronautical service.

Although steam engines have been greatly reduced in weight in the endeavour to secure power and speed in topedo boats, they are as yet unavailable for use in flying machines. M. Serpollet has designed a motor, using his instantaneous system of steam generation, which, for 30 h. p., weighs but 191 kilogrammes, or 6.4 kilogrammes (14.11 pounds) per h. p. It is, however, necessary to carry 10 litres of water (22 pounds) per h. p., which adds too much to the load for aeronautical purposes. The principal method by which the weight of a steam motor may be reduced is by increasing its speed, and in this respect the steam turbine offers possibilities.

MM. Renaud & Krebs used a battery and motor of 9 h. p., with a weight of 25 kilogrammes per h. p. hour (55 pounds), and this was a great advance over the 68 kilogrames per h. p., of M. Tissandier, or the weight of the eight men, (400 kilogrammes) employed by M. Dupuy de Lôme.

In order the better to show the reduction in weight per horse power which has been attained in the more recent internal combustion motors, M. Armengaud gives a diagram in which the curves show the results of various makers. Without going into details it may suffice to state that for motors of 50 h. p. the weight has been reduced to 5 kilogrammes (11 pounds) per horse power, while for motors as large as 100 h. p. this may be reduced to 3 kilogrammes (6.6 pounds) per horse power.

Referring to the points to be observed in the construction of future dirigible balloons, it will be interesting to note the rules laid down as long ago as 1886 by Colonel Renard, as a result of his practical experience. In order to obtain successful results it is desirable to:

1. Give the balloon an elongated form, similar to that of a boat;

2. To maintain the form of the balloon by the use of an internal vessel, permitting the replacement of the gas by atmospheric air;

3. To maintain the longitudinal stability by connecting the car to the balloon by a rigidly braced framework;

4. To use a propeller of suitable dimensions, actuated by a motor of as great power, and relatively light weight as possible;

5. To place the rudder in the rear, in a manner similar to that employed in steering boats.

To these rules Mr. Armengaud adds some of his own, based upon the most recent experience.

1. Employ an internal-combustion motor having at least four cylinders, in order to permit the best degree of balancing, and to use electric ignition, in order to avoid interruptions in the action of the cylinders.

2. Bring the propeller shaft as close as possible to the longitudinal axis of the balloon, that is, to the line passing through the centre of pressure.

3. Provide sufficient distance between the centre of pressure and the centre of gravity of the system to maintain operative stability.

4. Provide, in the case of small aerostats, an auxiliary couple for stability, by the use of a guide rope or a movable weight.

5. Provide an easily regulated motor, in order to enable the sudden variations in resistance to be met promptly.

6. In the case of large machines, to provide two propellers, one in front, and the other in the rear, each propeller being actuated by an independent motor.

Space Telegraphy.

At a recent meeting of the Société Internationale des Electriciens, Captain Ferrié of the French military telegraph service, read a paper on the present state of wireless telegraphy with Hertzian waves.

After reviewing the history, the principles and the theory of space telegraphy, the author discussed some of the difficulties met with. The parasitic signals due to atmospheric and terrestrial electrical phenomena, encountered by himself and other experimenters, he divides into three classes: First, those caused by lightning discharges, which are sometimes perceptible at great distances. For instance, during experiments carried on in the environs of Paris, signals were registered caused by a thunderstorm at Angers, nearly 250 miles away, while the sky was absolutely clear at Paris. But these disturbances are of minor importance.

Second, those due to variations in potential of the earth plate and the upper part of the receiving wire caused by changes in the earth's field. Parasitic signals have frequently appeared at sunset and disappeared about 30 minutes thereafter, and are also caused by the passage of electrified clouds. By connecting the receiving wire directly to earth, as in the newer arrangements of Marconi and Slaby, that part of these disturbances due to slow variations of potential, can be eliminated.

Third, those which appear to bear relation to the temperature, and are met with in warm climates, beginning about ten o'clock in the morning and lasting until evening and sometimes completely preventing any communication between stations. These disturbances were encountered by Marconi in his work between France and Corsica.

All these influences are more apparent the higher the wires and the more sensitive the coherers, and a large part of them may be avoided by using coherers of a low degree of sensitiveness, though this remedy introduces other disadvantages, notably a diminution in the range of communication.

Several methods of syntonizing, or tuning apparatus are described, particularly those of Marconi and Slaby. These all consist essentially in regulating the period of the ether waves by putting definite amounts of inductance and electrostatic capacity in the oscillating circuits.

By tuning the transmitting and the receiving apparatus to the same pitch, a maximum amount of energy is made available at the receiver and greater effects can be produced and longer distances covered, but owing to the phenomenon of multiple resonance, no system of syntonization can prevent the receiving apparatus from being affected by waves of any pitch provided there is enough energy in them. According to this view, a powerful transmitter, working at a definite pitch, would affect receivers of all pitches situated within a limited radius, but at greater distances it would affect only those receivers which were tuned to the same pitch. For instance, a very powerful transmitting apparatus at Cornwall would cause transatlantic receivers to respond only if they were carefully attuned to it, but would affect receivers of all pitches along the English coast and in the English Channel. It would be interesting to know if any such effects were actually observed during recent transatlantic experiments.

On Marconi's latest voyage to New York on board the "Philadelphia," he received messages from Cornwall at a distance of over 1,500 miles and signals at over 2,000 miles, while it is stated that the instruments on the "Umbria," which followed close after, were entirely unaffected.

As a matter of fact, both Marconi and Slaby have received simultaneous messages on the same vertical wire, with two sets of receiving instruments tuned to very different pitches, over comparatively limited distances, but better results are obtained by having as many vertical wires as there are receiving instruments.

This question of syntonization is the crucial one, whose more or less perfect solution will determine the adaptation of wireless telegraphy to general purposes.

The objection that wireless telegraphy cannot insure secrecy is not of such great weight, for this disadvantage is more or less common to all methods of electric communication. Wires have been tapped, and "listening in" is not an unheard of occurrence in telephony. Code systems can obviate this objection, but a more serious trouble is the possibility of interference. If all the small stations have to "shut up" when a big one is shouting in their neighborhood, the practical limitations of space telegraphy are apparent, but whatever the final outcome of the work to secure perfect syntony, there will still remain a large and important field which space telegraphy will have all to itself. For communicating with ships at sea, with isolated lighthouses and with islands which cannot be reached by cable, its advantages are unique.

It seems as if there were room enough for all our systems of electric communication, and it is most probable that the net effect of wireless telegraphy upon the older methods will be an all-around improvement, such as was experienced by the gas industry after the introduction of electric lighting.

Studies in Radio-Activity.

We have referred several times in these columns to the curious phenomena which have been observed in connection with the rays emitted from certain metals (uranium, polonium, radium, etc.) and their compounds, believing that while these subjects belong at present to the domain of physics, their study may ultimately reveal many things of importance to the applied science of engineering. Much of the original research in this line has been done by the well-known physicist, M. Becquerel, while many of the latest developments are due to the careful work of M. and Mme. Curie. In a recent communication to the French Academy, made by M. Becquerel on behalf of M. and Mme. Curie, and published in the *Comptes Rendus,* we have some most interesting points upon the subject, which are briefly reviewed here.

In order that investigations may be conducted with method it is necessary to adopt some provisional theory, and then proceed with experiments which may serve to prove or disprove the assumptions which are involved. The theory upon which the present studies have been based assumes that the radio-activity is an atomic property of the substance. Naturally the most important point for examination is the assumption that each atom of the substance acts as a constant source of energy. This fact may be determined by means of a great variety of experiments upon the radiant energy, without demanding the discovery of the source from whence that energy is derived.

Experiments conducted through a number of years have demonstrated that for uranium, thorium, radium, and probably also for actinium, the radio-activity is entirely uniform when the body is maintained in the same chemical and physical condition, and that this activity is not diminished with the lapse of time. Polonium forms a curious exception to the above conditions. Its radio-activity slowly diminishes with the lapse of time, and the rays emitted differ from the others in that they are not deviated by a magnetic field, nor do they appear to be capable of inducing radio-activity in other substances.

Two theories have been advanced as to the source of the energy emitted by these substances. One theory assumes that each atom possesses in a potential condition the energy which it radiates, while the other assumes that the radio-active atom acts as a mechanism which draws each instant from without the energy which it disengages. The first hypothesis involves the assumption that the energy must eventually be exhausted, although the experience of several years has thus far failed to detect any variation. If we admit the supposition of Professor Crookes and Professor J. J. Thomson that the cathode rays are material, we may conceive that the radio-active atoms are in course of transformation. Experiments upon these points have thus far yielded only negative results. After an emission of four months there has been observed no appreciable diminution in the weight of the radiant substance, nor has there been seen any perceptible change in the spectrum.

The second hypothesis, on the contrary, assumes the radio-active body to be acting simply as a transformer of energy. This energy may be borrowed from the surroundings in the form of heat or it may be borrowed from unknown sources by means of radiations as yet undiscovered. It must not be forgotten that we are doubtless placed in the midst of many phenomena of which we are altogether ignorant, since our knowledge is limited to those things which are capable of acting upon our senses, either directly or indirectly.

The work which has thus far been done in this interesting field is an excellent example of modern methods of scientific investigation. When certain unknown phenomena are to be investigated various methods may be followed. Very broad and general hypotheses may be made, and then gradually narrowed in accordance with the results of experiment. This methodical advance is the most reliable, but it is also the slowest. On the contrary, one may make much bolder hypotheses, in which the mechanism of the phenomena may be assumed, and then far more definite experiments may be undertaken in order to test the correctness of the assumptions. At the same time one is apt to be led into error by the very necessity of making a working hypothesis, and indeed it must be expected that such a method must consist of a mixture of truth and error.

The Evolution of Fire Arms.

THE relation of military weapons to the advancement of civilization is a subject which has often been discussed, but at no time more effectively than in a recent paper presented before the Franklin Institute by General Joseph Wheeler, U. S. A., and published in the *Journal* of the Institute.

General Wheeler traces the use of gunpowder back to the East, where, in soil impregnated with nitre, the charcoal from a fire might well have been the cause of a flash which led to the discovery of the explosive. The written history of the use of firearms is lost in obscurity, but it appears certain that such weapons were known in Asia long before they became known in Europe.

Although cannon were used at Crecy in 1346, the long bow and the cross bow remained the superior weapons for a long time, and even so late as 1792, the archer proved himself a better marksman than the musketeer, in a trial at target shooting. The whole history of the development of weapons shows that improvements were made by laymen, and neglected or even opposed by military men until the latter were compelled to adopt them.

Thus the Napoleonic wars were fought with the old flint-lock musket, although the percussion lock was invented in 1800, and patented in England in 1807, so that with this greatly improved weapon in his possession the Duke of Wellington went into the battle of Waterloo, eight years later, with the muzzle-loading flint lock. But this was not all. In the face of abundant information that breech-loading arms had been before the public for centuries, and despite the fact that the percussion lock was publicly advocated in 1807, and in general use in Europe from 1838, and manufactured in the arsenals of the United States government in 1844, the army of General Scott in the Mexican war was armed wholly with flint-lock muskets.

Quoting the sarcastic remarks of Captain Kimball:

"The English bowmen made a gallant stand against the ignominy consequent upon the use of the brutal musket; the French bravely rejected the breech-loader in the Napoleonic wars; the Americans did nobly in refusing to use percussion-lock guns in Mexico, and in greatly preferring wonderfully bad muzzle-loaders to comparatively effective arms with which to kill each other during the Rebellion; but all these heroic attempts at stopping military progress fade into insignificance when one contemplates the glorious resistance to the utilizing of magazine mechanisms upon the rifle."

It would seem difficult to account for these repeated anomalies, but when we reflect that armaments are selected by experienced soldiers, and that they have been indelibly impressed with the excellence of weapons which they have used, and that they realize that any change would require a new course of instruction, and at the same time involve great expense in the change of armament, some idea is conveyed as to the reasons why they desire to adhere to old systems and weapons.

Even in late years, when a hammerless gun was offered to the government, officers of distinction urged as a serious objection that it would be impossible for the soldier to come to support arms. It seemed not to have occurred to them that the manual of arms could be changed and that there was no necessity for ever holding a gun in such a position.

Coming down to the present, General Wheeler shows the dilatory conduct of the United States in connection with modern firearms and smokeless powder.

Smokeless powder was invented prior to 1886 and was in general use in Europe soon after that date.

It was adopted by the United States, together with the Krag-Jorgensen, in 1892, and yet in June, 1898, every infantry volunteer regiment went to Cuba as an army of invasion armed with the old Springfield rifle with black powder cartridges. The Spanish had smokeles powder and the Mauser rifle, which many experienced officers regard as better than the Krag-Jorgensen. Even in the far-off Philippines, the insurgents were armed with the Mauser and Remington.

But what is still stronger evidence of this too conservative spirit, notwithstanding that smokeless powder has been used for heavy guns for ten years, black powder, with its clouds of smoke, was the only kind furnished to Dewey at Manila, or to Sampson, Schley and Clark at Santiago, and the "Brooklyn" was so enveloped in a mountain of smoke that officers on adjacent ships only knew that the Brooklyn had not gone to the bottom by hearing the thunder of her guns as this noble cruiser hurled tons of iron missiles into the Spanish ships.

The present line of improvement lies in the development of non-recoil and automatic guns. The principal cause of defective aim has been in the derangement due to the recoil after each discharge. Since increased power is attended with increased recoil, and since the limit of endurance has already been reached, it is evident that this must be neutralized, if not utilized, if further improvement is to be made. With such guns the soldier can keep his eyes directed constantly upon the enemy, and vary the direction according to the slightest indications. With this is required rapid fire and a high degree accuracy, and the army which is fully provided with such weapons will have a vast superiority over its opponents.

In the future, war must be conducted upon business principles. The use of a non-recoil, semi-automatic rifle, and thorough drill and instruction of the soldier, will entirely change this very unsatisfactory condition. The effort should be to so train an army that the missing of a shot would be the exception and not the rule, as it has been with the old recoil gun. We may not reach such a perfect degree of excellence, but we can and certainly will approach it.

Science and scientific skill now enter into every civil vocation. What has heretofore been accomplished by the exercise of manual strength is now done with a thousand or more times the ease with which it was formerly done by human effort. To-day, one man by the control of steam or electric power does work which a few years ago required the combined strength and exertion of a thousand or more human beings.

The nations which will win victories in the future will be those who use the most skill in the application of scientific methods and scientifically made arms, ordinance and other machines of war.

Methods of Illumination.

In an interesting paper recently presented before the American Institute of Electrical Engineers, Dr. Louis Bell discusses the art of illumination from its human and practical side, although he naturally devotes most of his subject to electric lighting.

After commenting on the tremendous increase in resources in illumination since the time of the once brilliant fetes of Louis XIV, Dr. Bell shows that with the immensely powerful sources of light now at our command, there is a constant and often reprehensible tendency to turn on more and more light, irrespective of quality and regardless of physiological and physical effects, thus keying up the vision to a pitch which demands extraordinary methods to produce common-place results.

The true end of artificial lighting should be to furnish illumination in quantity fully adequate for the conditions to be met, and in quality such as will neither unduly strain the eye nor in any way inconvenience the user. Thus quality is more important than quantity, and it is this feature which Dr. Bell seeks to emphasize.

The important qualities for a practical illuminant are: steadiness; suitable intrinsic brilliancy; and suitable color. Steadiness is placed first, and its importance cannot be too highly estimated, since without it the other properties are valueless. Visual inertia acts, by virtue of the property of persistence of vision, as a protection against very rapid changes, but not against slower ones, and there is a wide range of frequency below the point where visual inertia fails to protect and the point where the iris can give aid by its changes in aperture. This effect naturally varies with different persons, but Dr. Bell finds that in his own case a variation of 10 per cent. at the rate of one or two maxima per second is very annoying and tiring. This is an important element in the production of satisfactory lighting by incandescent electric lights. The question of intrinsic brilliancy is most important in its physiological effects, since the image of a brilliant light acts to produce serious inflammation if too long continued in one spot. If the image wanders over the retina, or moves quickly in and out of the field of vision, very unpleasant results are produced. The fundamental rule of proper illumination, therefore, is to keep brilliant radiants out of the field of vision. It is for the above reasons that a shading of the light, while diminishing the brilliancy, may greatly improve the seeing conditions. Experiments upon a number of sources of illumination show that for radiants within the field of vision at the distances ordinarily met in interior lighting, an intrinsic brilliancy of 5 c. p. per square inch is about as high as it is wise to go. If this is secured from direct sources it involves the use of diffusing globes of fairly large dimensions, but the better plan is to use arcs kept out of the working field of vision, and acting by reflection from the walls and ceilings of the rooms. In this latter case much depends upon the color and surface of the walls, and this important matter should be considered in connection with the system of lighting to be employed, especially in halls and places of public assembly.

In considering the question of color, it is usually unnecessary that any particular standard be adopted, but at the same time broadly colored lights are not desirable. It is the orange, yellow, and green that make up about 80 per cent. of the useful luminosity of the solar spectrum, and the energy required to produce a brilliant blue or red would be far more than for the same luminous effect in yellow or green. Naturally sunlight is the proper standard for the best work of the human eye, but this is a very variable quantity and can only be approximated.

Dr. Bell discusses the various sources of light, gas and electric, in accordance with the requirements above indicated, and gives some valuable hints as to the choice of illuminants for different conditions. For these we must refer the reader to the original paper only emphasising here again the important facts, that steadiness, and distribution are far more valuable than great brilliancy, that the human eye is the evolution of ages of illumination such as we now find in ordinary daylight, and that this natural standard should not be departed from more than is absolutely necessary.

The Powering of Electric Trains.

At a recent meeting of the American Institute of Electrical Engineers, Dr. Cary T. Hutchinson read a paper which was interesting in itself, but even more so from the discussion which it provoked, both at the meeting and in the technical press. This paper was entitled "The Relation of Energy and Motor Capacity to Schedule Speed in the Moving of Trains by Electricity," and it gave a general solution of the question involved in the movement of a body from rest to rest with velocity varying as in the typical case of car acceleration, namely: first, a uniform acceleration while getting up speed; second, a uniform retardation after the power is shut off and the car, or train, is "coasting"; third, a uniform retardation at a higher rate while brakes are being applied, until the train comes to rest.

The solution aims to afford a means of determining the energy, the power and the losses for any schedule speed, over a course of any length, with any initial acceleration, tractive resistance and braking effort, and with any desired use of the "motor curve," the latter showing the values of torque and speed for various inputs.

The method is partly analytical and partly graphical, and in order to solve the problem by mathematical formulæ, it was necessary to make various simplifying assumptions. Thus, for instance, the track is assumed to be absolutely straight and level, the train resistance constant for all speeds, and the acceleration and retardation uniform. Now, the validity of these assumptions was most strongly criticised, and it seems to be a fairly general opinion that the variations in actual operations from Dr. Hutchinson's ideal conditions are so great that his conclusions can be of little practical value. It is, perhaps, doubtful whether so complicated a problem as the one he attacked can have any useful general mathematical solution, but he appears to have gone as far in that direction as possible, and at the very least, deserves credit for having put the subject in concrete shape for a very useful discussion.

Dr. Hutchinson reaches the conclusion "that the acceleration that gives the lowest motor capacity per ton is in all practical cases the most economical. The very small saving in energy is not to be compared with the many disadvantages of very rapid initial accelerations. Assume, for instance, a gain of 10 watt-hours per ton mile for an acceleration of 3, over that required for an acceleration of one; for a 20-ton car, and with energy at 0.5 cent per kilowatt-hour, this represents a saving of 0.1 cent per car-mile. This is too trifling to be considered in comparison with the fixed charges on the greater investment for motors and distribution system; the poorer load factor at the power station, the increased cost of maintenance, the difficulty of accurate handling of cars, and, above all, the much greater discomfort to passengers."

The broader question of the successful operation of electric railways involves much more than the attainment of a certain schedule with the lowest possible energy expenditure. The argument in the concluding part of the last paragraph might go even further and say that the energy consumed by the motors of a train represents only a part of the cost of operating a road, and when all the fixed charges are taken into consideration, perhaps not a very important part of the total expenditure. As has been said in one of the critical articles on this topic, "electric railway operation is much more than a problem in kinetics," and, we might add, dynamics as well. In the end, it is a matter of business and common sense, where all parts of the problem are given proper weight. The object of a road is to build up a paying traffic, and to secure this a satisfactory train service is of the first importance. Good engineering is of course most necessary, but slight savings in energy consumed are of minor importance compared with the convenience and comfort of passengers. A train service should be reliable, safe, comfortable and as speedy as possible, and when these objects have been attained, the question of the energy expended in moving the trains can almost be left to take care of itself.

The Premium System of Wages.

The premium system has been much discussed from various points of view, and naturally there have been various objections made to it both of theoretical and practical grounds. In a recent address delivered before the students of Cornell University by Mr. F. A. Halsey, the originator of the system in the United States, some of these objections are considered and answered.

The fundamental principle of the premium system is that of inducing the workman to save time by giving to him a portion of its value, and, as Mr. Halsey well says, the first question is to determine what proportion of the value of the time is to be given to the workman who saved it. The matter must rightly be considered as a bargain, in which each party endeavours to get as much as possible for what he gives the other. From this point of view it will be seen that the premium is in no sense a bonus of gratuity, but that it is, in the fullest sense of the word, an earning. Assuming, then, that the premiums are settled upon a basis of increased output, there is no reason why they should be cut from time to time, and that so long as the methods of production do not change, the rates may be made permanent. Indeed, if cuts are introduced, there is at once produced the principal evil of piece-work and the workman's confidence is destroyed and with it the incentive to further effort.

The most fundamental objection is that which denies that time is the proper measure of wages, and insists that it is only the product which is of value; this leading directly to the position that piece-work is the only sound method of remuneration. This position is naturally that of the employer, since it is upon that basis only that he can obtain results for what he sells. The workman, however, has his time to sell, and naturally considers it the proper basis of payment. In other words, both employer and workmen are in business, the latter selling his time to the former, and the former selling the products of the latter's labor to the customer. Thus, as Mr. Halsey well says: The employer's interests are with low wages per unit of product, while the workman's interests are with high wages per unit of time. The premium plan attempts to make these interests as far as possible identical. Its true object is to provide increased wages per day with reduced wages per unit of product.

Another objection is that made from the standpoint of equity. It maintains that the increased output is due entirely to the efforts of the workman, and sees no reason why he should receive only a part and that the lesser part of the resulting gain. This objection must be met in the original position that the workman is in the business of selling his time to the employer, and that the law of supply and demand will operate to compel the employer to meet competition by reducing his selling price to the extent to which he at first shares in the gain, so that the gains due to the operation of the system will ultimately be divided between the workman and the purchasing public.

There is one feature here, however, which must be taken into account, namely, the difference in the nature of the workman's commodity, time, and the employer's commodity, merchandise. The latter can be stored, and held for a considerable period without losing its selling value, while the workman's time is a vanishing quantity, which he cannot store, but which he must sell day by day. A day's work, if not sold, is gone forever.

As opposed to the position that the value of a man's time is measured by its product, comes that which insists that the time value is fixed by the market rate, and that any more is a gratuity, and not wages. There is a market value of time, it is true, but that value is only to be had by proper management, and the mere presence of the workman in the factory without the provision of duties and direction of incentive, will not enable it to be realized.

Another objection is one commonly made, that the premiums are not intended for permanent use, but are only intended to be used to discover a man's capabilities, after which the reward will be removed and the production under the premiums still demanded. This corresponds to the standing objection to piece work, that is, the cutting of rates. It is answered by the standing fact that experience has long ago shown that the workman is worthy of his hire. All employers pay higher wages to efficient than to inefficient workmen, because compelled to do so. The premium plan simply systematizes this practice and grades, sorts, and pays men in accordance with their efficiency, instead of leaving that sorting to general observation, and even to favoritism. An employer can no more get the premium output without the premiums than he can get an efficient workman for an inefficient workman's wage.

In many establishments it is considered desirable to place the judgment of what constitutes a day's work in the hands of old and experienced workmen, assuming such to be safe guides, upon whom managers can depend, and by whose judgment foremen can be required to get the output of the men under them. If working conditions remained constant, and men lived forever, this might be a good method, but experienced men pass away, and operative conditions change, and we hope, improve, both for men and for employers. The premium system endeavors to determine the proper remuneration by the actual operative conditions, and from its very nature should grow with them, thus rendering the determination of a day's output a function of the actual conditions under which it exists, and not upon the experience of what has been in existence in past times.

If the industrial system of the world is, in a broad sense, simply the co-operative production and distribution of wealth, and if an increase in the total wealth produced, by giving more to divide, increases the amount available for each individual, the general adoption of the premium plan can do nothing less than advance the prosperity of all.

Artificial Graphite.

The production of carborundum in the electric furnace by the fusion of sand and coke and their conversion into silicon carbide is well known. In the course of this work it appeared that a certain proportion of pure graphite was produced, and since this product had a commercial value, experiments were conducted by Mr. Acheson, with the result of making artificial graphite a regular commercial product of the electric furnace.

In an article in a recent issue of the *En-*

gineering and Mining Journal, Mr. F. A. J. Fitzgerald discusses the process and shows the uses of the product.

In his patent, Acheson states that the graphite is really produced by the indirect conversion or dissociation of the carbon from combination with other materials, and shows that the product is enormously increased by mixing the carbonaceous material with a certain proportion of oxides of iron. The furnaces used in the process for making graphite and graphite electrodes commercially are similar in outward appearance and magnitude to those used in Acheson's process for making silicon carbide. They are built of brick in the form of a long, narrow trough lined with some suitable refractory material. In making graphite electrodes the latter are manufactured of petroleum coke and pitch like an ordinary carbon, such as is used in arc lights, but a certain amount of some carbide-forming material such as silica or iron oxide, is introduced. The electrodes are baked in the usual way, and are then ready for graphitization. To perform this operation they are placed in a furnace and heated to a temperature well above that of the volatilization of such bodies as iron, aluminum and silicon. That the temperature in the furnaces is well above this point may easily be demonstrated, as the bodies above named are condensed in the form of their oxides outside the furnace.

The carbonaceous substance which has been found most suitable for making graphite is anthracite coal, when the ultimate product is to be paint, crucibles, and similar work. When graphite electrodes are to be made, a petroleum coke or pitch is used, this being mixed with silica or oxide of iron, and the mass baked in the usual way before placing in the electric furnace. The advantages of artificial graphite over the amorphous variety is shown in the fact that the density of the latter is only 1.90, and compared with 2.19 for the artificial graphite, while the respective electrical resistances per cubic inch are 0.00124 ohm, and 0.00032 ohm.

Tests made on the graphite produced from anthracite show that it is free from amorphous carbon. The average product of the furnaces contain approximately 5 per cent. of ash, and is therefore far purer than the average natural graphite. When necessary, purer graphites are produced; this being done by heating to a high temperature for a sufficiently long time to volatilize and drive off all impurities. Anthracite treated in this way produced a graphite containing only 0.31 per cent. of ash, although the original coal carried about 15 per cent. ash. This small residual ash is undoubtedly due to the condensation of the vapors existing in the furnace when the current is cut off.

It is a remarkable fact that in spite of the large amount of work that has been performed by various experimenters on the conversion of amorphous carbon into graphite, half a century elapsed before a process was developed that is now becoming of greater importance every year. Over 50 years ago with a battery of 600 Bunsen cells Desprez attacked this problem; but it was only a few years ago that a method was discovered by which, in the first year of the new century, and with the electric current produced by the Niagara Falls, nearly 2,000,000 pounds of graphite were manufactured from amorphous carbon.

Electrodes, made of artificial graphite, are recommended for electrolytic and electrometallurgical processes, and the advantages claimed for them are long life, low porosity, high conductivity and great economy. The electrodes are made by treating in the electric furnace amorphous carbon articles made up in the shape desired. The product is stated to be entirely free from amorphous carbon, and the percentage of impurity in the finished electrodes is given as 1 part in 1,000. The size of the electrodes is limited generally by the difficulties of manufacture. In rectangular shapes the cross section is limited to about 28 square inches, and the length to 36 inches. The width of a carbon is usually limited to 8 inches. In round carbons the length is limited to 36 inches, and the diameter is 5 inches. These limits can be increased slightly when large amounts are ordered. Some striking results have been obtained in tests made in Germany with graphite electrodes in the electrolysis of sodium chloride solutions.

The production of artificial graphite is but another of the developments of the application of electricity to industrial technology, and doubtless many other substances will be added to the products of the electric furnace in coming years. The growth of the electrochemical industries gives another indication of the transformation which is overtaking the work of tne technical chemist. Indeed it is well understood in the United States that establishments which are as yet not prepared to abandon the older methods of producing various chemical supplies, are acquiring interests in hydro-electric power plants in eligible localities in order to be prepared for the inevitable transformation which can be foreseen. Such plants can be made to pay their expenses by the supply of current for local industries until such time as they may be needed for the special uses which their projectors had in mind, thus requiring no charge against present operating expenses to be made on their account. It is in methods of this sort that the combination of the engineer and the business man gives a strength which must be lacking in either considered separately.

Notes on the Isthmian Canals.

In a very interesting address delivered before the Chicago Commercial Club, and published in the Railroad Gazette, Mr. George S. Morison gave some points of interest in connection with the Isthmian canal projects which are here reviewed.

After comparing the constructive features of the Nicaragua and Panama routes, Mr. Morison shows that the main advantage of the Nicaragua route is that the west end of the Nicaragua canal is 500 miles nearer San Francisco than is Panama. This is a manifest gain for communication between New York and the Pacific ports, but it is nearly neutralized by the additional time required for the passage through the Nicaragua canal.

Mr. Morison calls attention to some interesting facts about the distances involved in traffic through an isthmian canal. Says he:

"We all measure our longitude from Greenwich; Greenwich is practically London. The Mississippi River, as marked by St. Louis, Memphis and New Orleans, all of which are on the same meridian, is in longitude 90 degrees west. The mouth of the Ganges is in longitude 90 degrees east. The mouth of the Mississippi is directly opposite the mouth of the Ganges. The mouth of the Mississippi is almost north of where the Isthmian canal would be. The mouth of the Ganges is a long way east of the Suez canal. This means that very little business can be expected to go from any European ports through the canal across the American isthmus. This canal must stand on its own merits. It must be a canal for American traffic. Furthermore, our Atlantic ports can reach Chinese ports by a little shorter route through the Suez canal than across the American isthmus. Manila is about equally distant by both routes. Japan would be nearer by the American isthmus.

"Another thing: a great circle curve drawn from the terminus of either canal to San Francisco would be almost entirely on land, it would pass through New Mexico; the shortest route by which any vessel could go from the terminus of either canal to Japan would take them so near to San Francisco that San Francisco would naturally be a coaling port. The distance from Panama to Yokohama, by way of San Francisco, is less than by way of Honolulu, San Francisco, furthermore, is the one port on the west coast of America which is nearest, not only to China and north Asiatic ports, but to Australia and New Zealand. There are some curiosities of this kind which it is important to think about.

"From New York to San Francisco is 5,144 miles by way of the Panama canal. A 15-knot ship going 360 miles a day would make that trip in about 15 days, including the canal, if everything was all right. From Plymouth, which may be taken as a sample European port, the distance is 7,674 miles; that would take 21 days; including the canal, probably with coaling, etc., 23. The opening of the canal would place our Pacific coast in direct communication with our Eastern coast and with Europe. It would place our Eastern coast and the Mississippi Valley in direct communication with the west coast of South America, the trade of which is now held in European hands. This is a thing to which little attention has been given, but it is likely to prove a very important one. But after all, I know of nothing which you can rely on less than statistics of transportation on a transportation route which does not exist. The profits and the business of the canal must be the results of conditions which that canal will create. The French company made very nice calculations based on the position of ships all over the world for several years. But the real fact is that the opening of this canal will encourage certain interests on our west coast and elsewhere, which cannot fail, in my judgment, to change many lines of trade, and to create traffic which does not now exist. If it were only to be the traffic which does exist, I should doubt the expediency of building the canal."

In regard to the military question, the canal, in Mr. Morison's opinion, would be an important factor in the prevention of war. In all probability fleets could not be taken through the canal in time of war.

But the value of a fleet is not so much to fight in war, as to prevent the occasion of war; and the exercise and duties which an American fleet could perform with the existence of a canal, the change of stations and the discipline of squadrons, would be very greatly improved. Our fleets would be much more effective, not perhaps in fighting, but in preventing the necessity of fighting.

The Ethics of Patents.

The ethics of the engineering profession is wrapped in a mist and haze which no one need hope to dispel, but a new feature has recently been brought out by a brief communication in the Proceedings of the American Society of Civil Engineers concerning the question as to whether it is unprofessional for an engineer to be a patentee. The writer, Mr. A. R. Eldridge, seems to have forgotten his ethics so far as to permit himself to poke fun at the dignified society; and, assuming himself to be in a benighted condition, he appeals to the membership for light.

After stating that he himself has not violated the ethics of the profession so far as to apply for a patent upon any article whatsoever, not even for a washing machine nor a car coupler, Mr. Eldridge proceeds to inquire as to the reasons involved in the extraordinary idea that it is unprofessional to become a patentee.

Let it be supposed that an eminent engineer, one of the leading lights of the profession, should, by chance, stumble upon a decided improvement in egg beaters. Would he debase the ethics of his profession by taking out a patent on his invention? It is hardly to be supposed that the engineering world would decry such an action; why, then, should it object to his taking out a patent on a new and improved method of rolling steel rails, on an improvement in the valve gear of a steam engine, or on the construction of a freight car? It the ranks of the profession were scanned carefully it would doubtless be found that many eminent engineers and scientists have taken out patents; witness the names of such men as Lord Kelvin, Captain John Ericsson, Professor Rankine, and others, not to mention numerous members of the American Society of Civil Engineers. Mr. Eldridge, however, strikes a very happy point when he compares patents and copyrights.

"One does not see or hear of any objection being raised when an engineer copyrights a book which he writes, or even compiles, yet wherein is to be drawn the fine distinction between a patent and a copyright? An article, a device, a method of manufacture may be patented, whereas a book may be copyrighted. In either case others than the owners of the patent or copyright are restrained from using the article or the contents of the book without compensation in one form or another, being paid to the holder of the patent or the copyright."

Especially pertinent is the fact pointed out that the Proceedings of the American Society of Civil Engineers are themselves copyrighted, so that the whole society as a body is continually doing that which some of its individual members would have us believe is in violation of the ethics of the profession!

It is indeed refreshing to see such solemn nonsense brushed away in the clever note of Mr. Eldridge, and to call attention to the manner in which an attempt to revive obsolete notions as to the unprofessional character of patents has been met. As a matter of fact there is no earthly reason why a civil engineer should not patent any original inventions relating to his profession just the same as any other man. He is in business, and is prepared to receive fees for his knowledge and work, and any attempt to make the blunder of pretending that he is not in business for its legitimate returns can only result in making him ridiculous.

THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCES IS THE ENGINEERING INDEX"

The following pages form an index to the contents of nearly two hundred of the leading engineering journals of the world, in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index item gives the following essential information about every article.

(1) The full title, (2) The name of its author,
(3) A descriptive abstract, (4) Its length in words,
(5) When published, (6) Where published.

We supply the article itself, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. Thus this Index makes it possible within a few minutes' time each month to inform one's self of every important article published anywhere in the world upon the subjects claiming one's special interest.

The original of any article referred to in the Index, together with all illustrations, can be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

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Brooklyn Bridge.

The Safety of the Brooklyn Bridge—A Rejoinder by Messrs. Hildenbrand and Henning. 4200 w. Eng News—Jan. 30, 1902. No. 45914.

Colonial Bridges.

Colonial Bridge Erection. Discusses types, the influence of climate, and other conditions. 3500 w. Engr, Lond—Jan. 31, 1902. No. 46131 A.

East River Bridge.

The Triangulation for Bridge No. 4 Across the East River, New York City. Oscar Erlandsen. Describes the novel methods used in obtaining the distances across the channels in the Blackwell's Island Bridge. Also the apparatus and results. Ill. 1500 w. Eng News—Feb. 13, 1902. No. 46194.

Flooring.

Experiments on the Strength of Wooden Floor Construction of Suspension Bridges (Versuche über die Tragfähigkeit der Hölzernen Fahrbahnconstructionen von Hängebrücken). A review of an article by M. Pierret in the *Revue Général de la Construction Métallique et de la Serrurerie*, giving the results of experiments on French highway bridges. 1500 w. Oesterr Wochenschr f d Oeffent Baudienst—Jan. 4, 1902. No. 46350 B.

Masonry Bridges.

Masonry Bridges for Railways. Discusses the reason for the recent construction of many masonry bridges for railways. 1200 w. Eng Rec—Feb. 22, 1902. No. 46423.

Reinforcing.

Reinforcing an Undermined Bridge Pier. Describes the method of sinking a new caisson around an old one which was thrown out of plumb by floods. 1300 w. Eng Rec—Feb. 8, 1902. No. 46162.

Saginaw Bridge.

Relative Merits of Swing and Bascule Bridges and the Saginaw Bridge Letting. Letters from Albert H. Scherzer and Edgar A. Rossiter. The first letter discusses the advantages of the bascule bridge; the second explains why it is not desirable or required at Saginaw. 2400 w. Eng News—Feb. 13, 1902. No. 46196.

Street Bridges.

A Report on the Condition of Street Bridges in Indianapolis. Report of T. L. Condron, showing the dangerous condition of four old bridges over the White River, three of which are carrying electric railway cars, although never designed for such loading. 1300 w. Eng News—Feb. 20, 1902. No. 46496.

Tennessee Bridge.

An Eventful Bridge History. Hunter M'Donald. Read at meeting of the Engng. Assn. of the South: History of the bridge of the Nashville, Chattanooga & St. Louis Railway over the Tennessee River at Johnsonville, Tenn. The bridge was subject to an unusual number of disasters. 2300 w. R R Gaz—Feb. 7, 1902. No. 46112.

Testing.

The Testing of Railway Bridges. Discusses the need of the first and of periodic tests, giving the opinions of various engineers and the methods used. 3300 w. Engr, Lond—Feb. 14, 1902. No. 46461 A.

Timber.

The Kintai Wooden Bridge. Illustrated description of a wooden arch bridge with three 150-ft spans and two somewhat shorter, built in Japan in 1673. 700 w. Eng Rec—Feb. 8, 1902. No. 46161.

Viaduct.

Arched Viaduct Over the Seine, Paris. Two-page plate and other illustrations, with description of interesting features. 1700 w. Engng—Jan. 31, 1902. No. 46-129 A.

Summer Street Viaduct, South Boston. Herman K. Higgins. A statement of the complicated conditions to be met with; an illustrated description of the structure and its construction. 3800 w. Jour Assn of Engng Soc's—Dec., 1901. No. 45931 C.

CANALS, RIVERS AND HARBORS.

Dock Equipment.

See Electrical Engineering, Power Applications.

Drainage.

Drainage Improvement by Dredging. E. E. Watts. Abstract of a paper read before the Indiana Engng Soc. Discusses drainage improvement works, methods and cost. 2500 w. Eng News—Feb. 13, 1902. No. 46198.

Land Improvement in Italy (Bodenmeliorationen in Italien). Adolf Friedrich. A well illustrated account of several great drainage and land reclamation enterprises and some irrigation work, visited by a party of students from Vienna. 2 plates. 1200 w. Oesterr Wochenschr f d Oeffent Baudienst—Jan. 18, 1902. No. 46354 B.

Dredges.

United States Dredger "Florida." Illustrated description of an interesting shallow draught dredger and snag-boat for government use in improving the channels of small rivers. 1200 w. Engr, Lond —Jan. 24, 1902. No. 45990 A.

Great Canals.

Great Canals of the World. Information from a study prepared by the Treasury Bureau of Statistics, for publication in the *Monthly Summary of Commerce and Finance*, showing the commerce, cost, and dimensions of the great canals of the world. 1200 w. Am Archt—Feb. 8, 1902. No. 46126.

Inclined Planes.

New Plans for the Lifts on the Danube-Moldau Canal (Neue Entwürfe für die Hebewerke des Donau-Moldaucanals). Victor Schönbach. A very well illustrated description of the proposed inclined-plane canal-boat railways, with map and profile of canal betwen Vienna and Budweiss, Bohemia. 6 plates. 4500 w. Oesterr Wochenschr f d Oeffent Baudienst—Jan. 4, 1902. No. 46348 B.

Isthmian Canal.

Panama or Nicaragua? Editorial discussion of the present position of this project, presenting the leading features of the two schemes. 1800 w. Engng—Jan. 24, 1902. No. 45982 A.

The Isthmian Canal. George S. Morison. Extracts from an address at a banquet of the Chicago Commercial Club. Gives brief descriptions of the Panama and Nicaragua routes, stating the advantages of each, and giving reasons why the Panama Canal is to be preferred. 5000 w. R R Gaz—Feb. 7, 1902. No. 46113.

The Latest Route Proposed for the Isthmian Canal—Mandingo Route. The statement of the American Isthmus Ship Canal Company concerning this proposed route, with map. 2500 w. Nat Geog Mag —Feb., 1902. No. 45964 C.

Time as it Affects the Selection of an Isthmian Canal Route. A letter from H. H. Trundle discussing various matters relating to proposed routes. Also additional notes. 2800 w. Eng News—Feb. 20, 1902. No. 46493.

Why Not Own the Panama Isthmus? Frederic C. Penfield. Discusses the canal routes, favoring Panama, and suggesting the purchase of the territory. 2500 w. N Am Rev—Feb., 1902. No. 45922 D.

Work of the Isthmian Canal Engineers. Frederick Moore. An outline of the work done in surveying routes and gathering the needed information to determine the most advantageous location. Sci Am—Feb. 1, 1902. No. 45959.

Philadelphia.

Development of the Delaware River Water Front of Philadelphia, Including Description of Bulkhead, Street, and Pier Construction. George S. Webster. An illustrated article giving early history and description. 10,000 w. Pro Engrs' Club of Phila—Jan., 1902. No. 46040 D.

Prague.

Progress in the Raft Harbor Works near Prague (Baufortschritt beim Flosshafenbaue auf der Kaiserwiese oberhalb Prag im Jahre 1901). M. Machulka. A brief illustrated account of harbor works, including a bridge, on the Moldau above Prague, Bohemia. 600 w. Oesterr Wochenschr f d Oeffent Baudienst—Jan. 11, 1902. No. 46352 B.

Sault Ste. Marie.

The Enlargement of the Sault Canal. Waldon Fawcett. An illustrated article on the proposal to enlarge the locks of the governmental ship canal which connects Lakes Huron and Superior. 1500 w. Am Mfr—Feb. 20, 1902. No. 46470.

Ship Canal.

The Proposed Taunton River and Boston Harbor Ship Canal. From the report of Frank W. Hodgson. An abstract of the surveys and estimates for a proposed ship canal to connect Narragansett Bay and Boston Harbor, by the way of the Taunton and Weymouth Fore Rivers. 900 w. Eng News—Feb. 6, 1902. No. 46110.

Tide Indicator.

See Electrical Engineering, Power Applications.

Vienna.

The Regulation of the Danube at Vienna (Ueber Donau-Regulierungs-Bauten bei Wien). Rudolf Halter. A general account of the river improvement and harbor work which has been carried on for many years. Plans. 6500 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 31, 1902. No. 46360 B.

CONSTRUCTION.

Dams.

British Practice in the Building of Earth Dams. Letter from E. Sherman Gould on the relative merits of masonry and puddle for core walls, and one from C. F. Marsh, with illustration, on the construction of an earth dam over 100 ft. high. 1000 w. Eng Rec—Feb. 8, 1902. No. 46172.

Concerning the Design of Earth Dams and Reservoir Embankments. Editorial discussion of various constructions, presenting one that is especially recommended for security and tightness as well as cheapness. 2500 w. Eng News—Feb. 20, 1902. No. 46492.

Remarks on the Recent Failures of Masonry Dams in the South. B. H. Haraway. Discusses the designs used, and the causes of failure. Ill. 1800 w. Eng News—Feb. 6, 1902. No. 46105.

The Design of American Dams. A discussion of the value of masonry as a material for core walls. 1100 w. Eng Rec—Feb. 15, 1902. No. 46254.

The High Earth Dam Forming Druid Lake, Baltimore Water-Works, Alfred M. Quick. An illustrated description of this dam, supposed to be the highest earth dam in the world, and the unusual plan followed in its construction. 1500 w. Eng News—Feb. 20, 1902. No. 46495.

The Limiting Height of Earth Dams. A letter from E. Sherman Gould, assuming 70 ft. as the maximum height yet attained, and discussing causes of destruction, construction, &c. 1600 w. Eng News—Feb. 20, 1902. No. 46494.

Fireproofing.

A New Method of Testing Fire-Resisting Qualities of Fireproofed Wood. Ira H. Woolson. Deals with the results obtained in a long series of experimental tests, describing methods and discussing other qualities that must be considered in the use of fireproofed wood. 4200 w. Eng News—Feb. 20, 1902. No. 46490.

Fire and Water Test of Vulcanite Fireproof Floor, Philadelphia, Pa. Illustrates the floor and test house, and gives the conditions and results of the tests. 1200 w. Eng News—Feb. 6, 1902. No. 46107.

Resistance to Fire of Floors and Doors. Edwin O. Sachs. From a paper read before the School of Military Engineering, England. A report of experimental tests, describing the construction, method of testing and effect. 4500 w. Arch't, Lond—Jan. 31, 1902. No. 46118 A.

Tests of Fire-proof Partitions by the New York City Building Department. Brief report of interesting series of tests of the effect of fire and water on various forms of partitions. 2200 w. Br Build—Jan., 1902. No. 45924 D.

Piles.

The Supporting Power of Piles. Letters by E. P. Goodrich and C. Baillairge discussing the supporting power of a pile and its carrying power considered as a column. 1500 w. Eng Rec—Feb. 22, 1902. No. 46433.

Prison Construction.

Cell Construction in the Tombs Prison, New York. Illustrated description of the steel work of the cells recently installed in the municipal prison. 1900 w. Eng Rec—Feb. 15, 1902. No. 46262.

Roads.

Civilization and Wagon Roads. Ira O. Baker. Read before the Illinois Soc. of Engrs. & Surv's. On the merits of dirt roads. 1900 w. Eng Rec—Feb. 15, 1902. No. 46257.

Oil in Street Construction. T. F. White. Abstract of a paper read before the League of California Municipalities. Describes the practice during the last three years in San Bernardino County, Cal., in making roads of loose sand and sandy clay as well as better material, by soaking them with oil. 2600 w. Eng Rec—Feb. 22, 1902. No. 46424.

Roads and Transport Systems in Madagascar. A sketch of the railway in progress of construction, and explanation of the nature of work. Also account of the macadamized road, and discussion of the system of vehicular traffic to be used on it. 1500 w. U S Cons Repts, No. 1276—Feb. 27, 1902. No. 46479 D.

The Settlement of Lorraine Street, Hartford, Conn. Frederick L. Ford. Illustrated description of a big landslide and the method of checking it. 1300 w. Eng Rec—Feb. 22, 1902. No. 46425.

Structural Work.

Architectural and Constructional Engineering. T. C. Cunnington. Read before the British Archt. Assn. Describes a series of steel frame structures recently erected. Deals first with American tall structures, then with roofs executed to fill special requirements. 2000 w. Arch't, Lond—Jan. 14, 1902. No. 46117 A.

Earthquake-Proof Buildings in Japan. Illustrated description of methods of construction adapted to divide up brick walls in small sections firmly held by steelwork. 1400 w. Eng Rec—Feb. 22, 1902. No. 46431.

Some Features of the Design and Construction of High Buildings. William Copeland Furber. Outlines the courses that led to this peculiar type of building, and discusses the design and construction, giving illustrations. Considers fireproofing, rust protection, wind bracing, &c., &c. 10,700 w. Pro Engrs' Club of Phila—Jan., 1902. No. 46036 D.

Structural Steel Details of a Two-Story Boiler House. Illustrates and describes details of the new 16,000 h. p. boiler house of the United Railways and Electric Co. of Baltimore. 2500 w. Eng Rec—Feb. 1, 1902. No. 46071.

Steelwork in the Prudential Building, Newark. Illustrated detailed description of an interesting building. 1800 w. Eng Rec—Feb. 1, 1902. No. 46072.

Subway.

Mining Methods in the New York Subway. D. H. Newland. An illustrated article giving an account of the methods of construction, the materials, mechanical devices used, &c. 3500 w. Eng & Min Jour—Feb. 1, 1902. No. 46043.

Tunnel Explosion.

Explosion of Dynamite at the Rapid Transit Subway. An illustrated account of the disaster in New York at the corner of Park Avenue and Forty-first street. 900 w. Sci Am—Feb. 8, 1902. No. 46087.

The Dynamite Explosion on the New York Rapid Transit Subway. An account of the accident in New York city on Jan. 27, which caused loss of life and great destruction of property. 1300 w. Eng News —Jan. 30, 1902. No. 45915.

The Effect of a Surface Explosion of Dynamite. Illustrates and describes the surface effect of the explosion at 41st street and Park Avenue. 2200 w. Eng Rec—Feb. 1, 1902. No. 46070.

Wrecked by Dynamite. Brief account of the terrible explosion in New York rapid transit tunnel, which caused loss of life, many serious injuries, and a destruction of a million dollars worth of property. Ill. 1000 w. Fire & Water—Feb. 1, 1902. No. 45968.

Tunnels.

Driving Tunnels by Hand. J. H. Shockley. Some points of value from an experience of over twenty years throughout North America. 1000 w. Min & Sci Pr—Feb. 1, 1902. No. 46050.

The Pennsylvania Railroad Tunnel Bridge. Longitudinal view and cross section of proposed construction with notes. 600 w. Sci Am—Feb. 1, 1902. No. 45958.

MATERIALS.

Cement.

Tests and Constitution of Portland Cement. A. D. Elbers. A discussion of the tests adopted by engineering societies, with suggestions helpful in the study of causes of deterioration of current work. 3300 w. Am Mfr—Jan. 30, 1902. No. 45935.

The History, Manufacture, Testing, and Uses of Portland Cement. H. Howard Humphreys. Reviews the history, principal methods of manufacture, and of testing, in the present article. 4000 w. Quarry —Feb. 1, 1902. Serial. 1st part. No. 46212 A.

Cement Works.

The Cement Works of I. C. Johnson and Co., Ltd., Greenhithe. Plan and description of these works and their equipment, and some of the methods employed. Ill. 4000 w. Engr, Lond—Feb. 7, 1902. No. 46239 A.

The Rudelsburg Portland Cement Works (Die Portlandzementfabrik Rudelsburg). An illustrated description of the works of the Saxon-Thuringian Company, near Kösen, particularly of the dust-prevention apparatus. 1 plate. 3000 w. Zeitschr d Ver Deutscher Ing—Jan. 25, 1902. No. 46310 D.

Concrete.

Concrete Structures for Railways. W. A. Rogers. Abstract of a paper presented to the Illinois Soc. of Engrs. & Surv's. Review of current practice on United States railways in building culverts, abutments and short bridges of concrete. 1700 w. Eng Rec—Feb. 8, 1902. No. 46163.

Reinforced Concrete.

Development of Reinforced Concrete Construction from the Beginning to the Present (Entwicklung des Betoneisenbaues vom Beginn bis zur Gegenwart). J. A. Spitzer. An illustrated general review of the subject, with a particular account of some experiments made at Vienna in 1898. 3500 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 31, 1902. No. 46-359 B.

Tiles.

The Architect's Use of Enamelled Tiles. Halsey Ricardo. Considers their use on hygienic grounds, for saving or reflecting light, and for decoration. Also reviews the history of their use in early times, giving interesting information. Also discussion. 9000 w. Jour Soc of Arts—Jan. 24, 1902. No. 45978 A.

Timber.

Southern Timber Resources. B. E. Fernow. Information concerning the supplies and suggestions for their management. 2800 w. Mfrs Rec—Feb. 20, 1902. Special number. No. 46417.

MEASUREMENT.

Surveying.

Directions for Topographical Work in Mountains (Neue Anweisung für Vermessungen im Hochgebirge). Some Swiss regulations for trigonometrical and tachymetrical surveying. 1000 w. Schweiz Bauzeitung—Jan. 4, 1902. No. 46375 B.

Surveyor's Chains.

Standardization of Surveyor's Chains. Henry Louis. Abstract of a paper and discussion before the N. of Eng. Inst. of Min. & Mech. Engrs. Calls attention to the precautions that should be observed in setting out a standard length, and details those employed by the writer. 1800 w. Col Guard—Feb. 14, 1902. No. 46-452 A.

MUNICIPAL.

Asphalt Paving.

Criticisms of the New York Asphalt Pavement Specifications. A. W. Dow. Discusses the proposed new specifications submitted by the Engineer of the Commissioners of Accounts. 5500 w. Eng News—Feb. 6, 1902. No. 46111.

Proposed Changes in the New York Asphalt Paving Specifications. Report of Otto H. Klein submitted to the mayor of New York by the Commissioners of Accounts. It is mainly a comparison of the old and proposed new specifications. 6000 w. Eng News—Feb. 6, 1902. No. 46109.

Pavements.

Roads, Streets and Pavements. H. G. Tyrrell. Gives points on the location of roads, and discusses their construction in the present article. 2500 w. Can Engr—Feb., 1902. Serial. 1st part. No. 45973.

The Wooden Pavements of Paris. Letters from Major F. A. Mahan and F. A. Kummer on the traffic and the durability of such pavement. 2000 w. Eng Rec—Feb. 8, 1902. No. 46173.

Refuse Disposal.

See Electrical Engineering, Generating Stations.

Sewage Disposal.

A Sewage-Disposal System for a Country House. William C. Tucker. Illustrates and describes a sub-surface disposal-system for a house with three bathrooms and about twenty-one fixtures. 700 w. Am Arch't—Feb. 22, 1902. No. 46469.

Sewerage and Sewage Disposal at the Paris Exposition (Canalisationswesen und Abwasserreinigung auf der Pariser Weltausstellung 1900). Josef Ruiss. A general review of the exhibits of the various countries, with a well illustrated and comprehensive description of the Paris sewerage works. Serial. 2 parts. 16000 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 10, 17, 1902. No. 46357 each B.

The Purification of Sewage by Septic Tanks and Various Supplemental Processes. W. S. Shields. A paper, slightly condensed, read before the Illinois Soc of Engrs. & Surveyors. Gives experience with plants at Wauwatosa, Wis., and Lake Foust, Ill., with general remarks. 1800 w. Eng News—Jan. 30, 1902. No. 45917.

The Purification of Sewage. W. S. Shields. Slightly condensed from a paper read before the Illinois Soc. of Engrs. & Surv's. Describes the principles involved in the design of a number of American septic disposal systems. 2200 w. Eng Rec—Feb. 8, 1902. No. 46168.

The Septic Tank System at Fond du Lac. Describes a plant in which sewage is pumped by electric motors, stopped and started automatically, to a septic tank, the effluent of which is discharged either to filter beds or directly into a stream. 800 w. Eng Rec—Feb. 22, 1902. No. 46428.

The Sewage Disposal of Suburban Houses and Public Institutions. Dr. P. H. Bryce. Read at meeting of the Ontario Assn. of Archt's. Indicates an efficient and economical method of dealing with all house wastes. 3500 w. Can Archt—Feb., 1902. No. 46411 C.

Sewers.

Cleaning an Altoona Sewer. Illustrated description of the method employed on about a mile of 30-in. pipe sewer and 44 x 33-in. brick sewer. 900 w. Eng Rec—Feb. 8, 1902. No. 46164.

Concrete Sewer Construction at Coldwater, Mich. Harry V. Gifford. Illustrated description of the methods used, and a report of tests of materials and other information. 2400 w. Eng News—Jan. 30, 1902. No. 45918.

Making Sewer Connections. Discusses the connecting of house drains, intercepting traps, air inlets, &c. Ill. 2500 w. Met Work—Feb. 1, 1902. No. 45923.

The Design of Sewers (Beitrag zur Berechnung von Kanalisationscitungen). Hr. Hecker. Graphical and other methods for calculating sewer systems adequate for any possible rainfall. Tables. Serial. 2 parts. 3 plates. 4000 w. Gesundheits Ing—Dec. 15, 31, 1901. No. 45897 each B.

The Early History of the Memphis Sewers. Extracts from a paper by A. T. Bell, describing the separate sewers built between 1880 and 1897, which first established in the United States the correct principles to follow in designing such work. Also editorial comment. 3300 w. Eng Rec—Feb. 15, 1902. No. 46258.

The Sewerage Systems of Sydney, N. S. W. Brief description of the various compressed air, electric, and steam pumping plants, mechanical and biological sewage treatment works, and other features of the sewerage systems employed. 1600 w. Eng Rec—Feb. 15. 1902. No. 46261.

WATER SUPPLY.

Driven Wells.

A Driven Well Gravity Water Supply. Describes an unusual well system installed as a supply for mills and tenements in Massachusetts. Ill. 1100 w. Eng Rec—Feb. 1, 1902. No. 46069.

Drought.

The Autumns's Drought. An Account of the drought in England during the autumn of last year, and its effect on the water supply. 4000 w. Engr, Lond—Feb. 7, 1902. No. 46240 A.

Filtration.

The Puech Graded Gravel Filters (Les Filtres Degrossisseurs Puech). Hippolyte Fontaine. A short, illustrated account of this filtration system, in which the water flows successively through three beds of gravel, the coarsest first. 1500 w. Bull Soc d'Encouragement—Jan., 1902. No. 46389 G.

Settling Basins and Slow Sand Filter Beds for Pittsburg, Pa. An illustrated description of the plan and details of the work proposed. The chief objects are to remove turbidity and bacteria. 2800 w. Eng News—Feb. 13, 1902. No. 46197.

Ground Water.

A New Method of Determining the Velocity of Underground Water. Charles S. Slichter. Describes an electrical method which has given satisfactory results with rapidity. Ill. 900 w. Eng News—Feb. 20, 1902. No. 46491.

Ground Water Supplies and the Oyster Industry. Text of a decision of the N. Y. Supreme Court in a suit to prevent the operation of a ground water pumping station because it diminished the fresh water at the mouth of a creek where oysters are fattened. 1100 w. Eng Rec—Feb. 22, 1902. No. 46430.

Hamilton, Ohio.

Contamination of the Water Supply of the City of Hamilton, Ohio. John Lorenz. Gives briefly the history of this city's supply, and the plan adopted for remedying the latest trouble. 1200 w. Munic Engng—Feb., 1902. No. 46034 C.

Inaugural Address.

Mr. Percy Griffith on Water Supply. Extract from the inaugural address at the Society of Engineers, touching on the lines of advancement for the present and future. 5000 w. Jour Gas Lgt—Feb. 11, 1902. No. 46437 A.

London.

London Water Supply. Editorial discussion of the present outlook for the settlement of the Metropolitan water question, by the establishment of a water board. 3300 w. Engng—Feb. 7, 1902. No. 46233 A.

The Purchase of the London Water Companies' Works. An outline of the Local Government Board's project for purchasing and managing the works of the companies supplying London and the vicinity with water. 1000 w. Eng Rec—Feb. 22, 1902. No. 46429.

North Sea Islands.

The Water Supply of Some North Sea Bathing Resorts (Die Wasserversorgung einiger Nordseebäder). Hr. Herzberg. A paper before the "Deutscher Verein von Gas und Wasserfachmännern," giving an account of borings and ground-water conditions on the East Frisian Islands, with discussion. 4000 w. Gesundheits Ing—Nov. 30, 1901. No. 45878 B.

Reservoirs.

Further Reports on the Jerome Park Reservoir. Letters from Mr. Elnathan Sweet, and Mr. J. J. R. Croes, with responses by Mr. Wm. R. Hill. 5700 w. Eng News—Feb. 6, 1902. No. 46108.

Government Construction of Reservoirs in Arid Regions. H. M. Chittenden. A statement of the reservoir problem of the arid section of the United States, showing its importance, and discussing the question in its various aspects. 6000 w. N Am Rev—Feb., 1902. No. 45921 D.

Riparian Rights.

Interstate Riparian Water Rights. Full text of decision of United States Circuit Court of Appeals in Pine v. Mayor of New York. This decision practically forbids any corporation or individual of one state to interfere in any manner with the free flow of water in a stream entering another state. Also editorial. 4600 w. Eng Rec—Feb. 8, 1902. No. 46169.

Turbidity.

Method of Calibrating Turbidimeters. George C. Whipple and Daniel D. Jackson. Illustrates the essential parts of the instrument explaining its use and the method of calibrating. 1500 w. Tech Quar—Dec., 1901. No. 46008 E.

Waste.

Water Cost and Water Waste. A. L. Holmes. Abstract of a paper read before the Mich. Engng. Soc. at Grand Rapids. Reports concerning the supply of several important cities, and favors the metering of water systems. 2300 w. Eng News—Feb. 6, 1902. No. 46106.

Water Waste in Cleveland. Describes experiments proving the large waste of water in Cleveland and the efficacy of meters in preventing it. 700 w. Eng Rec—Feb. 22, 1902. No. 46426.

Water Bill.

The London Water Bill. Abstract of the Government Bill in connection with the water supply, with editorial comment. Proposes to establish a Water Board of sixty-seven members with a chairman and vice-chairman. 4500 w. Engr, Lond—Feb. 7, 1902. No. 46241 A.

Water Works.

America's First Water Works. From the *Bethlehem Times*. Brief description of an arrangement for suplying a small community with water, which was put in operation in 1754. 1300 w. Dom Engng—Feb. 15, 1902. No. 46466 C.

Some Economic Features of Municipal Engineering. C. S. Burns. Mainly devoted to an explanation of the great possibilities in the way of economy that can be secured by attention to small details of water-works design. 2900 w. Eng Rec—Feb. 8, 1902. No. 46166.

MISCELLANY.

Temperature.

The Temperature of Germany in Its Relation to Artificial Heating (Die Temperaturverhältnisse Deutschlands, soweit sie für die Beheizung der Räume in Betracht Kommen). Hr. Marx. A paper before the Heating and Ventilating Engineers on the climate, and particularly the temperature of Germany, with tables and diagrams. 3000 w. Gesundheits Ing—Jan. 15, 1902. No. 45882 B.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cable Repairing.

A New Telegraph Steamer, SS. "Viking." Description of latest cable laying and repairing steamer, and its equipment. Ill. 1800 w. Elec Rev, Lond—Jan. 31, 1902. No. 46246 A.

Cables.

Telephone Cables—Their Construction and Maintenance. P. Kerr Higgins. An illustrated article stating the conditions as they exist at the present time. 3000 w. Am Tel Jour—Feb. 1, 1902. Serial. 1st part. No. 46024.

The German-American Cable. From the *Elektrotechnische Zeitschrift.* An interesting account of the new Emden-Fayal-New York cable which was laid over a year ago. 3500 w. Elect'n, Lond—Feb. 14, 1902. No. 46445 A.

The Manufacture of Submarine Cables. The new cable-works of Siemens and Halske are illustrated and the process of manufacture is described. 1400 w. Sci Am—Feb. 8, 1902. No. 46086.

Development.

The Development of Electrical Science. From an address by Henry A. Gray, at a meeting of the Engineer's Club of Toronto. Traces the development of telegraphy, telephony, and electric lighting. 3000 w. Can Elec News—Feb., 1902. No. 46187.

Exchange.

The National Telephone Co.'s New Battersea Exchange. Illustrated description of an exchange with a lamp-signal switch board, working on the Kellogg central battery system. 2000 w. Elect'n, Lond—Feb. 7, 1902. Serial. 1st part. No. 46219 A.

Farm Lines.

Farm Telephone Lines in Northern Ohio. A. E. Dobbs. Gives briefly the history of lines in Geauga County. Ill. 3500 w. Am Tel Jour—Feb. 15, 1902. No. 46273.

Space Telegraphy.

How to Construct an Efficient Wireless Telegraph Apparatus at a Small Cost. A. Frederick Collins. Illustrated description. 1500 w. Sci Am Sup—Feb. 15, 1902. No. 46207.

Induction Wireless Telegraphy. V. H. Emerson. A brief account of this system as operated on the Lehigh Valley and other railroads. 1000 w. Elec Wld & Engr—Feb. 15, 1902. No. 46292.

Marconi's Achievement. Remarks on his recent success in signalling from Cornwall, England, to Newfoundland. 1200 w. Mach, N. Y—Feb., 1902. No. 46078.

Some Wireless Telegraph Stations of the Allgemeine Elektricitäts Gesellschaft (Einige Funkentelegraphische Installationen der Allgemeinen Elektricitäts Gesellschaft). Graf Arco. An illustrated description of wireless telegraph installations on the Slaby-Arco system on board the "Deutschland," at Cuxhaven, and on a lightship and at a lighthouse near Esbjerg, Denmark. 1000 w. Elektrotech Zeitschr—Jan. 30, 1902. No. 46327 B.

The Actual State of Wireless Telegraphy with Hertzian Waves (Sur l'Etat Actuel de la Télégraphie sans Fil par Ondes Hertziennes). Capt. Ferrié. An illustrated paper giving a good general review of the whole subject. 1100 w. Bull Soc Internationale d'Electriciens—Jan., 1902. No. 46397 E.

The Marconi School of Wireless Telegraphy. H. J. Shepstone. Illustrated account of a school opened at Frinton-on-Sea, in Essex, England, for the teaching of wireless telegraphy. 800 w. Sci Am—Feb. 1, 1902. No. 45960.

Wireless Telegraphy. H. W. Sullivan. Notes on the history, and present and future prospects of the new enterprise as an industry. 1400 w. Elec Rev, Lond—Feb. 14, 1902. No. 46448 A.

Space Telephony.

Wireless Telephony Through the Earth (Téléphonie sans Fil, par la Terre). E. Ducretet. Notes on experiments with the transmitter connected to earth plates and the receiver to a small sphere on the floor of the catacombs. Speech was well reproduced. 400 w. Comptes Rendus—Jan. 13, 1902. No. 46396 D.

Synchronous Telegraphy.

Modern Synchronous Telegraph Systems (Moderne Telegraphen-Systeme mit Synchroner Bewegung). Karl v. Barth. An illustrated description of the Hughes, Baudot, Delany and other systems and apparatus. 1 plate. 5000 w. Oesterr Wochenschr f d Oeffent Baudienst—Jan. 25, 1902. No. 46355 B.

Telautograph.

The Gruhn Telautograph (Ueber einen Neuen Telautographen der Kopier-Telegraph-Gesellschaft m. b. H., Dresden). Hr. Gruhn. Paper before the Elektrotechnischer Verein giving an illustrated description of an aparatus for transmitting writing and sketches telegraphically. At the receiving station a mirror, controlled by the transmitter, throws a beam of light which photographs the record. 4000 w. Elektrotech Zeitschr—Feb. 6, 1902. No. 46332 B.

Telephony.

Electrolysis of Telephone Cables. A. E. Dobbs. Discusses the trouble in connection with underground cables, and the methods of preventing. Ill. 2000 w. Am Tel Jour—Feb. 8, 1902. No. 46140.

Multiple Switchboards. A. E. Dobbs. Describes only the drop or target type, and shows the advantage of multiple switchboard to operators of seven small exchanges. 1600 w. Am Tel Jour—Feb. 22, 1902. No. 46412.

Telephony in Great Britain. Gives brief descriptions of the three competitive systems which have been put into operation, explaining the attitude of the government. Ill. 2800 w. Elec Rev, N. Y—Feb. 15, 1902. No. 46284.

Telephony Twenty Years Ago and Today. Thomas D. Lockwood. A brief review of the general advancement made. 1600 w. Elec Rev, N. Y—Feb. 15, 1902. No. 46288.

The Common Battery System. J. J. Carty. An address before the New York Elec. Soc. Reviews the recent important advances made in telephony, and outlines the main features of the system named. 2400 w. Elec Rev, N. Y—Feb. 22, 1902. No. 46468.

Transmitter.

A New Loud Speaking Microtelephone (Un Nouveau Microtélephone Haut Parleur.) From a paper by W. Krejsa before the Vienna Electro-Technical Society. An illustrated description of a transmitting apparatus in which the indication coil has an armature whose distance from the core varies with the current. 400 w. Electricien—Sept. 28, 1901. No. 45847 B.

DISTRIBUTION.

Conduits.

Separate Conduits for High and Low Potential Wires. William Brophy. Abstract of a paper read before the International Assn. of Munic. Electr'ns. An account of the causes that led to placing all electric wires underground, and the systems of distribution in use. Considers also the losses due to the joint occupancy of conduits. 5200 w. Am Tel Jour—Feb. 22, 1902. Serial. 1st part. No. 46413.

Controller.

Simplified Polyphase Current Controller (Ueber Vereinfachte Drehstromkontroller). Eugen Klein. An illustrated description of a form of controller in which the number of contact pieces and connections is greatly reduced. 800 w. Elektrotech Zeitschr—Jan. 23, 1902. No. 46322 B.

Distributing Mains.

Practical Notes on Continuous-Current Distributing Mains. John C. A. Ward. Abstract of a paper read before the Glasgow Soc. of the Inst. of Elec. Engrs. Presents some of the causes that effect the efficiency of distribution, and gives a comparison of the different systems. Ill. 2500 w. Elect'n, Lond—Jan. 24, 1902. Serial. 1st part. No. 46000 A.

Earth Currents.

Earth Currents Derived from Distributing Systems. E. Basil Wedmore. Read before the Inst. of Elec. Engrs., England. A statement of some of the conclusions reached, with their application. 3500 w. Elect'n, Lond—Jan. 24, 1902. Serial. 1st part. No. 45999 A.

The Leakage of Current from Buried Bare Conductors. Reviews the paper by E. Basil Wedmore before the Inst. of Elec Engrs and its discussion. Ill. 1400 w. Elec Rev, Lond—Feb. 14, 1902. No. 46447 A.

Electricity Supply.

Some Notes on the Influence of the Sub-Station Equipment and Transmission Line on the Cost of Electricity Supply. Andrew Stewart. Read before the Newcastle section of the Inst. of Elec. Engrs. Discusses the distribution system under present conditions, and some points in the equipment of sub-stations. 2400 w. Elec Engr, Lond—Jan. 31, 1902. Serial. 1st part. No. 46125 A.

Single-Phase.

Single-Phase Transmission Plant with Power Distribution. Illustrated detailed description of the water-power plant at La Goule. 1200 w. Am Elect'n—Feb., 1902. No. 46026.

Transformer Switches.

The Economy of Automatic Transformer Switches (Ueber die Oekonomie von Hochspannungsfernschaltern). E. H. Geist. A discussion, showing that only in exceptional cases is it economical to instal switches which automatically cut out the primary winding of a transformer when there is no load on the secondary. 1200 w. Elektrotech Zeitschr—Jan. 16, 1902. No. 46319 B.

ELECTRO-CHEMISTRY.

Accumulators.

Accumulator Cells with Carriers of Light Non-Conducting Materials. A description of a secondary cell, the invention of A. Ricks. 1400 w. Elect'n, Lond—Feb. 14, 1902. No. 46444 A.

The Construction of a Small Storage

Cell. H. F. Shepherd. Sketches and description of a cell which has given excellent results. 800 w. Am Elect'n—Feb., 1902. No. 46029.

The Influence of Temperature on the Capacity of Lead Accumulators (Ueber den Einfluss der Temperatur auf die Kapacität der Bleiakkumulatoren). Ch. Liagre. From *L'Eclairage Electrique.* A record of experiments with a d'Arsonval-Vaugeois cell, with positive and negative Planté plates, showing that the capacity increases with the temperature. Diagram. 600 w. Elektrotech Zeitschr—Jan. 16, 1902. No. 46320 B.

The Leitner Accumulators for Electromobile and Traction Work. Illustrated article giving information concerning storage batteries for automobile and traction use, for central station work, and for train and yacht lighting. 2000 w. Elec Times —Feb. 6, 1902. No. 46208 A.

Welsbach's Carbon-Zinc-Cerium Salt Accumulator. Brief description. 1600 w. Horseless Age—Feb. 12, 1902. No. 46183.

Alkalies.

The "Bell" Gravity Process for the Electrolytic Production of Alkalies and Chlorine. John B. C. Kershaw. A description of the "Bell" cell and estimates of costs. 1100 w. Elect'n, Lond—Feb. 7, 1902. No. 46223 A.

Aluminum.

The Electrolytic Production of Aluminum (Versuche über Aluminiumdarstellung). F. Haber and R. Geipert. An illustrated account of elaborate laboratory experiments to determine the processes in general use with scientific exactness. 2 parts. 7000 w. Zeitschr f Elektrochemie —Jan. 2, 9, 1902. No. 45863 each G.

Carbon Bisulphide.

The Electrical Manufacture of Carbon Bisulphide. Edward R. Taylor. Gives illustrations of the furnace, with description. 1000 w. Elec Rev, N. Y—Feb. 1, 1902. No. 45944.

Review.

Electro-Chemistry in 1901 (Die Elektrochemie im Jahre 1901). Dr. M. Krüger. A general review. The present number is devoted to theoretical investigations and publications. Serial. 1st part. 2000 w. Elektrochemische Zeitschr—Jan., 1902. No. 45868 G.

Storage Batteries.

See Electrical Engineering Generating Stations.

ELECTRO-PHYSICS.

Atomic Theory.

Recent Developments of the Atomic Theory and Its Connection with Light and Electricity. C. C. Garrard. Gives, in the present article, a summary of recent investigations and discoveries which show that long accepted theories must be revised. 1600 w. Elec Rev, Lond—Feb. 7, 1902. Serial. 1st part. No. 46217 A.

Discharges.

Rotary Disks. Alfred G. Dell. A report of experimental investigations of electrical discharges in a spark gap beneath a rotating mica disk. 1800 w. Elec Wld & Engr—Feb. 15, 1902. No. 46293.

Electrical Phenomena.

Celestial Explosions and Their Relations to Electrical Phenomena. Hudson Maxim. Explains what an explosion really is, and considers some celestial explosions. Ill. 4700 w. Elec Age—Jan., 1902. No. 46020 C.

Electrodynamics.

General Equations of Electrodynamics in Conductors and Perfect Dielectrics at Rest (Equations Générales de l' Electrodynamique dans les Conducteurs et les Diélectriques Parfaits en Repos). E. Carvallo. A generalisation of Kirchhoff's two laws, with interpretation, application and comparison with Maxwell's results. 800 w. Comptes Rendus—Jan. 6, 1902. No. 46393 D.

Electrostatic Field.

The Electrostatic Field about an Electric Current and the Theory of Professor Poynting (Sur le Champ Electrostatique autour d'un Courant Electrique et sur la Théorie du Professeur Poynting). W. de Nicolaiève. A description and record of experiments. 600 w. Comptes Rendus—Jan. 6, 1902. No. 46392 D.

Hysteresis.

Rotary Hysteresis (Ueber Rotirende Hysteresis). A. Dina. An experimental comparison between rotary, static and alternating current hysteresis, with curves and tables. 4000 w. Elektrotech Zeitschr —Jan. 16, 1902. No. 46316 B.

Interrupter.

A New Mercury Interrupter (Ein Neuer Quecksilverstrahl-Unterbrecher). An illustrated description of a current interrupter to be used in connection with induction coils for Röntgen ray work, in which a stream of mercury is broken at intervals in a liquid insulating material. 1000 w. Elektrotech Zeitschr—Feb. 6, 1902. No. 46-331 B.

Magnetic Deflection.

Magnetic Deflection of Long Steel-Wire Plumb-Lines. Dr. William Hallock. A report of experiments made and evidence found, which support the conclusion that iron or steel wire ought not to be used for plumb-lines where accuracy is needed. 700 w. Elec Wld & Engr—Feb. 8, 1902. No. 46157.

Magnetic Properties.

The Relation between the Magnetic

Properties and the Electrical Conductivity of Magnetic Materials (Ueber das Verhältniss der Magnetischen Eigenschaften zum Elektrischen Leitvermögen Magnetischer Materialien). E. Gumlich. A review of experiments by Barrett, Brown and Hadfield described in the *Scientific Transaction of the Royal Dublin Society,* showing particularly the influence of aluminum and silicon on iron. Tables. 1500 w. Elektrotech Zeitschr—Feb. 6, 1902. No. 46329 B.

Magnetic Saturation.

The Best Degree of Saturation for Polyphase Generators (Günstigster Sättigungsgrad Mehrphasiger Generatoren). Emil Korrodi. The best flux density for the field magnets of polyphase generators is shown graphically. 400 w. Elektrotech Zeitschr—Jan. 16, 1902. No. 46318 B.

Magnets.

Tractive Magnets for Straight and Circular Movements (Hubmagnete für Gerade und Kreislinige Bewegungen). F. R. Dietze. An illustrated description of electromagnets, with variously shaped cores and pole-pieces, for lifting and tractive purposes. 1000 w. Elektrotech Zeitschr—Feb. 13, 1902. No. 46334 B.

Radiography.

On Radio-Active Bodies (Sur les Corps Radioactifs). P. and C. Curie. On the nature of the emission from these bodies and of its duration. 600 w. Comptes Rendus—Jan. 13, 1902. No. 46395 D.

Resonance.

Resonance (Ueber Resonanzerscheinungen). Dr. Gustav Benischke. A paper before the Elektrotechnischer Verein, giving various examples of mechanical and electrical resonance, and describing experiments with a small revolving weight which set a table vibrating. 3000 w. Elektrotech Zeitschr—Jan. 30, 1902. No. 46-328 B.

Terrestrial Magnetism.

The Absolute Value of the Magnetic Elements on Jan. 1, 1902 (Sur la Valeur Absolue des Eléments Magnétiques au 1er Janvier, 1902). Th. Moureaux. The terrestrial magnetic components, declination, inclination and total force at the observatory of Val-Joyeux near Versailles away from the influence of railway currents. 200 w. Comptes Rendus—Jan. 6, 1902. No. 46394 D.

GENERATING STATIONS.

Alternators.

Alternating Current Machinery for High and Low Frequencies. B. A. Behrend. Illustrated detailed description of generating units in modern use. 1200 w. Elec Rev, N. Y—Feb. 15, 1902. Serial. 1st part. No. 46289.

Alternating Currents.

The Beginning of Alternating-Current Engineering. William Stanley. An interesting account of the introduction and development of the alternating system. Ill. 2500 w. Elec Rev, N. Y—Feb. 15, 1902. No. 46286.

Berlin.

The Berlin Electric Stations in 1902 (Die Berliner Elektricitäts-Werke im Jahre 1902). L. Datterer. A very comprehensive and well illustrated paper. In this part special attention is given to the engines in the Oberspree and Moabit stations. Serial. Part I. 2 plates. 6000 w. Zeitschr d Ver Deutscher Ing—Feb. 8, 1902. No. 46336 D.

Bermondsey.

Bermondsey Combined Refuse Destructor and Electricity Supply Works. Illustrated description of an installation in a suburb of London, said to constitute a part of the most complete and up-to-date municipal undertaking to be found in the United Kingdom. 2400 w. Elec Engr, Lond—Jan. 24, 1902. Serial. 1st part. No. 45994 A.

Bolton.

Electric Generators for the Bolton Corporation. Illustrates and describes the special tests of the two 1100-kilowatt generators, with brief history of the company that built them. 2300 w. Engr, Lond—Jan. 24, 1902. No. 45988 A.

Commutation.

Modern Commutating Dynamo Machinery, with Special Reference to the Commutating Limits. H. M. Hobart. Read before the International Engng. Con., Glasgow, 1901. Views regarding the continuous-current dynamo-electric machine, describing designs. Ill. 3200 w. Engng—Feb. 7, 1902. Serial. 1st part. No. 45237 A.

Electric Supply.

Principles and Profits in Electric Supply. (A Reply to Critics). W. B. Esson. An answer to criticisms, and supplemental to a previous article. 3200 w. Elect'n, Lond—Feb. 7, 1902. No. 46221 A.

The Supply of Electricity in Bulk. Hardman A. Earle. Abstract of a paper read before the Manchester Soc. of the Inst. of Elec. Engrs. Discusses the opposition to electric supply schemes due to the opinion that they are unnecessary and likely to prove financial failures. The present article outlines the general system, and discusses cost. 3500 w. Elect'n, Lond—Feb. 7, 1902. Serial. 1st part. No. 46222 A.

Germany.

Traction, Light and Power Practice in Germany. Abstracts of the discussions of the London section of the Inst. of Elec.

Engrs. on the works visited and things seen on their recent visit to Germany. The present article is devoted to the subjects in title. 2700 w. Elec, N. Y—Jan. 29, 1902. No. 45902.

"Hunting."

The "Hunting" of Parallel-Coupled Dynamos (Das Pendeln Parallel Geschalteter Maschinen). A. Foppl. A mathematical discussion of the oscillation of electrical energy between dynamos operated in parallel. 5000 w. Elektrotech Zeitschr—Jan. 23, 1902. No. 46321 B.

Isolated Plant.

The Electric Light and Power Plant of the New United States Mint, Philadelphia. Clayton W. Pike. An illustrated detailed description of the electrical equipment. 3300 w. Elec Wld & Engr—Feb. 1, 1902. No. 46011.

The Light and Power Plant of the Mazawattee Tea Company. Illustrates and describes an interesting installation in these new works at New Cross, Eng. 2700 w. Elec Engr, Lond—Jan. 31, 1902. No. 46247 A.

Manhattan Power Stations.

Electrical Machinery in the Power Station and Substations of the Manhattan Ry. Co. Illustrates the more important machines, with brief descriptions. 2000 w. Eng News—Jan. 30, 1902. No. 45910.

Melbourne.

City of Melbourne Electric System. A. J. Arnot. Illustrated detailed description of a comprehensive light and power plant. 2000 w. Aust Min Stand—Dec. 26, 1901. No. 45906 B.

New Zealand.

Electric Power Plant, Rotorna. Oswald Haes. Describes an interesting plant in New Zealand. 3000 w. Aust Min Stand —Dec. 12, 1901. Serial. 1st part. No. 45969 B.

Railway Generator.

1000 K. W. Railway Generator, built by the Union Electric Co., Berlin (1000 K. W. Bahngenerator der Union Elektricitäts-Gesellschaft in Berlin). Dr. Niethammer. An illustrated description of a compound wound, 500 volt, direct current dynamo for the Sheffield (England) tramways. 400 w. Elektrotech Zeitschr—Jan. 16, 1902. No. 46317 B.

Rheostat.

See Electrical Engineering, Measurement.

Rochester, N. Y.

The Central Station of the Citizens' Light and Power Company, Rochester, N. Y. History of this company with illustrated description of the plant and equipment. 7200 w. Elec Rev, N. Y—Feb. 1, 1902. No. 45945.

The New Power Plant of the Citizens' Company of Rochester, N. Y. Illustrated detailed description of a first-class modern electrical station. 6000 w. Elec Wld & Engr—Feb. 1, 1902. No. 46010.

Shawinigan Falls.

The Shawinigan Falls Electrical Development. An illustrated article giving information, particularly relating to the hydraulic portion of the plant. 2500 w. Elec Wld & Engr—Feb. 8, 1902. No. 46156.

Storage Batteries.

Storage Batteries in the Baltimore Belt Line Tunnel Power Plant. An illustrated article describing the battery installed and the service. 900 w. Elec Wld & Engr—Feb. 15, 1902. No. 46291.

Some Results of a Secondary Battery in a Traction Station. States the conditions to be met and the successful results, giving cost. 1100 w. Elec Rev, Lond—Feb. 14. 1902. No. 46446 A.

The Storage Battery in Central Stations. Otto E. Osthoff. Describes some of the details of these installations and discusses their application. 1800 w. Central Station—Feb., 1902. No. 46023.

HEATING AND WELDING.

Electric Furnace.

Electricity in Glass Manufacture. From *Elektrochemische Zeitschrift.* Illustrates and describes the Becker furnace used in experiments at Cologne, discussing the theoretical and practical aspects of the subject. 1700 w. Engr, Lond—Feb. 14. 1902. No. 46463 A.

LIGHTING.

Enclosed Arcs.

The Spectrum of the Enclosed Arc. Dr. Louis Bell. Describes a spectrum accidentally observed. 1200 w. Elec Wld & Engr—Feb. 1, 1902. No. 46009.

Illumination.

The Principles of Illumination. A study in abstract of a paper by D. Burnett, read before the Brooklyn Inst. of Arts and Sciences, indicating the directions in which further improvement in artificial light may take place. 1200 w. Engr, Lond—Jan. 31, 1902. No. 46133 A.

Municipal Plant

An Analysis of the Sixth Detroit Municipal Plant Report. The report of the Detroit Public Lighting Commission. 3500 w. Elec Wld & Engr—Feb. 15, 1902. No. 46295.

Municipal Electric Light Plants. An unfavorable report on municipal plants by a committee of the Worcester, Mass., board of aldermen. 2000 w. Elec Rev. N. Y—Feb. 8, 1902. No. 46159.

Nernst Lamps.

Practical Value of Nernst Lamps. Alton D. Adams. Discusses to what extent the qualities of the Nernst lamp fit it to displace the arc and incandescent types. 1300 w. Sci Am—Feb 8, 1902. No. 46085.

Night Lamps.

Home-Made Electric Night Lamp. George M. Hopkins. Illustrated description of a simple device for producing a temporary light. 500 w. Sci Am—Feb. 15, 1902. No. 46203.

Review.

Electric Lighting Twenty Years Ago and Since. Prof. Elihu Thomson and Mr. Edwin R. Weeks. Two reviews of interest. 2000 w. Elec Rev, N Y—Feb. 15, 1902. No. 46285.

MEASUREMENT.

Dynamo Testing.

Dynamo-Testing at the English Electric Manufacturing Company's Works, Preston. Comments on the striking features of the works of the English Electric Manufacturing Co., and the tests of two 1100-kilowatt continuous-current machines. Ill. 2800 w. Engng—Jan. 24, 1902. No. 45984 A.

Energy.

Some Important Points in the Commercial Measurement of Electric Energy. Elton J. King. Considers some points in the problem of metering the circuits by the most generally used methods. 4000 w. Engr, U S A—Feb. 1, 1902. No. 46048.

Motor Losses.

The Testing of Motor Losses. W. E. Sumpner. Read before the Birmingham Sec. of the Inst. of Elec Engrs. Suggests three methods of making measurements each of which possesses some advantages. 3000 w. Elect'n, Lond—Feb. 7, 1902. No. 46224 A.

Motor Tests.

Tests of a Compensated Asynchronous Motor. Alexander Heyland. From *Elektrotechnische Zeitschrift.* An account of interesting tests. Those with the compensated motor consisted in determining the position of the brushes giving a minimum phase displacement, and then determining the number of turns of exciting winding just sufficient to prevent all phase displacement. The tests as a generator were the more interesting Ill. 1700 w. Elect'n, Lond—Jan. 24, 1902. No. 45997 A.

Phase.

A New Method of Determining the Shifting of Phase in Alternators with Revolving Pole Rings (Eine Neue Methode zur Bestimmung der Phasenverschiebung an Wechselstrommaschinen mit Rotirendem Polrad). Ottomar Queisser. The poles appear to stand still, when viewed by the light of an arc lamp fed with the alternating current, in a position depending upon the phase angle. 900 w. Elektrotech Zeitschr—Feb. 6, 1902. No. 46330 B.

A New Method of Determining the Angle of Phase Displacement in Alternators with Rotating Pole Rings. O. Queisser. Translated from the *Elektrotechnische Zeitschrift.* Explanation of method. 1100 w. Elec Engr, Lond—Feb. 14, 1902. No. 46443 A.

Rheostat.

Determination of the Number and Amount of the Steps of a Rheostat for the Shunt Windings of Generators (Bestimmung der Stufenzahl und der Einzelnen Stufen für Nebenschlussregler von Generatoren). Rudolf Krause. An illustrated description of a method for designing the resistances for regulating the electromotive force of a dynamo. 1000 w. Elektrotech Zeitschr—Jan. 23, 1902. No. 46-323 B.

Improved Plug Rheostats (Neuerung an Stöpselrheostaten). W. Knobloch. An illustrated description of resistance boxes in which one or more metal strips are inserted between those in which are the plug holes, by which arrangement the manipulation is simplified. 800 w. Elektrotech Zeitschr—Feb. 13, 1902. No. 46335 B.

POWER APPLICATIONS.

Cotton Mills.

Power Plant of Dominion Cotton Mills Co., Magog. Illustrated detailed description of a plant in Quebec, and its equipment. 2700 w. Can Engr—Feb., 1902. No. 45971.

Crane.

Five-Ton Electric Traveling Gantry Crane. Illustrated description of a large gantry crane made in Cleveland, Ohio. 1000 w. Engng—Feb. 7, 1902. No. 46231A.

Dock Equipment.

Electric Cranes and Capstans at Middlesbrough Docks. Illustrated description of an example of the complete equipment of docks with electric cargo appliances. Also editorial. 3000 w. Elect'n, Lond—Feb. 7, 1902. Serial. 1st part. No. 46220 A.

Electric Equipment of Railway Docks, Middlesborough, England. Illustrates and describes a fine plant at Middlesborough, England, for the North-eastern Railway Co's docks. 2200 w. Elec Wld & Engr—Feb. 1, 1902. No. 46012.

Induction Motor.

The Induction Motor. Alfred E. Wiener. Explains the principle of the rotary magnetic field, and the design of the induction motor. Ill. 4800 w. Elec Age—Jan., 1902. No. 46021 C.

Mining Plant.

A Large Electrical Winding Plant. Lee Murray. Illustrates and describes the plant installed in a mine at Thiede, near Brunswick (Germany). 3900 w. Aust Min Stand—Jan. 9, 1902. No. 46439 B.

The Progress of Electricity in Mining During 1901. Reports steady progress without startling developments, noting the special features. 2200 w. Col Guard—Jan. 31, 1902. No. 46128 A.

Motor Work.

Starting Resistances. Arthur E. Gott. Read before the Newcastle Sec. of the Inst. of Elec. Engrs. Discusses incorrectly divided resistances, starting without resistance, and early starters, in this present number. 2700 w. Elec Engr, Lond—Jan. 24, 1902. Serial. 1st part. No. 45995 A.

Power Consumption.

The Power Consumption of Electrically Driven Machines (Force Motrice Applications du Moteur Electrique). M. Derry. From a paper before the congress of the "Syndicat des Usines d'Electricité," giving figures for a great variety of machines. 700 w. Electricien—Dec. 28, 1901. No. 45857 B.

Shipbuilding.

Electric Appliances in Shipbuilding Yards. Sydney F. Walker. Mr. Walker's second paper is devoted to the construction and uses of portable electric tools in all departments of shipbuilding. 3500 w. Engineering Magazine—March, 1902. No. 46385 B.

Electric Transmission at the Palmer Shipyard at Jarrow-on-Tyne (Transmission de Force par l'Electricité dans les Ateliers de la Palmer Shipbuilding and Iron Co. à Jarrow-sur-Tyne, Angleterre). Chas. Dantin. An illustrated description of the electric plant and electric driving in the shops and yard. 3000 w. Génie Civil—Feb. 1, 1902. No. 46344 D.

Tide-Indicator.

Description of an Electrical Tide-Indicator. L. Y. Schermerhorn. Illustrated description of an apparatus that has been in successful operation since Aug. 26, 1901. 1500 w. Pro Engrs' Club of Phila—Jan., 1902. No. 46039 D.

Tool Operation.

Electrical Operation of Tools. Abstract of a lecture by Robert T. Lozier before the New York Electrical Society. Discusses the economy, increased output, convenience, &c. 2400 w. Mach, N. Y—Feb., 1902. No. 46079.

MISCELLANY.

Electrical Development.

Twenty Years of Electrical Development. Charles T. Child. A review of progress from 1882 to 1902. 5200 w. Elec Rev, N Y—Feb. 15, 1902. No. 46283.

Europe.

Electricity in Europe Twenty Years Ago and To-day. A statement of such facts as will show a comparison between the use of a score of years ago and today. 3800 w. Elec Rev, N Y—Feb. 15, 1902. No. 46290.

Gutta Percha.

Gutta Percha in the Philippines. J. Orton Kerbey. Information from advance sheets of the Philippine Commission's reports. 1800 w. Elec Wld & Engr—Feb. 1, 1902. No. 46013.

Lightning Protection.

Lightning and Lightning Protectors (Ueber Blitz und Blitzableiter). F. Wellisch. A review of the theory and practice of lightning protection. 4500 w. Oesterr Wochenschr f d Oeffent Baudienst Jan. 4, 1902. No. 46349 B.

Pan-American.

Electricity at the Recent Buffalo Exposition. Comments on the illuminations and electrical exhibits, giving highest praises. 3300 w. Engng—Jan. 24, 1902. No. 45-980 A.

Stray Currents.

See Electrical Engineering, Communication, Street and Electric Railways.

Terminology.

Technical Terminology. Calls attention to some of the errors in terminology, and also to terms susceptible of improvement. 1500 w. Elec Rev, Lond—Feb. 14, 1902. No. 46449 A.

GAS WORKS ENGINEERING

Acetylene.

Acetylene Gas. A report of progress. 1200 w. Gas Wld—Feb. 1, 1902. No. 46-123 A.

Lighting with Dissolved Acetylene (Société Française de Physique). A paper before the above society on the present state of lighting with acetylene dissolved in acetone. 1500 w. Revue Technique—Jan. 10, 1902. No. 46363 D.

Address.

Mr. Percy Griffith on Gas Supply. Address to the Society of Engineers, London. Deals with various aspects of gas supply and describes a new development of the Scott Snell self-intensifying gas lamps.

3000 w. Gas Wld—Feb. 8, 1902. No. 46216 A.

Benzol.

Commercial Benzol. Dr. Fritz Frank. Abstract translation from *Die Chemische Industrie*. Reviews its history, describes methods of testing, and enumerates its uses. 3000 w. Gas Wld—Feb. 1, 1902. No. 46122 A.

Enrichment of Gas by Benzol. M. A. Lecomte. Illustrates and describes apparatus used for enrichment of benzol, discussing points in this method of enrichment. 2300 w. Gas Engrs' Mag—Jan. 10, 1902. No. 45977 A.

Blast-Furnace Gases.

Comparison of Cost of Operating an Iron Smelting Plant by Gas Engines Using Waste Blast Furnace Gas, and by Gas Fired Boilers and Steam Engines. William M. Chatard, Henry J. Botchford and Emley M. Holcombe. Graduation thesis. A report of experimental investigations with results. 2500 w. Stevens Ind—Jan., 1902. No. 45932 D.

The Purification of Blast-Furnace Gas (Beiträge zur Frage der Gichtgasreinigung). Bernhard Osann. A description of methods of cleansing blast-furnace gas, with estimates of the cost. 6500 w. Stahl u Eisen—Feb. 1, 1902. No. 46339 D.

Carbonization.

Improvement in Carbonization in Recent Years. E. W. Smith. Read before the Eastern Counties Gas Managers' Assn. Discusses such developments as are within the reach of small and medium sized works. 2700 w. Gas Engrs' Mag—Jan. 10, 1902. No. 45976 A.

Conveying Machinery.

Criticisms on Construction of Coal and Coke Handling Plant at Zurich Gas Works. Archibald Little. An investigation of the question of suitability in design of the coal and coke conveying machinery in its situation at Zurich, and adaptability for similar duty in other towns. 6000 w. Jour Gas Lgt—Feb. 4, 1902. Serial. 1st part. No. 46214 A.

Fuel Gas.

An American Fuel-Gas Method and Its Applications. Explains the preparation of the fuel, and its utilization. 1500 w. Jour Gas Lgt—Jan. 21, 1902. No. 45948 A.

Hints on Extending the Uses of Coal Gas. The present article is based on the experience of the writer in connection with the introduction of gas as a heating agent in trade and factory processes. 4000 w. Gas Wld—Feb. 8, 1902. No. 46215 A.

Natural Gas and Other Fuels. A comparison. Abstract of results obtained by Mr. Samuel T. Murdock in an elaborate series of tests concerning the relative value of fuels used in stoves such as are used in heating living rooms of dwellings. 2500 w. R R Gaz—Feb. 7, 1902. No. 46114.

The Changing Use of Gas. Alton D. Adams. Discusses the tendency to use gas for heating purposes instead of illumination. 1100 w. Sci Am—Feb. 15, 1902. No. 46205.

Gasholders.

A Holder Foundation on Quicksand. C. A. Learned. Read at meeting of New England Gas Engrs. Describes the location, near Meriden, Conn., and the materials on which the foundation for a steel tank holder was constructed, and the methods used. 1800 w. Am Gas Lgt Jour—Feb. 24, 1902. No. 46476.

Gas Stoves.

The Fitting of Gas Stoves. From *The Ironmonger*. Considers the use of gas stoves and the best methods of erecting and fitting them. 3000 w. Gas Wld—Jan. 25, 1902. No. 46002 A.

High Pressure.

High-Pressure Gas Lighting in the City. An account of lighting by Sugg's high-pressure burners in London, with remarks on certain features. 2200 w. Jour Gas Lgt—Feb. 4, 1902. No. 46213 A.

Invention.

The Trend of Gas Invention. An examination of new invention as revealed by the specifications published during the last year, with remarks on the comparison to be made between Great Britain and other countries in this industry. 2300 w. Jour Gas Lgt—Jan. 21, 1902. No. 45947 A.

Legal Relations.

The Legal Relations Between Gas Supply Undertakings and Consumers. Considers enactments and judgments, in England, bearing upon points connected with the relations of gas undertakings with consumers who are in financial difficulties. 3000 w. Jour Gas Lgt—Feb. 11, 1902. Serial. 1st part. No. 46434 A.

Mixed Gas.

A Continuous Process for Making a Mixed Gas of Uniform Composition. An abstract translation of an article by Dr. Besenfelder, in the *Journal für Gasbeleuchtung*. Gives a description of his new process for making gas, and reviews the principles underlying other processes. 2800 w. Jour Gas Lgt—Jan. 21, 1902. Serial. 1st part. No. 45949 A.

Oldham, Eng.

New Carburetted Water Gas Plant at Oldham. Illustrated description of new plant. 1800 w. Jour Gas Lgt—Jan. 28, 1902. No. 46121 A.

Photometry.

The Table Photometer and the Standard Pentane Lamp. Abstract of description of the lamp and its accessories, and the method of using them as given by Dr. Frank Clowes, with discussion. 4000 w. Jour Gas Lgt—Feb. 11, 1902. No. 46436A.

Power Gas.

Improvements in Power-Gas Plants (Neuerungen an Kraftgas-Anlagen). H. Gerdes. A description of the water-gas plant of Pintsch, in which the carbonic oxide is drawn off separately for use in gas engines. The improved pressure regulator is described. Paper before the Verein Deutscher Maschinen Ing., with discussion. 2 plates. 6000 w. Glasers Ann—Jan. 15, 1902. No. 46301 D.

Retorts.

Inclines and Their Feeding Arrangements. The present article discusses the inclined system and its economy. 1800 w. Jour Gas Lgt—Jan. 28, 1902. Serial. 1st part. No. 46119 A.

Statistics.

Gas Manufacture. Arthur L. Hunt. Extracts from the Bulletin No. 123, Jan. 3, 1902, of the Twelfth Census of the United States. Statistics concerning the operations of establishments engaged in the manufacture of gas for sale, including municipal plants, but not private plants. 4000 w. Pro Age—Feb. 1, 1902. No. 45925.

Welsbach.

Gas Companies, the Welsbach Company, and the trade. Norton H. Humphreys. Discusses the present state of affairs in England and the experience of the Welsbach Company. 2800 w. Jour Gas Lgt—Feb. 11, 1902. Serial. 1st part. No. 46435 A.

The Welsbach Crisis. A report of the recent meeting of the investors of capital in the Welsbach Company in England, with editorial comment. 6500 w. Jour Gas Lgt—Jan. 21, 1902. No. 45950 A.

INDUSTRIAL ECONOMY

Alcohol.

Progress in Alcohol Lighting (Progrès Réalisés dans les Applications Industrielles de l'Alcool. Eclairage). Louis Denayrouze. A review of the great advance made in alcohol lighting in France in the last three years. 1500 w. Mem d l Soc d Ing Civils de France—Dec., 1901. No. 46379 G.

The Alcohol Motor. Ernst Neuberg. An account of experiments in connection with the competition for alcohol motors, carried out in the gas engine laboratory of the Technical High School of Berlin. 1700 w. Auto Jour—Feb., 1902. No. 46483 A.

The Problem of Alcohol. Discussion of the Applicability of alcohol to the operation of explosion engines, and the experiments made in France and other places. 2500 w. Auto Jour—Feb., 1902. No. 46485 A.

Apprentices.

What Can Our Schools Do for Foundry Apprentices? P. Kreuzpointner. Discusses school training and what should be demanded of apprentices. 4800 w. Jour Am Found Assn—Feb., 1902. No. 46174.

Coal Trade.

American Coal in Europe. Discusses the important factors in the creation of a permanent export trade. 1500 w. U S Cons Repts, No. 1258—Feb. 6, 1902. No. 45992 D.

Commerce.

Our Foreign Commerce in 1901. Extracts from the Review of the World's Commerce, introductory to Commercial Relations of the United States, 1901. 3700 w. U S Cons Repts, No. 1269—Feb. 18, 1902. No. 46249 D.

Education.

Education of Railway Mechanical Engineers. C. V. Kerr. Gives suggestions based on the successful practice of leading engineering schools. Followed by general discussion. 8500 w. W Ry Club—Jan. 21, 1902. No. 46252 C.

Prussian Industrial Schools (Die Preussischen Maschinenbauschulen). Th. Peters. An account of the recent organization of the trade and industrial schools, with a review of their development. 2400 w. Zeitschr d Ver Deutscher Ing—Jan. 11, 1902. No. 46303 D.

Reform in Mathematical Education. Robert H. Smith. A discussion of the plan advocated by Prof. John Perry. 5400 w. Engr, Lond—Feb. 7, 1902. No. 46238 A.

The Needs of Industrial Education in America. A topical discussion. I. With Reference to the Schools. Edgar Marburg. II. With Reference to the Machine Trades. Samuel W. Vauclain. III. With Reference to the Building Trades. John M. Shrigley. Followed by general discussion. 14300 w. Pro Engrs' Club of Phila—Jan., 1902. No. 46037 D.

The Technical Education of Railway Apprentices in France. A description of the educational system afforded by apprenticeship classes of the Chemins de fer de l'Est. 4800 w. Engr, Lond—Jan. 24, 1902. No. 45986 A.

Eight-Hour Day.

The Eight-Hour Bill. Testimony of the

iron interests before the House Committee on Labor. 3700 w. Ir Age—Feb. 20, 1902. No. 46298.

The French Mine-Owners and the Eight Hours' Day. Editorial review of the recent agitation of this subject in France, and the information drawn out by questions to mine owners upon the probable results. 1700 w. Ir & Coal Trds Rev—Feb. 7, 1902. No. 46226 A.

Exposition.

The Düsseldorf Exposition of 1902 (L' Exposition Régionale de Düsseldorf en 1902). J. Dujardin. A general description of the exposition to be opened in the spring of 1902, with illustrations of the buildings, and a review of the economic situation in Germany at the close of 1901. 2000 w. Génie Civil—Feb. 8, 1902. No. 46346 D.

French Patent Office.

French Patent Legislation (Legislation Industrielle). An official circular giving notice of the establishment of the French patent and trade-mark office at the "Conservatoire National des Arts et Metiers." 1100 w. Electricien. Nov. 9, 1901. No. 45850 B.

Germany.

The German Iron Industry. Editorial review of the features of special interest, especially the increase of exports, and diminution of the imports. 1600 w. Engr, Lond—Feb. 14, 1902. No. 46459.

The Iron Industries of Germany. Information concerning the iron ore, the iron works, general conditions and the market. 1000 w. U S Cons Repts, No. 1270—Feb. 19, 1902. No. 46248 D.

Overcrowding.

Industrial Redistribution: the Crux of the Overcrowding Question. William Leonard Madgen. A discussion of conditions in London, England. Also discussion. 1400 w. Jour Soc of Arts—Feb. 14, 1902. No. 46410 A.

Peace Conference.

The Conference for Industrial Peace. Oscar S. Straus. An account of the recent conference in New York, and the benefits hoped to be derived from it. 2000 w. N Am Rev—Feb., 1902. No. 45919D.

Premium Plan.

The Premium Plan at the Works of David Rowan & Company—Piece Work, the Premium Plan, and Mr. Taylor's Plan Discussed. E. G. Herbert. 2200 w. Am Mach—Feb. 20, 1902. No. 46403.

The Premium System. An explanation of the system, discussing its advantages, and the workmen's objections, and hoping to consider every phase of the question. 2000 w. Engr, Lond—Jan. 24, 1902. Serial. 1st part. No. 45985 A.

Indexes.

Card Indexes. Prof. H. Wade Hibbard. Extracts from a paper on "Engineering Periodicals and the Card Index," describing the best method of indexing publications, books, drawings, and other technical documents. 2400 w. Eng Rec—Feb. 8, 1902. No. 46167.

Industrial Commission.

Industrial Commission on Railways. A summary of the commissions recommendations on and discussion of railway affairs. 8200 w. Ry Age—Feb. 7, 1902. No. 46155.

Labour Management.

Emotion and Reason among British Workmen. Percy Longmuir. A discussion of the impelling motives among workmen in their conduct of labour matters, showing the unfortunate effects of appeals to emotion, and calling for a national consideration of important questions. 3000 w. Engineering Magazine—March, 1902. No. 46384 B.

Over Production.

The Mischievous Fallacy of Over-Production. George H. Hull. Showing the utter fallacy of the theory of over-production, and establishing the theory of temporary surplus production. The manner in which the fallacy effects trade unions, strikes and fluctuating prices, is clearly shown. 3500 w. Engineering Magazine—March, 1902. No. 46381 B.

Recording.

The Numerical Recording of Shipping and Manufacturing Orders. Kenneth Falconer. A discussion of the applicability of the card index in connection with the recording and filing of shipping and manufacturing orders. 3500 w. Engineering Magazine—March, 1902. No. 46387 B.

Shipping.

The Development of Shipping in the United States. Lewis Nixon. Printed also in the *Cosmopolitan Magazine.* Discusses points in the oversea commerce, and the importance of American shipowning. 2800 w. Naut Gaz—Feb. 13, 1902. No. 46268.

Steel Corporation.

The United States Steel Corporation. A copy of the preliminary report to the stockholders. 3500 w. Ir Age—Feb. 6, 1902. No. 46101.

The United States Steel Trust (Der United States Steel Trust). A general review of the organization, aims and effect of this great corporation. 2500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Jan. 25, 1902. No. 46372 B.

Ship Subsidy.

New French Ship-Subsidy Bill. Gives the act passed by the French Chamber, intended to encourage the French shipping interests, and improve the merchant marine. 4500 w. U S Cons Repts, No. 1267—Feb. 17, 1902. No. 46184 D.

The Ship Subsidy Bill. Editorial discussion of the present position of the United States. 1200 w. Sci Am—Feb. 1, 1902. No. 45956.

Works Management.

Money-Making Management for Workshop and Factory. C. U. Carpenter. Mr. Carpenter's second paper discusses a concrete example of successful shop administration, and shows the detailed methods employed. 3000 w. Engineering Magazine—March, 1902. No. 46382 B.

MARINE AND NAVAL ENGINEERING

Anchors.

Anchors. Comdr. A. S. Thomson. Abstract of a paper read before the London Chamber of Commerce. Reviews the history of anchors, the improvements made, etc., giving interesting information. 2000 w. Naut Gaz—Feb. 6, 1902. No. 46-176.

Ballasting.

The Ballasting of Modern Tramp Steamers. E. C. Chaston. Read before the North-East Coast Inst. of Engrs. and Shipbuilders. Shows the short-sighted policy of sending vessels to sea without sufficient ballast. 1800 w. Naut Gaz—Feb. 13, 1902. No. 46269.

Battleships.

Japanese Battle ship "Mikasa." An outline of the six battleships built in England for the Japanese Government, with full description of the latest. Ill. 3700 w. Engng—Feb. 7, 1902. No. 46230 A.

Launching a Battleship from the Congressional Ways. William M'Adoo. Traces the steps necessary before a warship may be built. 7800 w. N Am Rev—Feb., 1902. No. 45920 D.

Boilers.

See Mechanical Engineering, Steam Engineering.

British Navy.

Naval Engineers. D. B. Morison. Read before the N. E. Coast Inst. of Engrs and Shipbuilders. Report on memorandums submitted to the First Lord of the Admiralty on July 16, 1901, with reference to the unsatisfactory condition of the engineer branch of His Majesty's Navy. Also editorial. 10400 w. Engng—Feb. 14, 1902. Serial. 1st part. No. 46457 A.

Collision Case.

Interesting Collision Case. Gives the opinion of the Court of Appeals by Judge Lacombe, in the Grand Traverse-Livingstone case, reversing the decree of the district court. 2100 w. Marine Rev—Feb. 6, 1902. No. 46154.

Cruisers.

New Japanese Cruisers Nütaka and Tsushima. Illustrates and describes these absolutely Japanese vessels; designed and built by Japanese, and all their material, armor, machinery, ammunition and guns obtained from the Japanese factories. 1400 w. Eng, Lond—Jan. 24, 1902. No. 45987 A.

Displacement.

Distribution of Displacements of Ships. Theodore Lucas. A discussion of the qualities that are affected by variations in the distribution of the bulk of the displacement, resistance, &c. 1800 w. Naut Gaz—Feb. 6, 1902. No. 46175.

Dock Equipment.

See Electrical Engineering, Power Application.

Economy.

The Growth of Economy in Marine Engineering. W. M. McFarland. The first of an important series of articles dealing with the development of steam economy in the marine engine from the beginning of steam navigation to the present. The first paper deals with the period of the simple engine. 4000 w. Engineering Magazine—March, 1902. No. 46383 B.

Floating Dock.

Official Test of Algiers Floating Dry Dock. Extract from the report on this dock at New Orleans, with the docking of the collier Sterling and the battleship Illinois, giving changes recommended. 1300 w. Marine Rev—Jan. 30, 1902. No. 45965.

The New Bermuda Floating Dock. Illustrated description of this recently launched floating dock, which is the largest and heaviest yet constructed. 2500 w. Engng—Feb. 14, 1902. No. 46454 A.

Lake Steamer.

Splendid Lake Passenger and Freight Steamer. Profile and deck plans of a new passenger and freight steamer, which has many original features, now in progress of construction. 800 w. Naut Gaz—Feb. 20, 1902. No. 46475.

Liner.

The White Star Liner Athenic. Illustration with brief description of one of three exactly similar ships to be added to those sailing from London to New Zealand via the Cape. 350 w. Engr, Lond—Feb. 14, 1902. No. 46464 A.

River Boat.

New James River Night Boat. · Illustration with description of the "Brandon," the first of two new passenger steamers. 800 w. Naut Gaz—Feb. 20, 1902. No. 46473.

Sailing Vessels.

Steamers and Sailing Vessels (Vapeurs et Voiliers). M. Kerlago. A comparison between steam and sail navigation and transportation. 3000 w. Revue Technique—Jan. 25, 1902. No. 46365 D.

Shipbuilding.

Risdon Iron Works, San Francisco. General illustrated description of this new shipbuilding plant, and its equipment. 4000 w. Marine Engng—Feb., 1902. No. 46016 C.

See Electrical Engineering, Power Applications.

Shipping.

See Industrial Economy.

Ship Resistance.

Tubes With Sides and Without, in Ship Resistance—An Example from Lord Kelvin. Marston Niles. A study of hydromechanics, with diagrams, giving theoretical conclusions. 5800 w. Sci Am Sup—Feb. 1 1902. No. 45963.

Ship Subsidy.

See Industrial Economy.

Shipyards.

Machine Tools in Ship Yards. Waldon Fawcett. An illustrated article describing the large machine tools in use at Newport News, Va. 2000 w. Mod Mach—Feb., 1902. No. 46015.

Steamers.

Built on the Lakes for Ocean Service. Illustrated descriptions of steamers Minnetonka and Minnewaska, of 7,000 tons capacity each, which are to be taken in sections to the Atlantic seaboard. 1600 w. Marine Rev—Jan. 30, 1902. No. 45966.

Tail Shafts.

Propeller Shafts and New Form of Stern Tube. Extract from the presidential address of Mr. John Corry, at a recent meeting of the Inst. of Marine Engrs., discussing tail shafts and stern tube bearings. 1800 w. Marine Engng—Feb., 1902. No. 46018 C.

Towing.

Tow Barges as General Freight Carriers. Edwin B. Sadtler. Considers sea-towing, giving a sketch of a barge suitable for handling freight of a miscellaneous character. 1500 w. Marine Engng—Feb., 1902. No. 46017 C.

Yachts.

The Emperor of Germany's New American Yacht. Description of the Meteor III, with drawing showing sail plan. 3000 w. Naut Gaz—Feb. 20, 1902. No. 46472.

The Palatial Hohenzollern. Illustration, with brief description. 600 w. Naut Gaz —Feb. 20, 1902. No. 46474.

MECHANICAL ENGINEERING

AUTOMOBILES.

Alcohol.

Competition of Alcohol Motors and Automobiles (Concours Générale des Moteurs et Automobiles à Alcool). M. Ringelmann. A short review of an exhibition and competition of stationary and automobile alcohol motors held in Paris, 1901. 2000 w. Mem d l Soc d Ing Civils de France—Dec., 1901. No. 46378 G.

Construction.

International Automobile Construction. A review of the novel constructions exhibited recently in Paris, Ill. 1700 w. Auto Topics—Feb. 15, 1902. No. 46185.

Cylinder Jackets.

Non-Freezing Liquids for Cylinder Jackets. E. E. Keller. A report of investigations made, giving curves of freezing and boiling points. 1500 w. Horseless Age—Feb. 12, 1902. No. 46181.

Electric Carriage.

The De Dion-Bouton Electric Carriage. From *La France Automobile.* An illustrated detailed description. 1000 w. Horseless Age—Feb. 2, 1902. No 46182.

Endurance Contest.

Lessons from the Automobile Endurance Contest. Prof. R. H. Thurston. Comments on the run which began at New York and terminated at Rochester, and the lessons of the test. 1800 w. Sci Am Sup—Feb. 1, 1902. No. 45961.

Energy Consumption.

Energy Consumption and Electric Automobile Performance. H. W. Alden. Calls attention to the importance of a high efficiency in the motors and gearing. 800 w. Elec Wld & Eng—Feb. 15, 1902. No. 46294.

Explosion Motors.

Improvements in Explosive Motors. A review of the more recent developments, due largely to the automobile, especially considering French progress in motors. 3000 w. Ir Trd Rev—Jan. 30, 1902. No. 46019.

Gasoline Engines.

The Self-Contained Motor. Calls attention to the need of the self-contained gasoline motive power equipment, capable of being connected directly to the driving wheels, showing that it is possible. 700 w. Horseless Age—Feb. 5, 1902. No. 46090.

Gasoline Racer.

Notes on a Gasoline Racer Design. F. D. Howe. Remarks on the kind of machine likely to be evolved for short races, with sketches . 1100 w. Horseless Age—Feb. 12, 1902. No. 46180.

Gears.

Planetary Gear Calculations. P. M. Heldt. A mathematical consideration of this subject. 1200 w. Horseless Age—Feb. 5, 1902. No. 46092.

Ignition.

Gas and Gasoline Engine Ignition. Albert Stritmatter. Considers the different methods of ignition in common use in the present article. 2000 w Am Mfr—Feb. 6, 1902. Serial. 1st part. No. 46152.

Lecture.

Existing Automobile Mechanism. Hiram Percy Maxim. A lecture before the Automobile Club of America. Especially considers the gasoline engine and the electric storage battery as applied to the automobile. 3700 w. Auto Mag—Feb., 1902. No. 45901 C.

Mors Carriage.

The New 15 Horse Power Mors Carriage. Drawings of the latest production of this company with description of the novel fixtures. 900 w. Horseless Age—Feb. 5, 1902. No. 46093.

Motor Cycle.

Benzine Motor Cycle. Illustrates and describes a machine made in Munich, Bavaria, and its action. 1200 w. Sci Am Sup—Feb. 1, 1902. No. 45962.

Paris Show.

The Automobile and Cycle Show at Paris, December, 1901 (Le Salon de l' Automobile et du Cycle). F. Drouin. Various illustrated notes on the automobiles and motors exhibited. 2500 w. Génie Civil—Jan. 25, 1902. No. 46343 D.

The Paris Automobile Show. Alex Schwalbach. An account of the recent very successful annual exhibition, with illustrated description of the most interesting features in the exhibits. 6300 w. Auto Mag—Feb., 1902. No. 45900 C.

Pressure.

The Pressure to be Used on an Electromobile. Sydney F. Walker. Some remarks on the subject of the best pressure to be used and other matters concerning accumulators for motor vehicles. 900 w. Autocar—Jan. 25, 1902. No. 46001 A.

Stables.

Private Automobile Stables. Illustration, with description, of buildings being erected in East 75th street, New York, with every convenience for the maintenance and care of steam, gasoline, or electric machines. 900 w. Horseless Age—Feb. 19, 1902. No. 46401.

Standardization.

Lines of Standardization. Albert L. Clough. On the control of gasoline carriages, the position of the operator, clutch levers position, &c. 800 w. Horseless Age—Jan. 29, 1902. No. 45941.

Steam Vehicles.

The Stanley Brothers New Steam Carriage. A. L. Clough. Describes the interesting features, the chief of which is the watertube boiler. 1100 w. Horseless Age—Jan. 29, 1902. No. 45943.

The White Steam Carriage. Illustrated detailed description. 2700 w. Horseless Age—Jan. 29, 1902. No. 45942.

Tires.

Tires for Heavy Vehicles. Arthur L. Stevens. Discusses the subject of a practical tire, presenting results of actual experience. 3000 w. Horseless Age—Feb. 5, 1902. No. 46091.

Vibration.

Vibration in Automobiles. M. Drouin. Translated from *Le Génie Civil.* Considers means of diminishing the vibration due to the motor. Mathematical. 3200 w. Auto Jour—Feb., 1902. Serial. 1st part. No. 46486 A.

HYDRAULICS.

Flow.

The Measurement of Water. C. V. Seastone. A paper, slightly condensed, read before the Indiana Engng. Soc. Describes methods of measuring the flow of water by orifices, weirs, nozzles, Venturi meters, and jet meters. Ill. 2100 w. Eng Rec—Feb. 15, 1902. No. 46256.

Pump Eciency.

The Efficiency of Compound Centrifugal Pumps. F. G. Hesse. Develops a formula for the efficiency of a compound pump, which indicates that, for a given head the efficiency will increase with the number of stages or pumps in series. Ill. 1000 w. Jour Assn of Engng Soc—Dec., 1901. No. 45930 C.

Pumps.

See also Mechanical Engineering, Miscellany.

Turbines.

Modern Hydraulic Turbines (Sulle Turbine Idrauliche Moderne). W. Zuppinger. An exhaustive discussion of the modern theory of turbine construction, with descriptions of various types and comparisons of their performances. Serial. Part 1. 1500 w. L'Industria—Jan. 19. 1902. No. 46380 D.

MACHINE WORKS AND FOUNDRIES.

Crane.

See Electrical Engineering, Power Applications.

Cupolas.

Improvements in Cupolas. Edward Kirk. Describes the first cupola furnaces used in the United States, and their working; and the improvements made are traced and discussed. 4500 w. Foundry —Feb., 1902. No. 46035.

Dies.

A Cutting Off and End Finishing Die, and an Accurate Sectional Die with a Chute Feed, and Finger Stripper. Joseph V. Woodworth. Illustrated detailed descriptions. 1100 w. Am Mach—Feb. 6, 1902. No. 46097.

A Piercing and Blanking Die, and a Novel Bending and Forming Die. William Doran. Illustrated descriptions. 1600 w. Am Mach—Feb. 6, 1902. No. 46096.

Dies for a Sheet Metal Bracket. Joseph V. Woodworth. Illustrated description of four dies and their use. 1100 w. Am Mach—Feb. 20, 1902. No. 46402.

Four "Follow" Dies. Joseph V. Woodworth. Illustrated description of four applications of the gang and follow principle for articles of sheet metal to be pierced, bent, formed or drawn, and finished in one operation. 900 w. Am Mach —Feb. 13, 1902. No. 46193.

Making a Large "Safety" Pin. William Doran. Describes and illustrates the dies and fixtures used in the manufacture of safety pins for horse blankets. 1100 w. Am Mach—Feb. 20, 1902. No. 46404.

Foundry.

The Vulcan Foundry, Newton-le-Willows. General history of these important works with illustrations, the improvements and developments, and some of the locomotives built. 3000 w. Engr, Lond—Jan. 31, 1902. No. 46132 A.

Grinding Machine.

The Hibbard Reversible Grinding Machine. Illustrates and describes a machine for circular grinding in which the work revolves. 1400 w. Ir Age—Feb. 6, 1902. No. 46098.

Hardening.

Hardening Rings. E. R. Markham. Describes treatment given large tool-steel rings. Ill. 800 w. Am Mach—Feb. 6, 1902. No. 46094.

Success in Hardening Steel. E. R. Markham. Practical suggestions about the fire, the steel, and the method of treatment. 3000 w. Mach, N Y—Feb., 1902. No. 46075.

Lathes.

Turret Lathe Fixture. Joseph V. Woodworth. Illustrated description of a handy attachment for forming irregular pieces. 1200 w. Mach, N. Y—Feb., 1902. No. 46077.

Machine Tools.

28-Ft. Boring and Turning Mill. Illustrated description of a large machine having novel features of interest. 800 w. Engng—Jan. 24, 1902. No. 45981 A.

Molding.

The Molding Machine. S. H. Stupakoff. Considers the subject of molding and the labor saving devices used. Ill. 3000 w. Jour Am Found Assn—Jan., 1902. No. 45991.

Planers.

Some Inventions in Planer Driving and Reversing Mechanisms. Howard A. Coombs. Illustrates and describes some ingenious devices. 2500 w. Am Mach—Jan. 30, 1902. No. 45927.

Portable Machines.

Portable Electrically-Driven Machine Tools. An illustrated description of recently designed machine tools for work connected with the manufacture of large electric generators. 700 w. Engr, Lond—Jan. 31, 1902. No. 46134 A.

Power Consumption.

See Electrical Engineering, Power and Transmission.

Premium Plan.

See Industrial Economy.

Punching.

Experiments on the Work of Machine Tools (Expériences sur le Travail des Machines-Outils). M. Codron. Another installment, this time dealing with punching machinery, of the author's important series of articles. Illustrations and diagrams. 8000 w. Bull Soc d' Encouragement—Jan., 1902. No. 46391 G.

Screw-Cutting.

Cutting Square Threaded Screws. W. S. Rowell. An illustrated description of method and tools. 2000 w. Am Mach—Feb. 13, 1902. No. 46192.

Screw Machines.

Camming Automatic Screw Machines. C. L. Goodrich. An illustrated detailed description. 2200 w. Ir Age—Feb. 20, 1902. No. 46299.

Slotting Machine.

Slotting Machine with Screw Driving Gear (Stossmaschine mit Schraubenantrieb des Stössels). Alexander Klehe. An illustrated description of a tool for machining the pole seats of large dynamo frames. 800 w. Zeitschr d Ver Deutscher Ing—Jan. 18, 1902. No. 46307 D.

Tool Operation.

See Electrical Engineering, Power Applications.

Turning Mill.

A Notable Boring and Turning Mill. Illustrates and gives particulars of the 28-foot boring and turning mills installed in the Westinghouse shops in Pittsburg. 1100 w. Mach, N. Y—Feb., 1902. No. 46074.

Works.

The Brush Electrical Engineering Company. Illustrations with description of the works at Loughborough, England. 2200 w. Engng—Feb. 7, 1902. Serial. 1st part. No. 46229 A.

Works Management.

See Industrial Economy.

MATERIALS OF CONSTRUCTION.

Armor-Plates.

Beardmore Armor Plates. An account of tests of these plates, made in Glasgow, with illustrations. 800 w. Engng—Jan. 31, 1902. No. 46130 A.

New Armor Plate Hardening Process. Describes an improved and economical method of hardening the face of the plates to any required depth, and toughening the face of the hardened portions. Patented by Benton Knott Jamison. 1700 w. Am Mfr—Feb. 6, 1902. No. 46153.

Hollow Cylinders.

Tests of Hollow Cylinders Subjected to Internal Pressure (Essais à la Traction sur Cylindres Creux Soumis a des Pressions Intérieures). Dr. C. de Szily. Paper before the Budapest Congress of the International Assoc. for the Testing of Materials, giving the theory and results of experiments. Serial. 1st part. 4000 w. Revue Technique—Jan. 10, 1902. No. 46362 D.

Impact Tests.

Impact Tests on Notched Steel Bars. Editorial on the plan advocated for the testing of notched bars, which are claimed to be extremely effective in showing brittleness or lack of homogeneity in structural steels. 1100 w. Engng—Feb. 7, 1902. No. 46234 A.

Springs.

Plate Springs. Results of extensive investigations are given with a table allowing of their practical application. 1400 w. Engr, Lond—Feb. 14, 1902. No. 46460 A.

Springs. A. A. Cary. Abstract of Mr. Cary's remarks in discussion of Prof. Benjamin's paper before the recent meeting of the A. S. M. E. and of his contribution to the topical discussion on "A Spring Testing Machine." 2500 w. Am Mach—Feb. 20, 1902. No. 46406.

Steel.

The Behavior of Steel Under Stress. C. H. C. Wright. A discussion of the peculiar properties and behavior of this material and its possiblities in structural work. 3000 w. Can Archt—Jan., 1902. No. 45903 C.

Strains.

The Elastic Line of Polyphase Machines with Large Diameters (Die Elastische Linie von Drehstrommaschinen mit Grossen Durchmessern). Hans Linsenmann. An elaborate mathematical discussion of the mechanical strains caused by the magnetic forces acting in the machine. Diagrams. Serial. 2 parts. 6000 w. Elektrotech Zeitschr—Jan. 30, Feb. 6, 1902, No. 46325 each B.

Testing Machines.

Mohr and Federhaff Testing Machines (Machines à Essayer les Materiaux de Construction Mohr et Federhaff). An illustrated description of various types of machines for testing materials made by this German firm. 2000 w. Revue Technique—Jan. 25, 1902. No. 46364 D.

MEASUREMENT.

Anemometer.

On a Miniature Anemometer for Stationary Sound Waves. Bergen Davis. Describes experiments undertaken to determine the relation between the amplitude of vibration and the rate of rotation, and also the influence of the size of the anemometer cups. 1000 w. Am Jour of Sci—Feb., 1902. No. 46033 D.

Flow.

See Mechanical Engineering, Hydraulics.

Speed Variation.

A New Apparatus for Measuring the Variation of Speed of a Flywheel During One Revolution. E. W. Mix. Describes an ingenious electro-mechanical apparatus for measuring the pulsation and also the angular variation of the moving parts involved. Ill. 800 w. Elec Wld & Engr—Feb. 8, 1902. No. 46158.

POWER AND TRANSMISSION.

Air Compressor.

A Vertical Compound Air Compressor at the "Minister Stein" Mine, Westphalia (Stehender Verbund Kompressor auf Zeche "Minister Stein"). R. Goetze. A well illustrated description of this air compressor, and account of tests and operation. 1 plate. 3000 w. Zeitschr d Ver Deutscher Ing—Feb. 1, 1902. No. 46314 D.

Conveying.

A Successful Bag-Conveying System. Illustrated description of a plant in Milton, Mass. 1000 w. Eng News—Jan. 30, 1902. No. 45909.

Cotton Mill.

See Electrical Engineering, Power Applications.

Economy.

Power and Its Economical Transmission. Extracts from a lecture by Henry Souther, delivered in the Board of Trade Building, Toronto, comparing the losses in gearing and belt transmission with the advantages of electric driving. 3500 w. Can Elec News—Feb., 1902. No. 46186.

Elevators.

Elevators: Their Construction and Operation. William Baxter, Jr. An illustrated article discussing in this number the hydraulic elevator, sheave and rope arrangement, methods of control, governors, &c. Ill. 3400 w. Steam Engng—Feb., 1902. Serial. 1st part. No. 46414.

Energy.

The Economical Conversion and Transmission of Energy. William C. L. Eglin. A study of economical methods under the heads of generators or converters, transmission systems, motors or consumption devices, and load factors. 5200 w. Pro Engrs' Club of Phila—Jan., 1902. No. 46038 D.

Gearing.

Gearing. C. F. Blake. The present article deals with calculations connected with the design of gear wheels, velocity ratio, sizing the blanks, &c. Ill. 1500 w. Mach, N. Y—Feb. 1902. Serial, 1st part. No. 46076.

The Strength of Shrouded Gear Teeth. Wilfred Lewis. A report of investigations which seem to indicate that from ¼ to ½ may be added to the strength of teeth by shrouding. 2100 w. Am Mach—Jan. 30, 1902. No. 45926.

The Wear and Friction of Spur Gearing (Beitrag zur Kenntais der Abnutzungs- und Reibungsverhältnisse der Stirnzahnräder). Karl Büchner. An elaborate mathematical discussion of the relations between friction, pressure, surface and wear of spur teeth with many diagrams. Serial. Part I. 2400 w. Zeitschr d Ver Deutscher Ing—Feb. 1, 1902. No. 46315 D.

Power Plants.

An Unusual Method of Constructing Condensing Water Tunnels. Illustrates and describes the tunnels of the power stations of the Manhattan Railway and of the New York Edison Co., consisting of concrete-lined tubes built on launching ways, like boats, floated to the station and then sunk into their final position. 1700 w. Eng Rec—Feb. 8, 1902. No. 46165.

Mechanical Plant of the Albany Station of the New York & Hudson River Railroad Company. Illustrated description of a very compact plant, particularly noteworthy for the forced circulation, hot-water heating system for the buildings, a water proof concrete piping tunnel and a self-sustained steel-plate smoke stack. 2300 w. Eng Rec—Feb. 15, 1902. No. 46255.

Power Plant of the Booth Cold Storage Warehouse, Chicago. Illustrates and describes an interesting mechanical equipment, where the power plant is located in the top story of a nine-story building. The electric part is a two-wire 220-volt system, involving 35 feeders. 3400 w. Eng Rec—Feb. 1, 1902. No. 46068.

The Power Plant of the New United States Mint at Philadelphia. Illustrated description of a plant having a nominal capacity of about 800 h. p. in electric generating units, besides boiler capacity for heating. The article describes the boiler and engine equipment, the generators and motors, the switchboard and the auxiliary plant. 5400 w. Eng Rec—Feb. 15, 1902. No. 46259.

Tunnel Construction for Underground Steam Pipes. Describes a tunnel 460 ft. long, built at the Iowa State College to accommodate electric, gas, water, and steam pipes. 1000 w. Eng Rec—Feb. 8, 1902. No. 46171.

Rope Transmission.

Rope Transmission of Power. E. C. De Wolfe. Extract from a paper before the Indiana Engng. Soc. Explains the important features to be considered in designing a system of rope drives for power transmission. 2500 w. Eng Rec—Feb. 8, 1902. No. 46170.

Spiral Gearing.

A Graphical Determination of the Efficiency of Spiral Gearing. Walter Ferris. An explanation of the application of the graphical method to such problems. 2800 w. Am Mach—Jan. 30, 1902. No. 45928.

Wire Ropes.

Stresses in Wire Ropes. Opinions of different manufacturers in regard to the effects upon the rope, of length of arc of contact on sheave. 1800 w. Mines & Min—Feb., 1902. No. 46148 C.

The Operation of a Wire Rope in Multiple Laps. A discussion by R. D. Seymour of Denver, Colorado, and William Hewitt. Ill. 1600 w. Stevens Ind—Jan., 1902. No. 45933 D.

SPECIAL MOTORS.

Alcohol.

See Mechanical Engineering, Automobiles.

Gas Engines.

Mr. Dugald Clerk on Gas Engines. Extracts from a lecture delivered at the meeting of the Inst. of Engrs. in Scotland. Considers the nature of a gaseous explosion, and describes the mechanical features of a gas engine. 3800 w. Jour Gas Lgt —Jan. 28, 1902. No. 46120 A.

Recent British and American Gas Engine Tests (Neuere Englische und Amerikanische Versuche on Gasmaschinen). R. Schöttler. A very well illustrated discussion of gas engine experiments, partly a review of papers before the Institution of Mechanical Engineers and the American Society of Mechanical Engineers. Serial. Part I. 5000 w. Zeitschr d Ver Deutscher Ing—Jan. 18, 1902. No. 46308 D.

The Design of Gas Engines (Beiträge zur Berechnung der Gasmaschine). Rudolf Barkow. A mathematical discussion of the action of two-cycle gas engines and the amount of compression. 1200 w. Zeitschr d Ver Deutscher Ing—Jan. 18, 1902. No. 46306 D.

The Gas Engine and Its Fuel. Abstracts of two lectures recently delivered in England; one by Prof. T. Hudson Beare on Recent Developments of the Gas Engine; the other by Mr. Frederick Grover, on Gas Engines. 2800 w. Gas Wld—Feb. 15, 1902. No. 46442 A.

The Maywood Gas Engine. Illustrations with brief description. 500 w. Am Mach—Feb. 20, 1902. No. 46405.

The Temperature of Gas Engine Cylinders (Untersuchungen über die Wärme der Gasmotorencylinder). Ernst Körting. An illustrated account of measurements to determine the temperature at different points of the cylinder of a 400 H. P. double-acting two-cycle gas engine, with a view to the prevention of injurious expansion of the metal. 1000 w. Zeitschr d Ver Deutscher Ing—Jan. 25, 1902. No. 46312D.

Gasoline Engines.

See Mechanical Engineering, Automobiles.

STEAM ENGINEERING.

Boiler Design.

The Best Improvement in Boiler Design. Committee report and general discussion. 4500 w. Cent Ry Club—Jan., 1902. No. 46136 C.

Boiler Explosion.

An Instructive Boiler Explosion (Eine Lehrreiche Dampfkesselexplosion). C. Bach. A paper giving a fully illustrated account of a boiler explosion at Rosenthal-Blankenstein, Germany, with discussion of the causes and the lessons to be derived, with tables of tests of the boiler material. 6000 w. Zeitschr d Ver Deutscher Ing—Jan. 18, 1902. No. 46305 D.

Boiler Explosion at Oldham. A report of the investigation with regard to the circumstances and cause of a boiler explosion which occurred on Oct. 31, with editorial. 3200 w. Engng—Feb. 7, 1902. No. 46236 A.

Boilers.

A New Express Boiler. Illustrations with explanatory notes of new water-tube boilers for first-class torpedo boats. 800 w. Engr, Lond—Feb. 7, 1902. No. 46243 A.

Boilers and Water Supply. F. G. Ansell. The present article discusses the nature of water, and the properties likely to give trouble in the steam-boilers. 3000 w. Elec Engr, Lond—Jan. 31, 1902. Supplement. Serial. 1st part. No. 46124 A.

Firing and Handling Steam Boilers. Charles L. Hubbard. Describes systems of firing and gives suggestions for the care of boilers and their management. 2300 w. Am Elect'n—Feb., 1902. No. 46030.

The Boilers for the New British Warships. Editorial discussion of the design of the different types of steam generators which have been tested, and comparison of the leading particulars. 1800 w. Engng—Jan. 24, 1902. No. 45983 A.

The Lagasse Semi-Multitubular Boiler (Le Générateur Semi-Multitubulaire Système Lagasse). A. Brüll. An illustrated description of a boiler having large water tanks above and below, connected by a great number of vertical water tubes. 1500 w. Bull Soc d'Encouragement—Jan., 1902. No. 46390 G.

The Schütte Boilers of the Steam Yacht "Lensahn" (Die Kessel der Grossherzoglichen Dampfjacht "Lensahn," System Schütte). Hr. Benetsch. A well illustrated description of combined cylindrical and water-tube boilers installed on the yacht of the grand duke of Oldenburg. 3 articles. 1 plate. 3000 w. Schiffbau—Dec. 23, 1901, Jan. 8, 23, 1902. No. 45871 each D.

Fuel Oil.

Tests of Beaumont Oil as Fuel. Report submitted by Prof. James E. Denton of the results of the full value of crude petroleum as used to operate a horizontal return tubular boiler. Ill. 5000 w. Eng & Min Jour—Feb. 1, 1902. No. 46042.

Furnaces.

Furnace Arch Bars. Discusses the arrangement of the rear arch in settings for horizontal tubular boilers. Ill. 1000 w. Locomotive—Dec., 1901. No. 46007.

Mechanical Draft.

The Advantages of Mechanical Draft. H. F. Schmidt. Considers the advantages of mechanical draft as compared with natural draft. Diagrams. 3000 w. Am Elect'n—Feb., 1902. No. 46027.

Pulverized Fuel.

A Rotary Brush System of Feeding Pulverized Fuel to Furnaces. Brief illustrated description of the Hesselmeyer & Schwartzkopff system. 1000 w. Eng News—Feb. 20, 1902. No. 46488.

Safety Valve.

A Valve which Closes Automatically on the Breaking of a Steam Pipe (Ein

Neues bei Rohrbruch Selbstthätig Absperrendes Dampfventil). Hr. Richter. A paper giving an illustrated description of a valve which automatically shuts off steam from the boilers in case of a steampipe explosion. 2000 w. Zeitschr d Ver Deutscher Ing—Jan. 18, 1902. No. 46309 D.

Smoke.

Smoke Abatement in St. Louis. William H. Bryan. A review of the history of the smoke movement in St. Louis, discussing the methods that have proved successful and what may yet be accomplished. Ill. 6300 w. Jour Assn of Engng Soc's—Dec., 1901. No. 45929 C.

Successful Smoke Prevention. Illustrated description of a device in use at the shops of the Chicago Bridge & Iron Works. An application of the steam jet, automatic in its operation. 800 w. Ry & Engng Rev—Feb. 8, 1902. No. 46179.

Speed Variations.

See Mechanical Engineering, Miscellany.

Steam Engines.

Steam Engine Trials. Editorial commending a set of rules issued by a Continental firm, for the occasional testing of engines to see whether they are falling away from their early excellence. 1400 w. Engng—Feb. 14, 1902. No. 46455 A.

Steam Hammer.

Steam Hammer Diagrams (Dampfhammer-Diagramme). Prof. Georg Lindner. A well illustrated account of experiments on a steam hammer at Karlsruhe. Germany, with many indicator diagrams and discussion of them. 2400 w. Zeitschr d Ver Deutscher Ing—Jan. 11, 1902. No. 46302 D.

Steam Loop.

The Steam Loop (Der Selbstthätige Dampfkreislauf). Gustav Huhn. Paper before the Verein Deutscher Maschinen-Ingenieure, giving an illustrated description of the system of piping for automatically returning the water of condensation to the boiler. 1100 w. Glasers Ann—Jan. 15, 1902. No. 46300 D.

Steam Turbines.

Some Notes on Steam Turbines. F. J. Warburton. Read before the Northeast Coast Inst. of Engrs. and Shipbuilders, at Newcastle. An illustrated article explaining the various powers of the steam turbine, and how the modern types differ from the earlier. 1800 w. Engr, Lond—Feb. 7, 1902. No. 46245 A.

See also Mechanical Engineering Miscellany.

Superheating.

Steam Superheaters (Les Surchauffeurs de Vapeur). Maurice Miet. A description of recent progress in superheater construction, with illustrations of various types. 3000 w. Génie Civil—Feb. 1, 1902. No. 46345 D.

The Use of Superheated Steam in Locomotives (Die Anwendung von Hochüberhitztem Dampf (Heissdampf) in Locomotivbetriebe). Hr. Garbe. A well illustrated account of the Schmidt system of using highly superheated steam in locomotives with a particular description of the Borsig locomotive exhibited at Paris, and many indicator diagrams. Serial. 2 Parts. 1200 w. Zeitschr d Ver Deutscher Ing—Feb. 1, 8, 1902. No. 46313 each D.

MISCELLANY.

Aeronautics.

Some Aeronautical Experiments. Wilbur Wright. Read before the Western Soc. of Engrs. Discusses mainly the subject of balancing and gives an account of personal work in this field. 4000 w. Auto Jour—Feb., 1902. Serial. 1st part. No. 46484 A.

The Progress of Aerial Navigation and the Experiments of M. Santos-Dumont (Les Progrès de la Navigation Aérienne et les Expériences de M. Santos Dumont). M. Armengaud, Jr. A well illustrated description of Santos-Dumont's experiments and a general review of the development of light-weight motors. 2 plates. 1100 w. Mem d l Soc d Ing Civils de France—Dec., 1901. No. 46376 G.

Acoustics.

A Century of Progress in Acoustics. James Loudon. Read before the Am. Assn. for the Adv. of Science. Refers to the various experimental methods which have been employed in acoustical researches and traces the advances made. 4200 w. Sci Am Sup—Feb. 8, 1902. No. 46089.

Braiding Machine.

The Schürmann Braiding Machine (Die Schürmannsche Flechtmaschine). Prof. Ernst Müller. A well illustrated description of a machine for simultaneously covering, braiding and stranding incandescent light cords, and other electrical conductors. 2000 w. Zeitschr d Ver Deutscher Ing—Jan. 25, 1902. No. 46311D.

Cold Storage.

A Unique Cold Storage Warehouse in Chicago. Illustrated description of a warehouse with the mechanical plant on the top floor, giving details of electrical equipment, etc. 4800 w. Ice & Refrig—Feb., 1902. No. 46025 C.

See also Mechanical Engineering, Power and Transmission.

Heating.

A Practical Air Moistener. An account of experiments conducted by the Bell Telephone Company to secure agreeable temperature conditions in their exchanges. 2800 w. Dom. Engng—Feb. 15, 1902. No. 46467 C.

Central Heating and Lighting Plant for the County Buildings, Indianapolis, Ind. Illustrated description of a power house containing 600 H. P. in water-tube boilers and 345 H. P. in engines. With notes on the way the various buildings are heated. 1600 w. Eng Rec—Feb. 22, 1902. No. 46427.

Heating and Ventilating Railway Shops at Elizabethport, N. J. Illustrated description of the plant installed for a number of large shops, the steam being furnished from a central station. 2200 w. Eng Rec —Feb. 22, 1902. No. 46432.

Operating Results with Central Heating Plants in Public Buildings (Betriebsresultate und Erfahrungen bei Central Heizungsanlagen in Amtsgebäuden). Leopold Nowotny. Gives experiences and costs in four Vienna public buildings. 4000 w. Oesterr Wochenschr f d Oeffent Baudienst—Jan 11, 1902. No. 46351 B.

Inventions.

Some Ingenious Inventions. Howard A. Coombs. Describes some simple inventions, showing great inventive ability, giving sketches. 1500 w. Am Mach—Feb. 6. 1902. No. 46095.

Kiln.

Thomson's Kiln. An illustrated description of a new kiln, with statement of the advantages claimed, and explanation of the method of working. 3000 w. Ir & Coal Trds Rev—Jan. 24, 1902. No. 45-993 A.

Plumbing.

Plumbing in the Hotel Wellington, New York. Illustrated description of hotel equipment, including 130 private bath and toilet rooms. 2700 w. Eng Rec. Feb. 1, 1902. No. 46073.

Resonance.

See Electrical Engineering, Electro-Physics.

Speed Variations.

Stroboscopic Study of the Variations in the Angular Velocity of the Fly-Wheel of an Otto Gas Engine (Etude des Variations de la Vitesse Angulaire du Volant d'une Machine a Gaz Otto a l'Aide de la Méthode Stroboscopique). A Cornu. A paper giving an account of experiments, with photographic records. 1500 w. Bull Soc Internationale d'Electriciens—Jan. 1902. No. 46398 E.

The Sartori Stroboscopic Method of Measuring the Variations in the Angular Velocity of a Machine (Sur les Procédés de Mesure de l'Ecart Angulaire d'une Machine Procédé Stroboscopique de M. Sartori). M. Blondin. A paper giving an illustrated description of an optical method, using Bedel-Moler disks, one revolved by the machine the other by a constant speed electric motor. 2000 w. Bull Soc Internationale d'Electriciens—Jan., 1902. No. 46399 E.

Standards.

The National Bureau of Standards. Samuel W. Stratton. Reviews the provisions made by Congress, and explains the duties of the National Bureau of Standards, established March 3, 1901. 4900 w. Jour Fr Inst—Feb., 1902. No. 46-034 D.

Ventilators.

High Pressure Ventilators Driven by Steam Turbines (Ventilateurs pour Hautes Pressions Mus pas Turbines à Vapeur). A. Rateau. An illustrated account of the advantages of steam turbines for driving centrifugal blowers and pumps, with results of tests. 2500 w. Génie Civil—Feb. 8, 1902. No. 46347 D.

Mechanical Ventilation. W. Yates. Read at meeting of the Brit. Inst. of Heat. & Ven. Engrs. Discusses the subject of vacuum or ventilation by extraction, and plenum, or ventilation by blowing in. Ill. 4200 w. Met Work—Feb. 22, 1902. No. 46408.

MINING AND METALLURGY

COAL AND COKE.

Australia.

The Coke Industry in Australia. A report of the various works, with general information. 4500 w. Ir & Coal Trds Rev —Feb. 7, 1902. No. 46225 A.

Coal-Cutter.

The Champion Eisenbeis Coal-Cutter. Illustrated description of a machine of the pneumatic percussive type, but differing in principle. 1000 w. Col Guard—Feb. 7, 1902. No. 46227 A.

Coal Fields.

The Development of the Indiana County, Pa., Coal Fields. William Gilbert Irwin. A report of this field which has been greatly benefited by a recently completed railroad. 1000 w. Eng & Min Jour—Jan. 25, 1902. No. 45952.

Coal Trade.

See Industrial Economics.

Composition.

The Coking and the Composition of Coal (Betrachtungen über das Backen und über die Bildung der Steinkohle). Prof. Ed. Donath. A discussion of the origin and composition of coal and of the theory of coking. Serial. 3 parts. 5000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Jan. 11, 18, 25, 1902. No. 46370 each B.

Mechanical Engineering.

Mechanical Engineering as Applied to Coal Mines, and Its Relation to the Economical and Successful Operation of the Same. William Glyde Wilkins. Read before the W. Penn. Cent. Min. Inst. 4200 w. Mines & Min—Feb., 1902. No. 46142 C.

New Plant.

New Plant at Shaft No. 5 of the Spring Valley Coal Co., at Spring Valley, Ill. A. Dinsmoor. An illustrated description of the underground and surface arrangements. 3300 w. Mines & Min—Feb., 1902. No. 46141 C.

Oregon.

The Coos Bay Coal Fields. Cleveland Rockwell. Illustrates and describes this region, giving the history of these coal fields and their working. The coal is lignite. 3300 w. Eng & Min Jour—Feb. 15, 1902. No. 46264.

Production.

Coal Production Measuring Southern Advance. Edward Wheeler Parker. Reviews the history of the coal-mining industry in the South. 3200 w. Mfrs Rec—Feb. 20, 1902. Special number. No. 46419.

West Virginia.

West Virginia Coal and the World's Industry. William A. MacCorkle. Discusses the deposits of coal and the successful competitive production. 3000 w. Mfrs Rec—Feb. 20, 1902. Special number. No. 46415.

COPPER.

Copper Situation.

A Consideration of the Copper Industry from a Statistical Standpoint. Walter Renton Ingalls. A discussion of facts relating to copper so far as they are apparent, reviewing the situation since the beginning of 1901. 4000 w. Eng & Min Jour—Feb. 22, 1902. No. 46481.

Lake Superior.

Lake Superior Copper. Horace J. Stevens. Reports work that has been done and improvements contemplated for the coming year. 1400 w. Mines & Min—Feb., 1902. No. 46147 C.

Smelting.

Ancient Copper Smelting in Mexico. C. W. Pritchett. Illustrates and describes a crude copper smelting plant, showing the methods used several hundred years ago. 600 w. Eng & Min Jour—Feb. 15, 1902. No. 46267.

Lead, Copper and Zinc Smelting and Refining. Charles Kirchhoff. A summary for the United States of these industries, with explanatory remarks. 800 w. Min Rept—Jan. 23, 1902. No. 45946.

Trans-Caucasus.

The Trans-Caucasus Copper Industry. Concerning the Deposits and why the copper smelting works are so few in number. Also general information. 800 w. Engr, Lond—Feb. 7, 1902. 46244 A.

GOLD AND SILVER.

Assaying.

The New York Assay Office. An illustrated article giving information concerning this interesting office and the methods in use there. 1200 w. Sci Am—Feb. 15, 1902. No. 46204.

British Columbia.

Characteristics of the Atein Gold Field. J. C. Guillim. Describes the placer bearing streams, and the region through which they pass. Ill. 2700 w. Can Min Rev—Jan. 31, 1902. No. 46046 B.

Hydraulic Mining in Omineca District During 1901. Report for the year of this placer district, especially the operations on the Vital and Town Creek section. Ill. 1800 w. B C Min Rec—Feb., 1902. No. 46190 B.

Recent Operations in the Atein District. Mostyn Williams. Brief accounts of the operations of five companies employed in construction and equipment of hydraulic plants. Ill. 2400 w. B C Min Rec—Feb., 1902. No. 46191 B.

California.

Meadow Lake Mining District. Charles W. Raymond. Outlines the history of this district, which is very interesting, and reports that recent investigations give promise of its becoming an important producer of gold. Map. 5000 w. Min & Sci Pr—Jan. 25, 1902. No. 45904.

Colorado.

Gilpin County, Colo., Mines in 1901. Reports one of the most successful years in the history of these mines. 1000 w. Eng & Min Jour—Jan. 25, 1902. No. 45953.

The Buckhorn Mine and the San Luis Park, Colo. Arthur Lakes. Illustrates and describes peculiar formations which contain some ores and present a striking appearance. Manganese and silver ores, with a little pure gold and other metals. 1700 w. Mines & Min—Feb., 1902. No. 46151 C.

The Mining Industry of Gilpin County. An interesting account of the discovery of gold in this region. Ill. 1300 w. Min Rept—Feb. 6, 1902. No. 46138.

Concentrates.

Realizing on Concentrates When Shipping is Impracticable. E. A. H. Tays. An account of treatment given some concentrates in Mexico and the results. Ill. 1400 w. Min & Sci Pr—Feb. 8, 1902. No. 46188.

Cyanide.

Notes on Cyanide Solutions. T. Lane Carter. Briefly describes methods used in South Africa. Eng & Min Jour—Feb. 15, 1902. No. 46263.

Dredging.

Dredging for Fine Gold in Idaho. Robert Bell. Describes methods of placer mining on the Snake River. Ill. 1800 w. Eng & Min Jour—Feb. 15, 1902. No. 46265.

Extraction.

Modern Methods of Gold Extraction. Walter E. Koch. An illustrated article discussing methods, and expressing the opinion that the cyanide process and pyritic smelting give more promise for the future than any other methods. Also discussion. 5000 w. Pro Engrs Soc of W Penn—Jan., 1902. No. 46137 D.

N. S. W. Filter-Press Practice. John W. Rock. Deals with the process of extraction of gold from auriferous slimes by means of filter presses. 1600 w. Aust Min Stand—Dec. 12, 1902. No. 45970 B.

Idaho.

The Thunder Mountain Mining District, Idaho. Walter Hovey Hill. Describes the location of this district and the different routes of travel necessary to reach the camp. Gold, silver and copper are found. Map. 600 w. Eng & Min Jour—Jan. 25, 1902. No. 45954.

Thunder Mountain and Mackay, Idaho. Robert Bell. Describes the principal mineral features of this region, principally gold and copper, the routes, railways, &c., and the already developed properties. 3500 w. Min & Sci Pr—Feb. 1, 1902. No. 46051.

Macedonia.

The Gold Mines of Philip of Macedonia. J. E. Spurr. An illustrated account of these interesting placers. 1700 w. Eng & Min Jour—Feb. 22, 1902. No. 46480.

Mexico.

The Etzatlan Mining District, Mexico. E. B. Van Osdel. Describes a newly developed silver and copper district. Ill. 1000 w. Eng & Min Jour—Feb. 15, 1902. No. 46266.

The Mining District of Guanajuato, Mexico. A condensed account of historical, political and statistical matters that affect the standing of this gold and silver mining district. Ill. 6000 w. Eng & Min Jour—Feb. 8, 1902. No. 46103.

Nicaragua.

Mining in Eastern Nicaragua. J. D. Lowry. A description of an out-of-the-way gold region, its people, and resources. 2200 w. Mines & Min—Feb., 1902. No. 46150 C.

Placers.

The Upland Placers of La Cienega, Sonora, Mexico. Robert T. Hill. An illustrated description of these rich placers, and the conditions and inhabitants of this region. 2000 w. Eng & Min Jour—Jan. 25, 1902. No. 45951.

Refractory Ores.

Treatment of Refractory Silver and Gold Ores at the Mine. R. C. Campbell-Johnson. Describes the ores of British Columbia and discusses their treatment, and economical working. 1200 w. Min & Sci Pr—Feb. 1, 1902. No. 46049.

Victoria.

The Walhalla (V.) Goldfield. H. Herman. A digest of a recent report on this goldfield, submitted to the Victorian Secretary for Mines. Ill. 2500 w. Aust Min Stand—Dec. 19, 1901. Serial. 1st part. No. 45907 B.

Yukon.

White Horse Mining District, Yukon Territory. William M. Brewer. A description of the district with illustrations. 4000 w. Eng & Min Jour—Feb. 1, 1902. No. 46041.

IRON AND STEEL.

Blast Furnaces.

Blast Furnace Dimensions (Einiges über das Hochofenprofil). F. Stille. From *Werml. Annaler.* Notes on blast-furnace practice in Sweden, principally with charcoal fuel. 800 w. Oesterr Zeitschr f Berg u Hüttenwesen—Jan. 4, 1902. No. 46368 B.

The Height of Blast Furnaces. F. L. Grammer. A discussion of this subject with the conclusion that high furnaces have been overestimated and have had their day. 2000 w. Ir Trd Rev—Feb. 20, 1902. No. 46471.

Blast Furnace Gas.

See Gas Engineering.

Cuba.

Cuban Iron. Editorial on the supplies of iron and manganese that the United States obtains from Cuba. 1100 w. Engng—Feb. 14, 1902. No. 46456 A.

Development.

Iron and Steel at the Close of the Nineteenth Century. James M. Swank. Extract from Mineral Resources of the United States, 1900. An account of the development and increase of production. 2200 w. Mines & Min—Feb., 1902. No. 46143 C.

Germany.

See Industrial Economy.

Iowa.

Iowa's Iron Mine. S. W. Beyer. Describes Iron Hill and its deposits, discussing the nature and origin of the ore, and the outlook for the industry. 2000 w. Eng & Min Jour—Feb. 22, 1902. No. 46482.

Iron Trade.

Some Features of the Continental Iron Trade. Largely a review of the German trade during 1901, with tabulated information of the iron and steel exported from Germany to other countries. 1300 w. Ir & Coal Trds Rev—Feb. 14, 1902. No. 46450 A.

Lake Superior.

Lake Superior Ore Output. Editorial giving information concerning the wealth of iron ore from this region. 2000 w. Engng—Feb. 7, 1902. No. 46235 A.

Liquid Fuel.

Russian Open-Hearth Furnaces with Oil Fuel (Der Russische Martinofen mit Erdölfeuerung). Adrian Byström. From *Jernkontorets Annaler*. Illustrated description of apparatus for using liquid fuel in Martin open-hearth furnaces. 900 w. Oesterr Zeitschr f Berg n Hüttenwesen—Jan. 18, 1902. No. 46371 B.

New Jersey.

The Revival of Iron Mining in New Jersey. F. W. E. Mindermann. Reports the working of the Wharton and other mines with improved appliances, giving the yield of the mines now being worked. 1100 w. Eng & Min Jour—Jan. 25, 1902. No. 45955.

Rolling Mill.

New Carnegie Plate Mill at Homestead, Pa. (Neue Blechwalzwerksanlage der Carnegie Steel Co. in Homestead, Pa.). Hermann Jelies. An addition to a previous article on "American Rolling Mills," giving an illustrated description of these works, in which a practically new plant of the Bethlehem Co. was used. 1 plate. 700 w. Stahl u Eisen—Feb. 1, 1902. No. 46-338 D.

Steel Corporation.

See Industrial Economics.

Steel Works.

The Cambria Steel Company's New Works. Illustrated description of recent improvements in these works at Johnstown, Pa. 2500 w. Ir Age—Feb. 6, 1902. No. 46100.

Tennessee.

The Smith Mine, Tennessee. N. W. Buckhout. The location and quality of the ores, which are limonite, or brown ore, and the methods of mining, cleaning, and handling them are described. 2200 w. Mines & Min—Feb., 1902. No. 46146 C.

Wyoming.

The Sunrise Iron Mines in Wyoming. John Birkinbine. Illustrations with brief description. 1600 w. Ir Age—Feb. 6, 1902. No. 46102.

MINING.

Barometer.

The Barometer in Mining. F. Z. Schellenberg. Read before the W. Penn. Cent. Min. Inst. Discusses the possibilities and importance of the use of this instrument in guarding against gas in mines. 1000 w. Mines & Min—Feb., 1902. No. 46149 C.

Drowned Workings.

Tapping Drowned Workings. W. B. Wilson, Jr. Abstract of a paper and the discussion before the N. of Eng. Inst. of Min. & Mech. Engrs. Describes the tapping at Wheatley Hill Colliery. The workings were those of Thornley Colliery, which, owing to a fire in 1858, it had been found necessary to drown out. 3000 w. Col Guard—Feb. 14, 1902. No. 46451 A.

Explosion.

Notes on the Llanbradach Explosion. A review of the report on this disaster, which occurred Sept. 10, 1901. 1800 w. Col Guard—Feb. 14, 1902. No. 46453 A.

The Llanbradach Colliery Explosion. Official report, by J. S. Martin, on the circumstances attending an explosion near Cardiff, on Sept. 10, 1901. 2800 w. Col Guard—Jan. 24, 1902. No. 45979 A.

The Talk o'-th'-Hill Colliery Explosion. Official report by W. N. Atkinson, H. M. inspector of mines, on the circumstances attending the accident. Ill. 5500 w. Col Guard—Jan. 31, 1902. No. 46127 A.

Explosives.

Government Explosives and Safety Appliances in the Wilczek Mines at Polnisch-Ostrau, Austria (Ueber die Anwendung ärarischer Spengmittel und einiger Sicherheits und Sanitätsbehelfe beim Gräflich Wilczek 'schen Bergbau in Polnisch-Ostrau). Josef Mauerhofer. An illustrated account of experiences with dynammon, a government safety explosive, and of safety and sanitary arrangements at these coal mines. Serial. 3 parts. 3 plates. 7000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Jan. 4, 11, 18, 1902. No. 46367 each B.

Freezing Process.

Shaft Sinking by the Freezing Process (Les Nouveaux Fonçages par Congélation). H. Schmerber. An illustrated description of shaft sinking at two French mines and at the Ronnenberg Alkali Works, Hanover. Serial. 3 parts. 6000 w. Génie Civil—Jan. 18, 25, Feb. 1, 1902. No. 46341 each D.

Geology.

Mining Geology. G. J. Binns. Lecture delivered before the South Midland Branch of the Coal Managers' Assn. Discusses geology especially in its relation to coal fields. 6300 w. N Z Mines Rec—Dec. 16, 1901. No. 45967 B.

Grades.

Mine Grades. A. W. Warwick. Considers some of the principles affecting mine grades, and the conditions upon which the choice depends. 2100 w. Min Rept—Feb. 6, 1902. No. 46139.

Jig.

A Single Track Mining Jig. Sketches and description of a single track gravity tramway that has been in successful operation at the Gold Hill Mine, Grass Valley, California. 1200 w. Min & Sci Pr—Feb. 8, 1902. No. 46189.

Mining Plant.

See Electrical Engineering, Power Applications.

Ores.

Variation of Ores in Depth. Dr. J. W. Gregory. Lecture on the factors that control the variation. 4300 w. Aust Min Stand—Dec. 19, 1901. Serial. 1st part. No. 45908 B.

Underground Transportation.

Transportation of Material Underground. A. W. Warwick. As an example, the working of a small low grade mine is considered. The present article deals principally with the financial side. 2700 w. Min Rept—Jan. 30, 1902. Serial. 1st part. No. 46045.

Water Problem.

The Water Problem in Cripple Creek and Other Colorado Camps. Arthur Lakes. A statement of the cause, and the methods used in freeing the mines from water. 3000 w. Mines & Min—Feb., 1902. No. 46145 C.

Winding Engines.

Schlüter's Safety Appliances for Winding Engines. Illustrated description. 600 w. Col Guard—Feb. 7, 1902. No. 46228 A.

MISCELLANY.

Briquetting.

The Briquetting of Fuels and Fine Mineral Ores. Wm. Gilbert Irwin. A review of the development of briquetting methods and machinery, with some account of their applications in the United States. 4000 w. Engineering Magazine—March, 1902. No. 46388 B.

Deposits.

Ore Deposits. F. Danvers-Power. The present article reviews the "nebular hypothesis" as explanatory to the origin of ores. 3000 w. Aust Min Stand—Jan. 16, 1902. Serial. 1st part. No. 46441 B.

Hungary.

Mining and Metallurgy in Hungary, in 1900 (Ungarns Berg und Huttenwesen 1900). From *Bány. és Koh. lapok.* General statistics. Serial. 3 parts. 4000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Jan. 4, 11, 18, 1902. No. 46369 each B.

Lead.

Lead Smelting in Southeast Missouri. R. B. Brinsmade. A description of the different methods used, and the advantages and disadvantages of each. Ill. 1600 w. Mines & Min—Feb., 1902. No. 46144 C.

Metal Statistics.

Metal Statistics for 1898 (Recueil Statistique des Petits Métaux Pendant l'Année 1898). An abstract of statistics published by the Metal Gesellschaft and the Metallurgische Gesellschaft, of Germany, giving production, prices, etc., of lead, copper, zinc, tin, nickel, aluminum, mercury and silver in various countries. 2500 w. Revue Technique—Jan. 25, 1902. No. 46366 D.

Petroleum.

Import of the Production of Southern Petroleum. F. H. Oliphant. Reviews the production in West Virginia, Texas, Kentucky and Tennessee, describing the character of the oil and giving related information. 3500 w. Mfrs Rec—Feb. 22, 1902. Special number. No. 46421.

The Chemical Analysis of Crude Petroleum and Oil Rock. Dr. J. Ohly. Explanatory of method of analysis used. 2200 w. Min Rept—Feb. 20, 1902. Serial. 1st part. No. 46465.

The Colorado Oil Industry. A report of conditions in this state, the processes and products, their use, &c., with brief notices of recently incorporated companies. 2500 w. Min Rept—Jan. 30, 1902. No. 46044.

Southern Petroleum and the Fuel Market. C. F. Z. Caracristi. A review of the petroleum development in the south, its values as compared with coal at present prices, and as a fuel. 3800 w. Mfrs Rec—Feb. 20, 1902. Special number. No. 46416.

Phosphate.

Progress in the Southern Phosphate Belt. Hugh Wiley. Historical review of the phosphate mining industry, and the location of the southern deposits. 2000 w. Mfrs Rec—Feb. 20, 1902. Special number. No. 46422.

Platinum.

The Platinum Metals. Notes where deposits are found, and the properties of platinum metals in the present article. 2400 w. Aust Min Stand—Jan. 16, 1902. Serial. 1st part. No. 46440 B.

Prussia.

The Production of Prussian Mines, Salt Works and Metallurgical Works in 1900 (Die Production der Bergwerke, Salinen und Hütten des Preussischen Staates im Jahre 1900). General statistical tables. 1000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Jan. 25, 1902. No. 46373 B.

Quarries.

Excavating Machinery for Quarry Use. An illustrated article giving particulars of the working of a steam navvy or excavator taken from a paper read by A. L. Stevenson, before the North of England Inst. of Min. & Mech. Engrs. 3000 w. Quarry —Feb. 1, 1902. No. 46209 A.

Irish Stone Quarries. A review of the quarries of limestone, marble and building stones. 3000 w. Quarry—Feb. 1, 1902. No. 46210 A.

The Stone Mining Industry in Greece. A. Cordella, in *Zeitschrift für das Berg-, Hutten-, und Salinenwesen.* Report of the mines of emery, magnesite, meerschaum, millstones, gypsum, marble, and various other deposits. 5000 w. Quarry—Feb. 1, 1902. No. 46211 A.

Southern Minerals.

Development of the Mineral Resources of the South. David T. Day. Explains how much is included in "the south," and reviews the developments. 3200 w. Mfrs Rec—Feb. 20, 1902. Special number. No. 46420.

Tin.

An Occurrence of Stream Tin in the York Region, Alaska. Alfred H. Brooks. From Mineral Resources of the U. S. Geol. Survey. A description of the deposit, which is of scientific rather than commercial interest. 1700 w. Min Rept—Feb. 13, 1902. No. 46272.

Australian Tin and Tin Mining. John Plummer. Information concerning the location of these deposits, and the extent to which they have been worked. 900 w. Ir Age—Feb. 6, 1902. No. 46099.

The Mining in Malaya. Discusses the tin deposits in the Malay Peninsula, and the future outlook as a tin-producing region. 1400 w. Aust Min Stand—Dec. 26, 1901. Serial. 1st part. No. 45905 B.

Tungsten.

Tungsten. G. M. Parker. A description of methods of tungsten determination, as given in a recent graduation thesis. 1600 w. Aust Min Stand—Jan. 2, 1902. No. 46438 B.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

Investigation of the Park Ave. Tunnel Collision. Report of testimony. 3000 w. Eng News—Jan. 30, 1902. No. 45916.

Report of the New York State Railroad Commission on the Park Avenue Tunnel Collision. Extracts from the report dealing with methods of improvement, with editorial discussion of the problem of tunnel ventilation. 7400 w. Eng News—Feb. 13, 1902. No. 46195.

The New York Tunnel Collision. Editorial discussion of this recent disaster. 1200 w. Loc Engng—Feb., 1902. No. 45940 C.

The Safety of Trains in the Fourth Avenue Tunnel—The Commissioners' Preliminary Order. Editorial discussion of the recommendations, and of the conditions. Also discusses the report on the collision. 3000 w. R R Gaz—Feb. 14, 1902. No. 46200.

Train Accidents in the United States in December. A condensed record of the principal accidents with editorial comments on the most serious. 5500 w. R R Gaz—Jan. 31, 1902. No. 46057.

Block System.

Kinsman Block System for Control of Railway Trains. Illustrated description. 1000 w. Elec Wld & Engr—Feb. 15, 1902. No. 46296.

Car Famines.

How to Prevent Car Famines. W. L. Surran. A letter giving suggestions that the writer thinks will alleviate if it does not remedy. 1800 w. Ry Age—Feb. 14, 1902. No. 46270.

Promptness.

What Can We Do Toward Getting Trains Over the Road with More Promptness? Eugene McAuliffe. States familiar troubles and offers some suggestions for remedying them. 1700 w. St. Louis Ry Club—Jan. 10, 1902. No. 46032.

Train Service.

British and French Train Services in 1901. Charles Rous-Marten. A review of the principal train services of Great Britain and France as scheduled in the official time-books during the first year of the twentieth century. 2700 w. Engr, Lond—Feb. 14, 1902. Serial. 1st part. No. 46458 A.

Transvaal.

The Railway Reorganization of the Transvaal. A. Cooper Key. A review of the former railway systems, and a critical examination of the conditions under which operations may be successfully re-established. 2500 w. Engineering Magazine—March, 1902. No. 46386 B.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Test of an Automatic Air-Safety Valve by the Pennsylvania Lines. Illustrated report of a test of a recently devised mechanism for attachment in connection with existing air-brake systems. The invention of F. B. Morrison. 700 w. Ry & Engng Rev—Feb. 15, 1902. No. 46277.

Bolsters.

New Construction of Steel Center Sills and Bolsters. Illustrates the arrangement employed in recent cars of the Chicago, Milwaukee and St. Paul Railway. 400 w. Am Engr & R R Jour—Feb., 1902. No. 46066 C.

The Bolster Problem. R. P. Lamont. Presents points, mainly from the standpoint of the manufacturer, giving also information of a large number of cars. Followed by general discussion. 11000 w. W Ry Club—Jan. 21, 1902. No. 46251 C.

Buffer.

Through Buffer Rods for Cars (Durchgehende Stossvorrichtung für Eisenbahnfahrzeuge). Ludwig Ritter v. Stockert. An illustrated description of the Alma-Weiss system of double buffers, in which the rods extend right through under the car and powerful springs under the center of the cars take up shocks. Record of tests. 1 plate. 2000 w. Oesterr Wochenschr f d Oeffent Baudienst—Jan. 25, 1902. No. 46356 B.

Cars.

Box Car, 80,000 Pounds Capacity. Drawings illustrating a new box car with wooden sills and metal bolsters, built for the Chesapeake & Ohio. 350 w. Am Engr & R R Jour—Feb., 1902. No. 46061 C.

Hocking Valley Ry. 30-Ton Side Dump Car with Steel Box. Illustrated description. 1000 w Ry & Engng Rev—Feb. 1, 1902. No. 46058.

60,000-Lbs. Capacity Stock Car, Illinois Central R. R. Detailed drawings, with description. 700 w. Ry & Engng Rev—Feb. 8, 1902. No. 46177.

Thirty-six Foot 60,000-lb. Capacity Box Cars, Delaware, Lackawanna and Western. Plans and brief description of design of which 1000 cars were recently ordered. 400 w. Ry Mas Mech—Feb., 1902. No. 45974.

Conveyor.

Cinder Pit Conveyor. An illustrated description of a device that has proved a great money-saver. 500 w. Ry Mas Mech—Feb., 1902. No. 45975.

Couplers.

I. Improvements in Car Couplers and Draft Rigging. II. Flexibility in Car Coupling Attachments. Two articles discussing recent papers before the railway clubs. 6000 w. Ill. Eng News—Jan. 30, 1902. No. 45913.

Flanges.

Standardization of Extra Heavy Flanges. A committee report of the recommendations and schedule for standard at a meeting held in New York City, June 28, 1901. 900 w. Stevens Ind—Jan., 1902. No. 45934 D.

Flue Rattler.

New Flue Rattler. Illustrates and describes a novel rattler which is giving good results in the boiler plant of the Chicago and Northwestern Railway at West Chicago. 500 w. Am Engr & R R Jour—Feb., 1902. No. 46062 C.

Locomotives.

Comparing Heavy and Light Locomotives. Edward Grafstrom. Comments on recent road tests made, and the lessons from them. Favors moderating the size of engines to suit the traffic demands. 1000 w. Am Engr & R R Jour—Feb., 1902. No. 46067 C.

Compound Consolidation Locomotive, M. St. Paul & S. Ste. M. Ry. Illustration, noting important features, of one of four recently built engines. 900 w. Ry & Engng Rev—Feb. 15, 1902. No. 46274.

Compound Consolidation Passenger Locomotive. Ilustrated description of a locomotive used on grades of 3 and 4 per cent., and curves of 16 degrees in the mountains of Colorado. 600 w. Am Engr & R R Jour—Feb., 1902. No. 46064 C.

Compound Tank Locomotive, Indian Netherlands Railway, Java. Sectional drawings with brief note. 180 w. Engr, Lond—Feb. 14, 1902. No. 46462 A.

Egyptian Experimental Locomotives. Illustrates and describes six striking examples of modern locomotive engineering, two British and four American built. 1200 w. Engr, Lond—Feb 7, 1902. No. 46242A.

Heavy Locomotives. Discussing the present tendency, and whether it is justified, and related questions in transportation. 2200 w. Am Engr & R R Jour—Feb., 1902. No. 46065 C.

Locomotive Building in the United States. Fred H. Colvin. A collection of notes from various sources giving information concerning locomotive works that have been in existence. 2000w. Loc Engng —Feb., 1902. Serial. 1st part. No. 45937 C.

Mathias Baldwin and the American Locomotive. Editorial review of the Baldwin Locomotive Works of Philadelphia, which have reached their seventieth anniversary as an industry, and completed their twenty-thousandth locomotive. 1700 w. Ir Age—Feb. 20, 1902. No. 46400.

Representative American Locomotive Exhibits. William B. Aiken. A comparison of the exhibits made at various American expositions during the last twenty-five years. 1000 w. Loc Engng—Feb., 1902. No. 45939 C.

Six-Coupled Express Locomotive, Eastern Railway of France. Illustrated description of a locomotive representative of recent French practice. 2000 w. Engr, Lond—Jan. 24, 1902. No. 45989 A.

Tandem Compound Decapod for the Santa Fe. Illustrated detailed description of the heaviest locomotives ever built up to the present time Oil is the principal fuel used. 2000 w Ry Age—Jan. 31, 1902. No. 46054.

Thomas & Stetson Oil Burning Locomotive. An illustrated description of a new style boiler for locomotives burning oil as fuel. 600 w. Loc Engng—Feb., 1902. No. 45936 C.

Motive Power.

The Proper Utilization of Motive Power. T. M. R. Talcott. Condensed from a paper presented at meeting of the Southern & Southwestern Ry. Club. Generally favorable to pooling or double crewing locomotives. 2800 w. Ry & Engng Rev—Feb. 8, 1902. No. 46178.

Snow Plow.

Self-Turning Snow Plow on the Delaware, Lackawanna & Western R. R. Illustrates and describes a car with a self-contained turntable arrangement for turning the plow end for end at any point without having to use a stationary turntable. 5000 w. Ry & Engng Rev—Feb. 22, 1902. No. 46477.

Steam Motor Cars.

Steam Motor Cars for Railway Service. An illustrated account of some experiments undertaken a few years ago with steam motor cars for railway service, with disappointing results. Also editorial discussion of some of the reasons of their failure, and of the great field awaiting a successful independent motor car. 7500 w. Eng News—Feb. 6, 1902. No. 46104.

Steel Cars.

Shop Practice in Maintenance of All-Steel Cars. Report of committee with general discussion. 5000 w. Cent Ry Club —Jan., 1902. No. 46135 C.

Superheated Steam.

See Mechanical Engineering, Steam Engineering.

Valves.

By-Pass and Starting Valves A. T. & S. F. Four Cylinder Tandem Compound. Illustrated description. 700 w. Ry Age—Feb. 14, 1902. No. 46271.

NEW PROJECTS.

Ship Railway.

An Isthmian Ship Railway. A. E. Cheff. Gives designs of the Eads ship-railway proposed, and discusses the Tehuantepec route, and the practicability of the scheme. 1200 w. Sci Am Sup—Feb. 15, 1902. No. 46206.

Victoria Nyanza.

To the Victoria Nyanza by the Uganda Railway. Commander B. Whitehouse. A paper containing much information of the railway, the survey of the future port, &c. Also discussion. 9800 w. Jour Soc of Arts—Feb. 14, 1902. No. 46409 A.

PERMANENT WAY AND FIXTURES.

Bern-Neufchatel.

The Bern-Neufchâtel Railway (Die Bern-Neuenburg Bahn). Albin Beyeler. An illustrated general account of the new direct line between these Swiss cities, with descriptions of bridges and construction work. Serial. 2 parts. 5000 w. Schweiz Bauzeitung—Jan. 4, 11, 1902. No. 46374 each B.

Canadian Railway.

The Construction of the Great Northern Railway of Canada, 1899-1900. J. M. Shanly. Interesting account of the undertaking with description of the work. 3 plates. 4800 w. Can Soc of Civ Engrs—Adv. proof.—Feb., 1902. No. 46250 D.

Crossing Gates.

Some Features of Crossing Gate Operation. Illustrates and describes features of the pneumatic gates of the Bogue and Mills system. 1000 w. Ry & Engng Rev —Feb. 1, 1902. No. 46059.

Curves.

Slide Rule Computations for Laying Out Curves. Henry T. Stiff. Briefly explains how the slide rule may be used with accuracy and a great saving of time. 900 w. Eng News—Feb. 20, 1902. No. 46489.

Dutch East Indies.

The Railways of the Dutch East Indies (Les Chemins de Fer aux Indes Nerlandaises). Auguste Moreau. A comprehensive account of the railways and tramways of Java, Madura and Sumatra, and their construction and operation. Maps. 9000 w. Mem d l Soc d Ing Civils de France—Dec., 1901. No. 46377 G.

Grade Crossings.

Abolition of Grade Crossings. Charles Zueblin. An illustrated article reviewing what has been accomplished and what should be done in various cities of the United States. 3200 w. Munic Af—Dec., 1901. No. 46297 D.

New York Terminal.

New York Central Underground Passenger Loop. Plan with brief description.

Also recommendations of the New York Railroad Commissioners concerning the movement of trains, &c. 1100 w. Ry Age—Jan. 31, 1902. No. 46052.

The Proposed Tunnel Loop at the Grand Central Station. Plan showing the arrangement proposed with explanatory notes. 700 w. R R Gaz—Jan. 31, 1902. No. 46055.

Paris.

The New Paris Terminal of the Orleans Railway (Prolongement de la Ligne d'Orléans dans Paris). A Dumas. A very well illustrated description of the underground extension of the Orleans Ry. along the left bank of the Seine, and of the magnificent station on the Quai d'Orsay and its mechanical equipment. 1 plate. 1200 w. Génie Civil—Jan. 25, 1902. No. 46342 D.

Railway Improvements.

The Cincinnati Southern Ry. and Its Improvements. History, with general description of the original combination of this municipally owned line, its recent improvements, operation, equipment, &c. Ill. 6500 w. Eng News—Feb. 20, 1902. No. 46487.

Shops.

Erie Railroad Shops, Dunmore, Pa. Plan and front elevation, with description of shops representing the best modern practice. Gives also a list of tools and motors used. 3000 w. Loc Engng—Feb., 1902. No. 45938 C.

Rock Island Shop Improvements at Chicago. Information concerning recent changes made necessary by the increase in traffic. 900 w. Ry Age—Jan. 31, 1902. No. 46053.

Signalling.

Interlocking Signalling. W. H. Patton. Read before the Engrs. Club of Toronto. Describes some signals now in use, showing their importance, and reviews various forms and the development of the interlocking system. 2500 w. Can Engr—Feb., 1902. No. 45972.

Railway Signalling. Describes a system that has been experimented upon in France, by which a signal disc and alarm bell inside the cab are electrically operated when the engine runs accidentally past a danger signal. 1300 w. Engng—Feb. 7, 1902. No. 46232 A.

Track Elevation.

Track Elevation on the New York, New Haven & Hartford R. R. at Boston, Mass. Illustrations, plans and description of work to eliminate a number of grade highway crossings where condensed traffic had to be protected. 7700 w. Ry & Engng Rev—Feb. 1, 1902. No. 46060.

Tracks.

Construction Work on the Aurora, Elgin & Chicago Railway. An illustrated account of probably the best example of heavy high-speed electric railway work now to be found. 1400 w. St Ry Jour—Feb., 1902. No. 46083 D.

TRAFFIC.

Progress.

Community of Interest from a Traffic Standpoint. B. D. Caldwell. An interesting address on the progress we may look for in this new century, and its application to the community of interest in railroading. Discusses some of the principles essential. General discussion. 16000 w. N. Y. R R Club—Jan. 16, 1902. No. 46253.

Report

Annual Report of the Interstate Commerce Commission. Extracts concerning packing-house products, rates, traffic associations, safety appliances, &c. 4500 w. R R Gaz—Jan. 31, 1902. No. 46056.

Ton-Mile.

The Ton-Mile in India. Notes by Lieut.-Gen. Sir Richard Strachey stating the reasons which led to the adoption of ton and passenger mileage returns, more than 30 years ago, under the orders of the Governmen of India, and the results which have followed. 1800 w. Transport—Jan. 31, 1902. No. 46116 A.

Tonnage

Handling Less Car Load Tonnage. Edwin H. Lea. Discusses the causes of the irregularities that lead to losses in the payment of damage claims, and the remedies. 1100 w. R R Gaz—Feb. 14, 1902. No. 46199.

Tonnage Rating on Railways. J. W. Harkom. Describes methods of rating locomotives in use on the Canadian Pacific Railway. 2000 w. Am Engr & R R Jour—Feb., 1902. No. 46063 C.

Train Tonnage. Henry Miller. Discusses, in a general way, how to properly and economically load and operate trains. 1000 w. St. Louis Ry Club—Jan. 10, 1902. No. 46031.

MISCELLANY.

Comparison.

Railways: British and American. A. H. Tatlow, in the *Railway Official Gazette.* A comparison of cost, mileages, construction and equipment, traffic returns, &c., giving much information of interest. 2000 w. Ry & Engng Rev—Feb. 15, 1902. No. 46278.

Education

See Industrial Economy.

Government Ownership.

Government Ownership of Railroads. Hon. Martin A. Knapp. Extracts from an article in the *Annals of the American Academy, &c.* Outlines some of the arguments for and against the public ownership of railroads. 3000 w. Ry & Engng Rev—Feb. 15, 1902. No. 46276.

Great Britain

Light Railroads in Great Britain. C. H. Grinling. States what led to the passing of the Light Railways Act of 1896, its object, and the power of the Board of Trade over this class of railways. 1300 w. R R Gaz—Feb. 7, 1902. No. 46115.

Interstate Commerce

The Interstate Commerce Law. Editorial discussion of the Elkins bill to enlarge the powers of the Interstate Commerce Commission. 2000 w. R R Gaz—Feb. 14, 1902. No. 46201.

Railroad Development.

Phases of Southern Railroad Development, 1881-1901. John P. Meany. Historical review. 5400 w. Mfrs Rec—Feb. 20, 1902. Special number. No. 46418.

Siam

Railways in Siam. Gives briefly the history of railroads in this country, and their present condition. 1400 w. U S Cons Repts, No. 1272—Feb. 21, 1902. No. 46407 D.

STREET AND ELECTRIC RAILWAYS

Accidents.

Accidents to Tramway Passengers from Contributory Negligence. J. Neville Porter. Discusses the legal aspects of the question of compensation for personal injuries. 2800 w. Tram & Ry Wld—Jan. 9, 1902. Serial. 1st part. No. 46006 B.

Berlin.

The Electric Elevated and Underground Railway in Berlin (Die Elektrische Hoch- und Untergrundbahn in Berlin). Hr. Frahm. A well illustrated description, particularly of the elevated structure and details of construction. 3500 w. Stahl u Eisen—Feb. 1, 1902. No. 46337 D.

Brakes.

The Price Friction Brake. Illustrated detailed description of a device for tram-cars operated by the energy of the moving car, and claiming many advantages. 1100 w. Tram & Ry Wld—Jan. 9, 1902. No. 46005 B.

Brighton.

Brighton Corporation Electric Tramways. Illustrated detailed description of the tramway system of Brighton, England. 1800 w. Elec Rev, Lond—Jan. 24, 1902. No. 45996 A.

Car Equipments

Electric Car Equipments and Their Maintenance. A. W. Wigram. Abstract of paper read before the Newcastle Sec. of the Inst. of Elec. Engrs. Discusses tracks, brakes, life guards, motor equipment, trolley heads, controllers, &c. 4000 w. Elect'n, Lond—Jan. 24, 1902. No. 45998 A.

Car House.

Car House at Worcester, Mass. Brief description with plan and diagram. 700 w. St Ry Rev—Feb. 15, 1902. No. 46281 C.

Dangers.

The Supposed Dangers of Electric Traction. Editorial discussion of the recently published letter from Mr. George Westinghouse. 1100 w. Sci Am—Feb. 1, 1902. No. 45957.

Electric Railways.

Electricity for the New York Central Tunnel. Frank J. Sprague. A reply to the letters of Mr. George Westinghouse on the subject of the dangers of electric traction in tunnels. 1500 w. Elec Wld & Engr—Feb. 1, 1902. No. 46014.

The Rise of Electric Railways in Massachusetts. Alton D. Adams. A review showing remarkable development and financial expansion. 3000 w. Elec Rev, N. Y—Feb. 8, 1902. No. 46160.

Some Personal Notes on Electric Railways. Frank J. Sprague. Interesting notes relating to the Union City Railway of Richmond, 1887, and the South Side Elevated of Chicago, 1897. 2800 w. Elec Rev, N. Y—Feb. 15, 1902. No. 46287.

Express Business.

Handling Express Matter in Electric Cars in New York. Information concerning the methods adopted for carrying on the details of the express, freight and baggage service in special express cars of the Metropolitan St. Ry. system of New York, including the Union Ry. lines in the Bronx. Ill. 1700 w. St Ry Rev—Feb. 15, 1902. No. 46280 C.

Fenders.

Street Car Fenders (Schutzvorrichtungen an Strassenbahnwagen). M. Kosch. An illustrated description of various kinds of fenders for picking up people falling in front of street cars. 3000 w. Elektrotech Zeitschr—Jan. 30, 1902. No. 46326 B.

Germany.

Experiments with Electric Traction on Standard Railways in Germany (Versuche über Elektrischen Betrieb auf einigen Hauptbahnen in Deutschland). Ludwig Spängler. A well illustrated account of some of the electric railways in successful operation, and particularly of recent high-voltage and high-speed experiments on the Wannsee Ry., at Lichterfelde and on the Zossen Ry. Serial. 2 parts. 10,000 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 17, 24, 1902. No. 46358 each B.

We supply copies of these articles. See page 159.

High Speed.

High-Speed German Railway at Zossen. Frank C. Perkins. Illustrations and description of the car equipment for the high-speed, polyphase railway experiments, where more than 100 miles an hour has been attained. 1500 w. Sci Am—Feb. 8, 1902. No. 46088.

Modern Fast Trains (Moderne Schnellzüge). A short review of high-speed train records and of electric high-speed projects. 1200 w. Oesterr Wochenschr f d Oeffent Baudienst—Jan. 11, 1902. No. 46353 B.

Interurban.

The Hartford and Springfield Street Railway. Illustrates and describes a line that forms an important link in connecting New York and Boston by trolley. 1500 w. St Ry Jour—Feb. 1, 1902. No. 46081 D.

The Lansing, St. John & St. Louis Electric Ry. An illustrated account of the opening of a new electric interurban road for passenger and freight traffic, in Michigan. 1400 w. Ry & Engng Rev—Feb. 15, 1902. No. 46275.

Lifts

The Electric Lifts of the City and South London Railway. Illustrated detailed description of the satisfactory apparatus at the stations for the use of passengers. 1800 w. Tram & Ry Wld—Jan. 9, 1902. No. 46004 B.

Mails.

Mail Transportation in Cities. Waldon Fawcett. An illustrated article on the recent improvements made, by the establishing of sub-stations for postal distribution, electric cars, pneumatic tubes, and automobiles for transportation, &c. 1000 w. Sci Am—Feb. 15, 1902. No. 46202.

Newcastle-on-Tyne.

The Electric Tramways of Newcastle-on-Tyne. Illustrated description with account of some of the difficulties attending the work of construction. 4500 w. Tram & Ry Wld—Jan. 9, 1902. No. 46003 B.

New York.

The New York Rapid Transit Railway. This first article of a series reviews the early history of rapid transit enterprises in New York city. 5000 w. Eng News—Jan. 30, 1902. No. 45911.

New York Elevated R. R.

Electrical Equipment of the Manhattan Railway. Brief description with illustrations of the largest electrical plant yet built in the United States. 1400 w. St Ry Rev —Feb. 15, 1902. No. 46282 C.

Electricity on New York's Elevated Railways. Hermann A. Strauss. Outlines the plan of power supply giving illustrations. 3300 w. Elec Age—Jan., 1902. No. 46022 C.

Power System and Generating Station of the Manhattan Railway Co., New York. Arthur L. Rice. An illustrated detailed description of the power station, boiler plant, feed water system, steam piping, engines, exhaust system, etc. 10500 w. Engr, U S A—Feb. 1, 1902. No. 46047.

New Power Station of the Manhattan Railway Company. Illustrations and descriptive notes on the engines and generators of the electrical system being installed on the Manhattan Elevated Railway, in New York. 2000 w. St Ry Jour —Feb. 1, 1902. No. 46080 D.

Some Features of the Manhattan Elevated Railroad Company's Station Equipment. Illustrated description. 2500 w. Am Elect'n—Feb., 1902. No. 46028.

Park.

An Attractive New England Street Railway Park. H. S. Knowlton. Illustrated description of the park at Whalom Lake, belonging to the Fitchburg & Leominster Street Railway Co. 2500 w. St Ry Jour—Feb., 1902. No. 46084 D.

Pittsfield, Mass

New High Alternating Current Installation of the Berkshire Street Railway Co., at Pittsfield, Mass. Illustrated description of a route through western Massachusetts, a region renowned for its beauty. The powerhouse, sub-stations, overhead construction, and equipment are described. 2200 w. St Ry Rev—Feb. 15, 1902. No. 46279 C.

Storage Batteries

See Electrical Engineering, Generating Stations.

Stray Currents.

The Path of the Return Currents in Electric Street Railways and their Electrolytic Action (Ueber den Verlauf der Rückströme von Strassenbahnen und über ihre Elektrolytischen Wirkungen). Illustrated abstract of a paper by M. G. Claude before the Paris Electrical Congress, giving the results of experiments, with recommendations. 2000 w. Elektrotech Zeitschr—Jan. 23, 1902. No. 46324 B.

See also Electrical Engineering, Communication.

Surface-Contact.

The Lorain Surface Contact System. Illustrated detailed description of the equipment of the Wolverhampton Corporation tramways. 2500 w. Elec Engr, Lond—Feb. 7, 1902. No. 46218 A.

Tracks.

Progress in Street Railway Track Construction. Charles S. Butts. Reviews the methods of track construction in early days of street railroading, and describes the most approved modern practice. 2500 w. St Ry Jour—Feb. 1, 1902. No. 46-082 D.

EXPLANATORY NOTE.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
American Telephone Journal. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Armee und Marine. *w.* Berlin.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, Eng.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin Scientifique. *m.* Liege.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Age. *m.* New York.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical Times. *w.* London.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.

Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemist & Metallurgist. *m.* London.
Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *w.* New York.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Indian and Eastern Engineer. *m.* Calcutta.
Ingeneria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Assn. Eng. Societies. *m.* Philadelphia, U.S.A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, Mass.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. w. San Francisco, U.S.A.
Mining Journal. *w.* London
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. m. Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Wurtt. Ver. f Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Power Quarterly. New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *or.* Philadelphia, U. S. A.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Railroad Digest. *w.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. ed Agr. *b-m.* Catania.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Steam Engineering. *m.* New York.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Telephony. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a. S.

THE WORLD IS ITS FIELD.

THE ENGINEERING MAGAZINE

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THE COAL RESOURCES OF THE PACIFIC.

By Harrington Emerson.

The development of the Pacific and the determination of its naval and commercial control must depend largely upon the existence of sufficient and available coal supplies. Mr. Emerson has made an exhaustive study of this most important problem, and writes with a close personal knowledge of the subject, knowledge gained by his own familiarity with the Pacific coast and its resources in the course of many professional investigations.—THE EDITORS.

COMMERCE and civilization have passed from the Mediterranean to the Atlantic and perhaps in turn will pass from the Atlantic to the larger ocean, the Pacific. England has been and is the world power in the Atlantic. Her coal mines have furnished the fuel for the sea commerce of the world; her coaling stations dot the Atlantic shores east and west, in Europe, in the Americas, and in Africa, and from 60 degrees north to 51 degrees south latitude. No other power in Europe can rank with England as a sea power. None has the coal, the coaling stations on all oceans. Russia in extent and number of inhabitants is easily the foremost European land power, but everywhere she is hemmed in from the sea—on the north by the Arctic ice, on the east shut in by the Baltic, on the south shut in by the Black Sea, on the west even until recently closed in by ice. In spite of denials it is readily believed that Russia is willing to foment trouble between Sweden and Norway in order to acquire from the latter a port on the Atlantic, to foment trouble in Turkey in order to take possession of the Golden Horn, to foment trouble in Persia in

FORT LISCUM, PRINCE WILLIAM SOUND, ALASKA

Lat. 61°, long. 147°. At this point begins the military road over the pass to the Copper River. The tarpaulins cover sacks of coal, brought from Tacoma, 1,800 miles southeast.

order to acquire seaboard rights in the Persian Gulf, and we know of present trouble in Eastern waters where thus far Russia has most profited, taking Port Arthur from Japan and Manchuria from China.

Great Britain on the Atlantic—but the United States on the Pacific; the latter destined to become the greater trade ocean of the two. Not only do the most dense and industrious populations of the world line the western shores of the great ocean, but the western coast of North America in natural wealth far surpasses the eastern coast, with the exception of coal; yet if the Crows Nest coal mines of British Columbia, lying on the west slope of the Rocky Mountains and but 500 miles from the Pacific be included in Pacific Coast resources, then in coal also the west surpasses the east; for these measures, many hundred

NUTCHEK BAY, PRINCE WILLIAM SOUND, ALASKA

A United States mail steamer makes the round of the Southern Alaskan coast each month. This part of Alaska is heavily timbered.

miles, in area, contain, in fifteen veins, 150 feet of solid coal, some of it gas coal, some anthracite, and the soft varieties superexcellent coking coal.

In gold the Pacific slope has produced more than all the balance of the United States and last year produced more than all the balance of North America. In fisheries the Pacific coal is easily first, and also in exports of lumber and fruit, if not of cereals.

The general expansion of American interests in the Pacific is exemplified by the fight over the isthmian canals at the extreme east, the judicial scandals at Nome in the extreme north, and the perennial Philippine trouble in the extreme west, not to speak of the Alaskan boundary, undetermined for 1,200 miles, every foot in dispute, and the payment of the Chinese indemnity. Are not the largest steamers ever designed even now building in Connecticut for traffic between Puget Sound and Japan? Certainly the Pacific Ocean is assuming importance, and modern commercial importance is founded on coal.

INDIAN RIVER, NEAR SITKA

Lat. 57° N., Long. 135° 25'. Sitka is the old Russian capital of Alaska. On this river are spruce trees 8 feet in diameter.

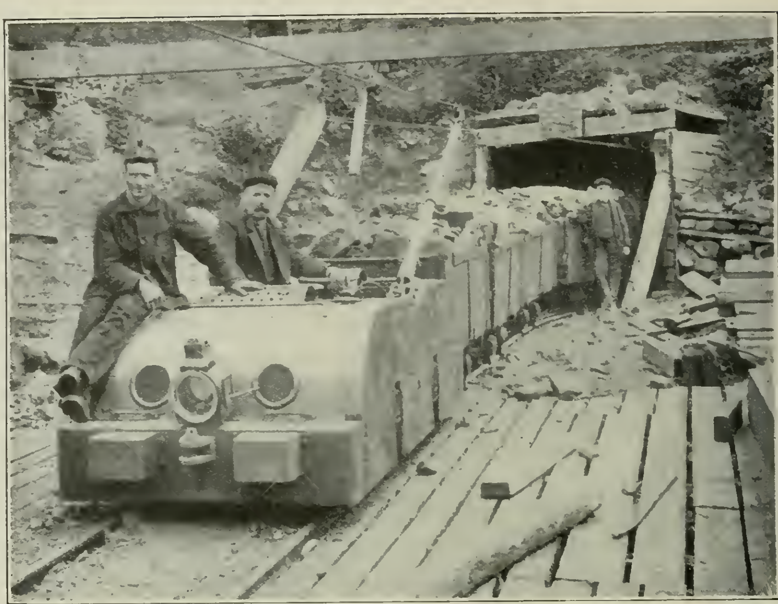
Coal mines and coal fields occur along the Pacific shores, northwest from Chile to Alaska and thence southwest to Australia and New Zealand. The chief geographical difference between the Atlantic and Pacific is that the latter is open to the north, or partially occupied by such worthless regions as Iceland and Greenland, while the whole north Pacific is bounded by Alaska, a region as large as Great Britain, Belgium, Holland, Denmark, Norway, Sweden, and the German Empire, and by good authorities who know it, declared to be richer in natural resources, with the exception of lumber, than all the Pacific Coast States.

Since 1896 five events have occurred that wholly change conditions in Alaska for the better. (1) In that year the Klondike gold discoveries were made and in 1897 and 1898 a great rush to and through Alaska began, resulting in a doubling of the population and in an output of gold from the Yukon region to date of $75,000,000. (2) In 1898 the Philippine Islands were acquired by the United States, giving importance to the direct route along the Alaskan coast between North America and the new possessions. (3) In 1899 gold was discovered on the beach at Nome and this carried 30,000 people to this part of Alaska and resulted in an output of $5,000,000 in gold annually, or more than twice as much as all Alaska had previously yielded. (4) The Alaskan salmon fisheries, in their infancy in 1896, have grown in 1902 to great companies, capitalized for $20,000,000 with net earnings last year of more than $2,000,000, and employing 10,000 men. (5) Two railroads have been constructed in Alaska, one of which in the extreme southeast, costing $4,000,000, earned last year over $3,000,000 net, and the other in the extreme northwest near Nome, a little road five miles long which earned $80,000 net. (6) Coal fields formerly superficially known have been explored and investigated, while new ones of great value have been discovered.

The popular impression of Alaska is that it is a far northern region producing gold and intensely cold. The popular impression misses much. Colonel P. A. Ray, U. S. A., late in command of the Department of Alaska, states: "Many have an idea that there is nothing worth going to Alaska for except gold. The same was true of California in 1849, but there are greater resources in Alaska to-day, aside from gold, than in the Pacific Coast States, if timber is left out. There has not been enough told of the diversified possibilities of the country, which if developed would be of greater importance than all the gold." The United States Agricultural Bureau reports over 100,000 square miles adapted to agriculture and grazing.

It is true that on the Yukon near the Arctic Circle there is in winter intense cold, and that the northern shores of Bering Sea are closed each year by ice; but from end to end of the Yukon there is no snow in summer, but long hot summer days. The southern Alaskan coast lies almost due west of British Columbia, and has, owing to the warm winds of the Japan current, a mild and equable climate the year around, the thermometer never reaching zero in winter nor as high as 77 degrees in summer. This is not so surprising, since the Alaskan coast reaches as far south as London, and the towns of Juneau, Sitka, and Dutch Harbor are in the same latitudes as Aberdeen, Edinburgh, and Glasgow, and on a similar coast with a similar climate.

Politically Alaska is important because it borders on three of the



TRIP OF MINE CARS FROM NO. 1 TUNNEL, CROW'S NEST COLLIERY.

great world powers. The boundary between Alaska and Canada is almost as long as the whole of the land boundary between the United States and Canada; Alaska faces Russia across the whole of Bering Sea and the boundaries touch in the Diomede Islands, while the nearest Japanese islands are but 600 miles from the furthest Alaskan islands.

A little understood feature of the North Pacific Ocean is that the shortest steamer route from Panama to Singapore runs very close to San Francisco, to Puget Sound, to the British Columbian cities, to the Alaskan coast and its coal mines, and thence by way of Yokohama, Manila, and Singapore to India, so that the opening of any isthmian canal to traffic will put all the North American western coast cities, as well as Alaska, on the direct and shortest American route from London and New York to the east coast of Asia, all of which can best be seen and understood by stretching a string on a globe, and certainly not perceived by looking at the usual distorted Mercator projection of the world.

There are now important coal mines at Lota and Coronel in Chili, lat. 38° south, long. 73°, which will, with the straits of Magellan, probably lose their importance when the isthmus is opened, as thereafter all western South American trade will be diverted to the much shorter and safer route. The Chilean coal, not as good as the Alaskan coals, is very high in sulphur.

The next commercial outcropping of coal on the Pacific occurs at Coos Bay, Oregon, lat. 43°20′, long. 124° 20′, where the U. S. Government has expended more than $820,000 to make a harbor. The output of this coal in 1900 was 104,294 tons. It is the poorest of all the Pacific commercial coals from Chile to New Zealand, an average analysis being 13.6 moisture, 42.4 volatile matter, 37.4 fixed carbon, 6.6 ash, and 1.54 sulphur.

North of Coos Bay, in that splendid fjord called Puget Sound, and near the cities of Whatcom, Seattle, and Tacoma, in the United States and at Comox and Wellington, on Vancouver Island, occur very extensive coal fields of various qualities of coal. These fields are today the most important on the Pacific and have such an advantage of location that the better and more easily mined coal of the Crows Nest, 500 miles inland, nearly 800 by railroad, can scarcely compete.

In 1901 the output of the American mines was 2,504,190 short tons, an increase of 86,156 tons over 1900, and the output of the Canadian mines in British Columbia, including the Crows Nest (about 300,000 tons), was 1,712,715, an increase of 87,100 tons over 1900. The Vancouver mines were opened as early as 1867, but the American mines have increased in output much more rapidly—145,000 tons in 1880, 525,705 in 1887, 1,330,192 in 1897, and 2,504,190 in 1901; but the opening of the Crows Nest threatens to transfer the supremacy again

ELECTRIC TROLLEY CHARGING COKE OVENS, FERNIE, B. C.

to British Columbia. The best seam in the Wellington colliery is from 5 to 10 feet thick.

Exclusive of Vancouver Island, the Puget Sound coal basin covers an area of about seven hundred and fifty square miles. There are several distinct fields within this basin but the character of the coal

SUMMIT OF WHITE PASS, LOOKING SOUTH TO THE PACIFIC OCEAN

This is the present boundary between Alaska and British Columbia, elevation 2,880 feet, and 14 miles in air line from Dyea Inlet and Skaguay, 20 miles by railroad, which 90 miles further north reaches deep water on the Yukon.

differs in each separate field, varying from a lignite to rich bitumnous coking coals. In percentages, these coals run:

	Moisture.	Volatile.	Fixed Carbon	Ash.
Lignites	8 to 12	35 to 45	30 to 45	6 to 18
Bituminous	1 to 3	25 to 35	45 to 60	2 to 8

Some of these coals make excellent coke. The lignites are hard, bituminous lignites soft but firm, and the bituminous coking coals are soft and require washing.

It is very encouraging to find seams of coal near Alaska 18 feet in thickness, as the seams in the Puget Sound region rarely exceed 7 feet and many of only 30 inches are worked.

Some of the Puget Sound mines seem to produce more tons per employe than any other coal mines in the world. A few years ago world statistics showed that the output per man was:

	TONS.
Japan	87
Belgium	165
France	200
France per miner	280
Germany	260
Great Britain	300
N. S. Wales	400
United States Bituminous	540
United States Anthracite	369
State of Washington, all the mines	514
State of Washington per miner, all the mines	617
State of Washington, Roslyn mine	711
State of Washington, Roslyn mine, per miner	774

Westward from Puget Sound along the coast no coal seams of commercial value are met with until the headwaters of the Yukon River are reached. This river rises only 14 miles from the Pacific Ocean, from which it is separated at the top of the divide by a narrow ridge only a few feet high and wide. At this point the White Pass is 2,885 feet above sea level and is occupied by the White Pass Railroad, which cost $4,000,000 to build from Skaguay to White Horse, a distance of 110 miles, where deep-water navigation on the Yukon begins. Last year the railroad earned $3,000,000 net over operating expenses; it is owned wholly in England, as the English, much more than Americans, have the courage of distant and bold enterprises. In 1901 the freight traffic, 1,000 miles from Seattle to Skaguay, 110 miles to White Horse, over the White Pass 380 miles by Yukon boats to Dawson, was 22,597 tons, and by the lower river, 2,600 miles by sea from Seattle to St. Michaels, 1,600 miles from St. Michaels by river boats to Dawson, was 13,930 tons, both routes showing a gain, of 2,180 tons and 2,303 tons respectively. The fuel for a single freight contract on the lower river cost $50,400.

It is near this White Pass Railroad, in lat. 61°, long. 135°, that a very valuable coal mine has been recently discovered. It is thus described by Mr. Wm. M. Brewer in the *Engineering and Mining Journal:*

"The first discovery was made in a narrow gulch between two high mountains. The first outcrop, which represents the lower seam opened, on which work as done, is about 5 feet in thickness. A short tunnel was driven

COAL HARBOR, SOUTH SHORE HERENDEEN BAY, ALASKA

The outcrops of coal occur in the little valley in the foreground, about two miles from the sea and at an elevation of 800 feet.

on this, and the coal found to lie beteen a slate roof and a conglomerate floor. About 300 feet higher another seam outcropped, about 18 feet in thickness. On this a tunnel was run 60 feet in length. The coal lay between a slate hanging-wall or roof and shale foot-wall or floor. A sample of this coal, which is very free from slate, was hauled over the snow last winter to White Horse, and tested on the engines of the railway company. The superintendent of the railroad informed the writer that this test was very satisfactory, and the steaming qualities of the road were fully determined. The third outcrop, which may belong to a still higher seam or may be the same seam as the second mentioned, was discovered on the plateau apex of a mountain 700 feet higher than the gulch in which the two first outcrops were discovered, and easterly about half-a-mile distant. This outcrop had been opened by a shallow crosscut which exposed the seam 18 feet in thickness having the same line of strike, but dipping about 20° nearer the vertical than the other outcrops. A survey for a tram track from the railway has been made by J. E. Beatty, assistant engineer for the White Pass & Yukon Railway Company, and all arrangements perfected to organize a company to acquire 1,500 acres of this coal field. The route followed by the survey line is through a comparatively easy country, to construct a narrow-gauge line of railway."

With one exception none of the other Pacific coast coal mines are as far north as this and none of them in so rigorous a climate. Westwards along the coast there are outcroppings of coal at Lituya Bay, at Yakutat and on the flanks of Mt. St. Elias, but the first field that promises to be of great commercial importance is one very recently discovered near the Chilkat River between Mt. St. Elias and the mouth of the Copper River, lat. 60° 20′, long. 144° 30′. This coal is extraordinarily good, as clean to touch as glass and almost identical in composition with Albion Cardiff, Glamorganshire, Wales, adopted by the United States Bureau of Equipment as a standard:

	Moisture.	Volatile.	Fixed Carbon.	Ash.
Albion Cardiff........	0.352	14.	82.44	0.06
Alaskan Kyak........	0.77	13.79	82.36	3.08

I have not seen the seams, but they are credibly reported as being very extensive and of great thickness. They are being developed by a strong English company, who, however, will find it an expensive undertaking to bring the coal down to a suitable loading harbor owing to the mountainous character of the country and the failure of nature to provide a protected roadstead near the mine. In the same region the same company has extensive petroleum deposits and wells, the oil containing no sulphur. It is a cause for congratulation that Alaska has produced better coal than any other coal anywhere on the Pacific Ocean, coal almost equal to the best in the world.

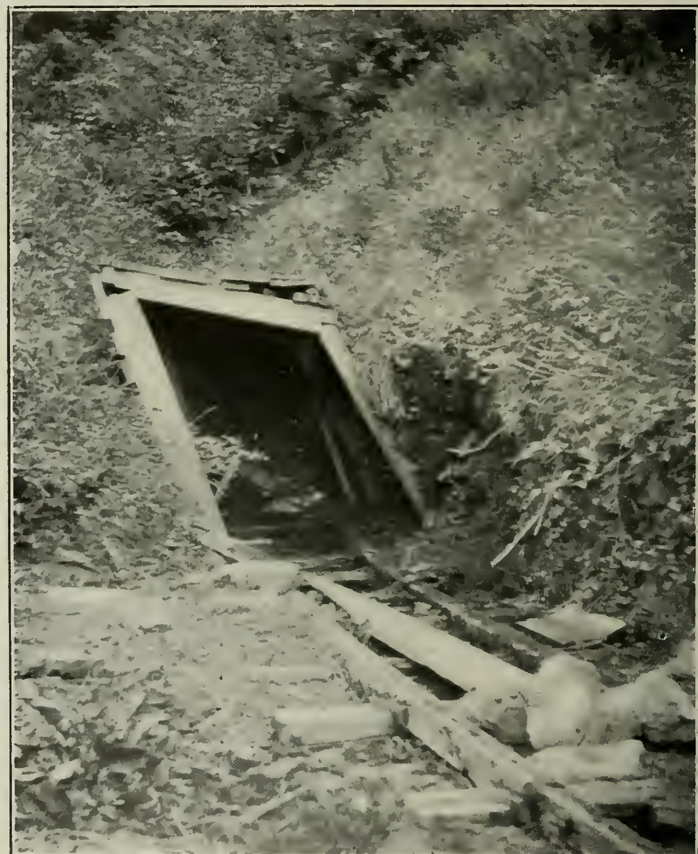
The next commercial occurrence of coal is in the Kenai Peninsula in Cook's Inlet, a deep sound discovered by Cook in 1787, left unnamed by him, but named after his death by Lord Sandwich. Here the coal for scores of miles crops out in numerous seams along the ocean front, and at low tide is loaded into small boats. Much of it is very lignitic, light and brittle in character, but burns well. At one single point a long sand spit juts out into Kachemak Bay where the tides rise 30 feet and this makes the only available harbor, lat 59° 40', long. 151° 30'. Mr. Geo. Jamme, Jr., of Pittsburg, had charge of the opening up of this mine. He built 7 miles of railroad and a fine dock to bring the coal from a great level basin lying a short distance inward from the ocean front. Unfortunately the company working this mine has no ocean transportation equipment and is thus

OLDEST RUSSIAN BLOCK HOUSE IN ALASKA, AT NUTCHEK

Nutchek, lat. 60° 15', long. 147°, is at the entrance to Prince William's Sound, explored and named by Capt. Cook, in 1778. These block houses took several years to build and are fastened with hand-forged copper or iron nails brought from Russia.

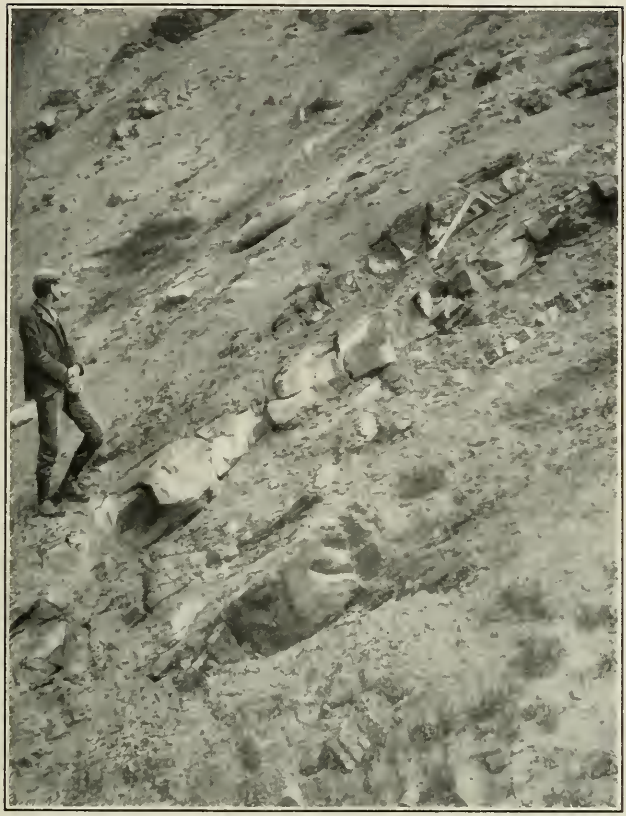
severely handicapped. Local settlements, fishing steamers, etc., quarry their own coal at low tide along the beach at merely nominal expense, while a few hundred miles away coal is selling at $12 to $20 a ton. The location of this mine is such as not to enable it to compete with other Alaskan mines in Bering Sea markets where a very large demand exists at a very high price, running from $10 to $100 per ton.

The question of harbor is always an important one on the American Pacific coast, where even in the calmest summer weather the surge of the Pacific beats angrily on the rocky American shore. With the drive of a storm the waves gain in height all the way from Japan, and break with indescribable fury against the American coast. The har-



OLD TUNNEL INTO ALASKAN COAL MINE

This tunnel was opened ten years ago and about 1,000 tons of coal mined with the expectation of supplying San Francisco, but it proved at that time more profitable to use the equipment in a neighboring gold mine.

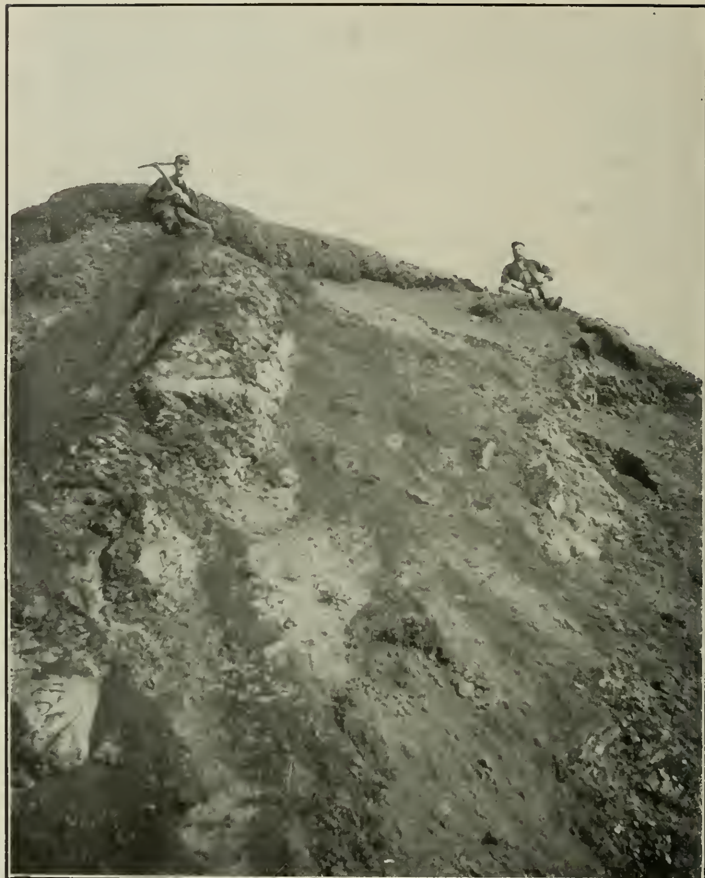


AN OUTCROPPING OF COAL

The upper pick tip points to the top. The seam is 47 inches thick at outcrop and 53 inches thick at the end of a drift 97 feet long.

bors of the coal fields of Puget Sound and Vancouver Island are admirably protected from storms, but the Kyak coal has no natural harbor, and this is true of many of the Alaskan coal fields.

Westward from Kenai, the greatest and most extensive coal field in Alaska is reached, cropping out in many different seams, in two harbors on the Pacific and one on Bering Sea. These Chignik-Unga-Herendeen Bay coal measures, lat. 55° 30′ to 56° 30′, long. 158° to 161°, are not only the most extensive and most accessible fields in Alaska with coal in quality next to that of Kyak, but fully equal to any coal mined further south. The specific gravity runs from 1.33 to 1.49; the coal is hard, brilliant, clean and very strong, not crumbling under severe exposures to water, frost, or sun, nor with very rough usage. This field is of unique value because of its location in the key-



A BERING SEA HILL TOP, COVERED WITH TUNDRA

Each man is sitting on an outcropping coal seam. The tundra is broken by mud patches into which one can sink knee-deep.

stone of the North Pacific. Not only does the shortest possible steamer line from the United States or British Columbia to any part of Asia run within 20 miles of this field, but it is also the nearest of all American coal mines to all the island possessions of the United States on the Pacific, the nearest part of the American mainland to Hawaii, to Samoa, to Guam, and to the Philippines, and also by nearly 2,000 miles nearer than the Puget Sound mines or San Francisco to all parts of Asia, and especially to the great mining region recently developed on the shores of Bering Sea. There is a market to-day on the shores of Bering Sea, according to the United States census agent in Alaska for 1890 and 1900, for 80,000 tons of coal at prices from $10 to

SACKS OF COAL AT FORT LISCUM, PRINCE WILLIAM SOUND, ALASKA
The pile of sacks is in the left middle ground between two buildings and covered over with a white tarpaulin.

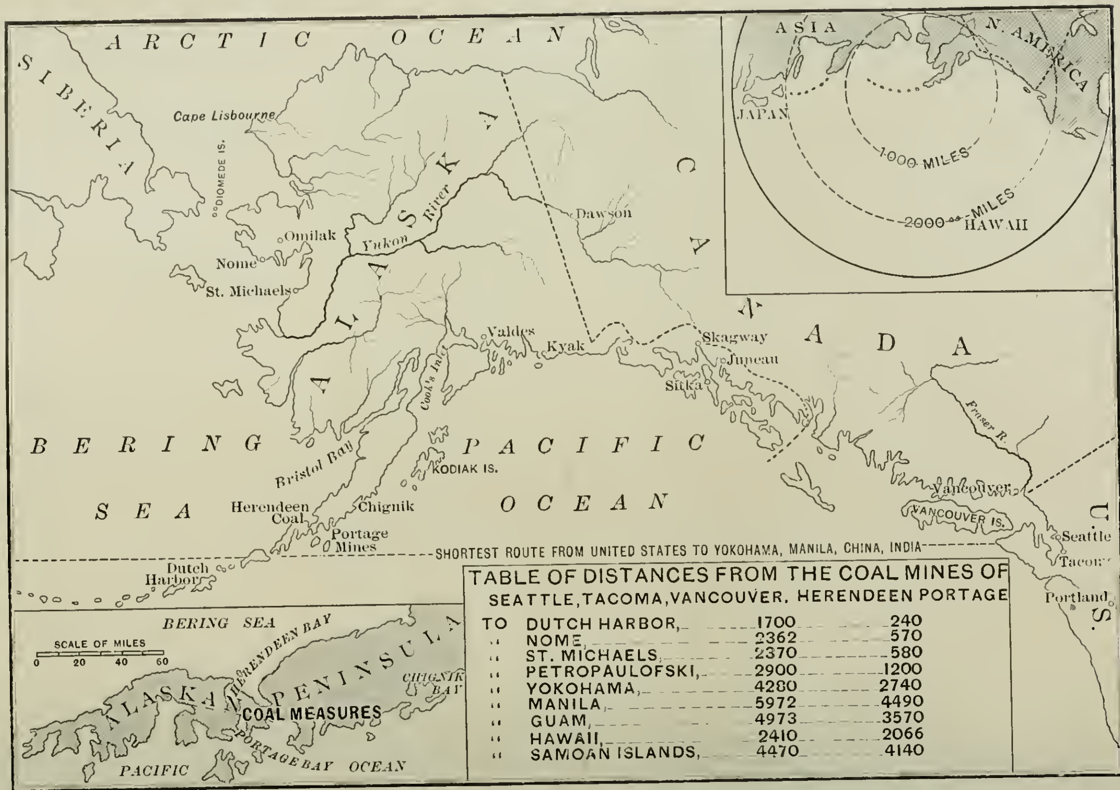
$30 a ton at lowest, ranging upwards to $75 a ton. The consumption in Hawaii is 150,000 tons, and the conditions are such that this coal can be competitively exported southeastward for the Californian, Mexican, and Central American markets, and southwestward to the Philippine Islands, for the Japanese go further, even to India, with coal of poorer quality.

DISTANCES IN NAUTICAL MILES FROM

	Chignik-Unga. Herendeen Bay.	Seattle.	San Francisco.
Dutch Harbor to	240	1,702	2,035
Yokohama to	2,726	4,280	5,500* / 4,581†
Philippine Islands to	4,507	5,972	6,855* / 6,370†
Honolulu to	2,066	2,410	2,100
Guam to	3,580	4,943	5,437* / 5,430†
Nome to	550	2,362	2,770
St. Michaels to	540	2,360	2,760

*Via Honolulu. †Via Portage Bay.

From the above figures taken from maps, charts, and statements furnished by the United States Coast and Geodetic Survey, Department of the Treasury, and by the Hydrographic Office, Department of the Navy, it is apparent that:—from Seattle to Yokohama via Portage

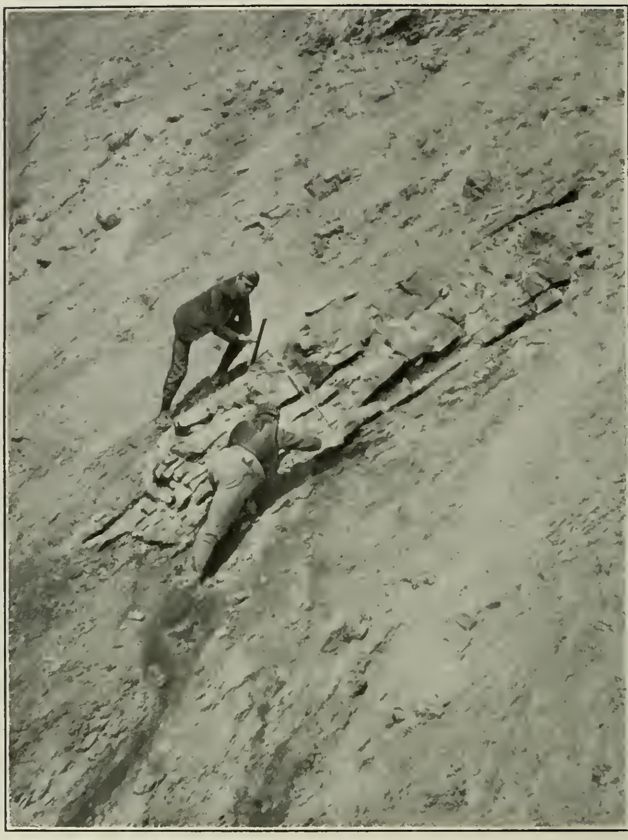


MAP SHOWING THE ALASKAN REGION AND COMPARATIVE DISTANCES FROM THE COLUMBIA RIVER AND HERENDEEN PORTAGE TO THE PRINCIPAL PORTS OF THE PACIFIC

COAL HARBOR, NORTH SHORE HERENDEEN BAY, ALASKA
Herendeen Bay is the largest and safest harbor on Bering Sea.

Bay, Alaska, is 72 miles longer than the shortest possible route. From Seattle to Manila via Portage Bay is only 25 miles longer than shortest possible route. From San Francisco to Yokohama via Portage Bay is 919 miles shorter than via Honolulu. From San Francisco to Manila via Portage Bay is 485 miles shorter than via Honolulu. From Portage Bay it is 1,482 miles shorter to Manila, 1,403 miles shorter to Guam, 344 miles shorter to Honolulu, and from Herendeen Bay, 1,460 miles shorter to Dutch Harbor, 1,790 miles shorter to St. Michael's, 1,792 miles shorter to Nome, than from the coal supplies of Seattle, Tacoma, and Vancouver.

Herendeen Bay is in many respects a counterpart of New York Bay—a Sandy Hook surrounded by shallows, a Coney Island beach where great herds of walrus bask, a Staten Island protecting the mouth of the harbor, narrows leading into a great deep bay, wholly



MEASURING AN ALASKAN COAL SEAM

An outcropping of coal on the side of a gulch above Herendeen Bay.

protected, with ten square miles of water from 60 to 200 feet deep; but the climate is warmer in winter in Herendeen Bay than at New York.

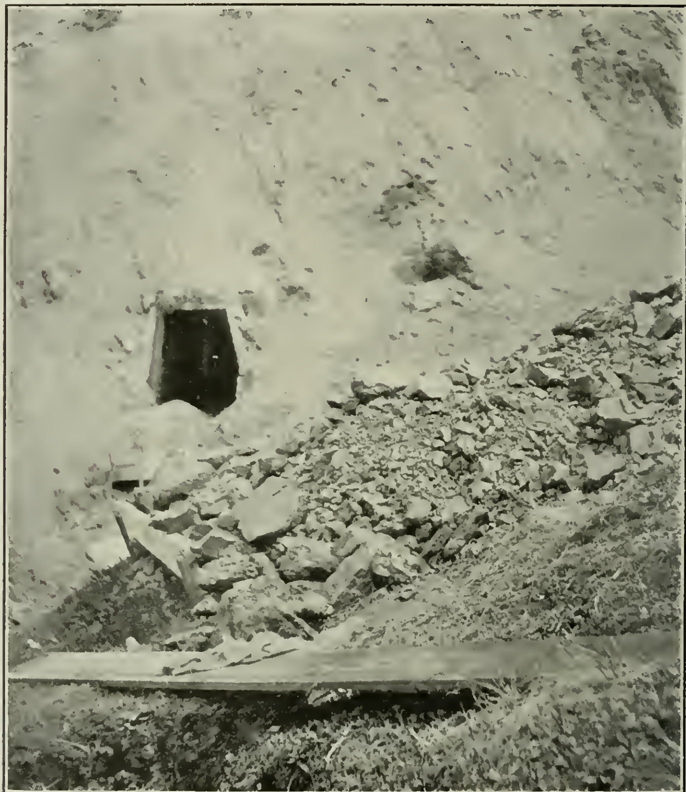
At a point 800 feet above the sea level, only two miles from the best anchorage, coal crops out in thirteen seams of which the best five are 43, 30, 55, 45 and 43 inches thick. Other seams not yet explored are reported seven and eight feet in thickness. With modern equipment it ought to be possible to deliver this coal in deep-sea vessels at any time of the year for one dollar a ton, making it the cheapest seaboard coal in the world. The calorific value from a sample from one of the veins, by no means the best, as determined by the Pittsburg Testing Laboratory, was 12,692 B. T. U.

Herendeen Bay opens on Bering Sea and this makes this mine but half as far from Nome and St. Michael's as any other workable coal mine. The seams near Chignik Bay and on Unga Island open on the Pacific. The latter have been worked in a small way for sixteen years by Mr. H. S. Tibbey, but until the recent growth of Alaska the market, though high-priced, was small. This year Mr. Tibbey is putting in $50,000 worth of machinery and will receive the just reward of his faith and patience. At Unga, as elsewhere in Alaska, Washington, and Vancouver Island, there are various seams of varying quality. Some of them are lignitic and contain consider-

A MINER'S CABIN AND TOOL HOUSE NEAR HERENDEEN BAY
In front of the cabin is a pile of coal. All the lumber for this cabin was brought 2,000 miles and carried on men's backs over a mountain path 1,000 feet high. The summers are cool, the winters less severe than at Philadelphia.

able sulphur, others are of excellent quality. At Chignik the seams outcrop from 5 to 7 feet in thickness and from 2 to 5 miles from the sea.

One hundred and fifty miles west of Herendeen Bay and Unga the American continent ends. North of Bering Strait, in the Arctic Ocean, lat. 69° long. 166°, at Cape Lisborne, is a very extensive field of excellent coal, but of commercial importance owing only to the enormous price ($75 a ton) the few cargoes shipped to Nome have realized. Bering Strait is closed nine months in the year by ice, the coal crops out on an unprotected stormy ocean front, and conditions of operation must always be prohibitively expensive, there being as much difference in climate and distance between Herendeen Bay and Cape Nome as between New York and the shores of Hudson Bay.



RECENT TUNNEL INTO NEWLY DISCOVERED COAL SEAM ON HERENDEEN BAY
Lat. 55° 45′ N., long. 160° 40′. At the end of tunnel, seam is 53 inches thick. Pile of coal in foreground.

The North Pacific Ocean coal mines on the American side produced in 1901, on Puget Sound, 2,504,190 tons, and in British Columbia about 1,712,715 tons, a total of 4,216,905. The consumption of coal is approximately:

Along the Mexican Coast and Central America....	200,000 tons
In California	2,000,000 tons
In the Hawaiian Islands..........................	150,000 tons
In Alaska	100,000 tons
Locally in Oregon, Washington and British Columbia, including steamers and railroads..........	2,217,000 tons
Total..	4,667,000 tons

FLOAT COAL IN AN ALASKAN STREAM

The shovel rests on a big lump of coal which has fallen from an outcrop and rolled down the stream. Alaska is so little explored that coal and other minerals are only discovered by outcrops or float in the streams and valleys.

The difference of 450,000 tons is made up by importations from Wales, Australia, and the Atlantic seaboard.

Owing to improving conditions and increasing demand all the Pacific coal mines, whether in Australia, Japan, British Columbia or Washington, are prosperously increasing their output with no apprehension of any overstocking of the market. In Hawaii, coal consumption has doubled in five years, and in the State of Washington the increase has already been noted. The great discoveries of oil in California have prevented a similar increase in coal consumption there, yet imports have not fallen off and twice at least within the last three years San Francisco has suffered from a coal famine.

In this review of the American Pacific coals, the Japanese, Chinese, Australian and New Zealand coals will be mentioned only in the table of comparative analyses furnished by the United States Government.

With isthmian concessions near the equator, with great gold, copper, silver and lead mines near the Arctic circle, with a vision of American ships steaming from New York to Manila, via San Francisco, Seattle and Tacoma, Dutch Harbor, and Yokohama, coaling at American coal mines all the way, the United States, while yielding to England supremacy in the Atlantic from the Orkneys to the Falkland Islands, can gather to herself the immeasurably greater trade possibilities of the whole American and Asiatic Pacific coast, along which her own continental seaboard extends 4,000 miles and her outlying possessions from equator to Arctic Ocean and back again to equator.

ANALYSIS OF THE PACIFIC OCEAN COALS.

Commercial Name.	Location.	Moisture.	Volatile.	Fixed Carbon.	Ash.	Sulphur.
*Albion Cardiff	Wales	.352	14.	82.44	.06	.06
Lota	Chile	3.9	34.49	58.76	2.85	3.4
Newport	Coos Bay, Oregon	13.69	42.44	37.35	6.61	1.54
Blue Canyon	Washington	1.79	31.48	62.74	3.68	.38
Wilkeson	Washington	.7	23.54	56.90	18.71	.14
Roslyn	Washington	1.45	32.8	53.66	11.94	.15
Comox†	Vancouver Island	1.1	20.19	69.75	8.06	.53
New Vancouver,	Vancouver Island	2.78	35.1	56.95	6.66	.25
Wellington	Vancouver Island	1.82	29.9	52.6	15.-	.66
Nanaimo	Vancouver Island	3.35	35.76	46.	14.32	.17
Kyak, Controller Bay	Alaska	.77	13.79	82.36	3.08	
Homer	Kachemak Bay, Alaska	1.25	39.87	49.89	7.82	1.2
Herendeen Bay	Alaska	3.22	30.78	60.52	5.48	.4
Herendeen Bay	Seam 2, Alaska	4.37	39.35	53.23	6.08	.5
Yokoshima, best	Japan	1.44	38.31	55.22	5.03	.08
Yoshinstani, poorest	Japan	2.52	38.12	49.95	9.41	.7
Kaiping	China	.66	24.14	61.92	13.28	.6
Labuan	Borneo	6.	39.45	51.1	3.44	1.46
South Bulli, N. S. W.	Australia	.89	21.3	66.91	10.35	.41
Newcastle, N. S. W.	Australia	2.39	33.64	57.55	6.42	.15
Gravity Creek	New Zealand	1.01	34.	62.23	2.77	.45
Hikwiangi	New Zealand	6.05	39.63	49.29	5.03	3.18

* The Standard of the Bureau of Equipment, U. S. N.

† This shaft now closed.

In the mighty and unsubdued Alaska the explorer, prospector, or engineer is dependent on kindly help. In my Alaskan expeditions I received willing co-operation and support from the director and members of the Coast and Geodetic Survey, of the Geological Survey, of the Land Department, of the Fish Commission, from army and navy and treasury officers, from the governor of Alaska and United States officials at Sitka and Dutch Harbor, from the Pacific Coast Steamship Company, from the Pacific Steam Whaling Company, from the Alaskan Trading Companies and from the owners of the coal seams in Southeastern Alaska, at Yakutat, Controller Bay, Homer, Amalik, Chignik, Unga Island, Herendeen Bay and Cape Lisbourne, nor am I less indebted to the prospectors and miners whose tents and fare I shared on the shores of Bering Sea.

THE FIRST TRAIN OVER THE PRETORIA-PIETERSBURG RAILWAY.

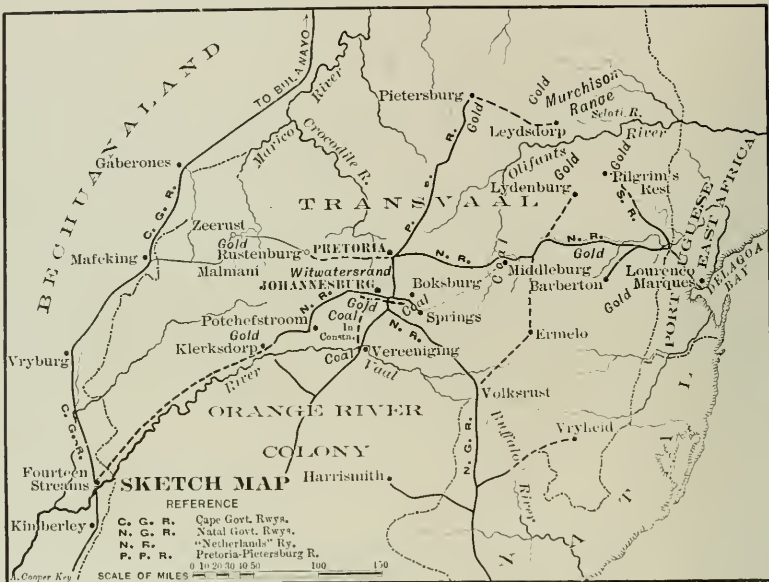
RAILWAY DEVELOPMENT IN FEDERATED SOUTH AFRICA.

By A. Cooper Key.

Newspaper dispatches from South Africa show that the labor market in Johannesburg is already over-supplied with men who have gone there in search of work in the mining industry; important discoveries of new copper and iron fields are announced; and there is no doubt that the enterprising spirits of the Anglo-Saxon race from all parts of the world will be flocking to South Africa so soon as stable conditions are promised. All Britain is interested in and committed to the development of South Africa, and in the light of all these facts Mr. Key's review of the railway situation—the basis of all development—is both timely and important.—The Editors.

THERE is ample scope for railway construction in the Transvaal region. Formerly this was in large measure prevented by the restrictive treaty between the late governments of the South African Republic and the Orange Free State. By this convention the Transvaal agreed not to make railway extensions westward except with the consent of the Orange government. For had the Netherlands Railway been connected with the Cape system on the west side of the Transvaal, the whole of the passenger traffic to Cape Town and large portions of goods traffic to Port Elizabeth would have been diverted from the main line of the Free State government.

With federated South Africa, we shall probably have a federated system of railways in the sub-continent. Until that consummation, similar objections to railway extension will be continually cropping up. New schemes will clash with vested interests. A new railway policy must be so framed as not to injure and impoverish existing lines. The



railway through the Orange River Colony will form a very valuable revenue-earning asset of the new administration. The pros and cons of any scheme which would diminish this revenue capacity must be carefully considered beforehand. For instance, a line from Klerksdorp to Kimberley is an obvious extension in the general scheme of development. Would it be wise to construct it in view of the interests of the Orange River Colony? Do the demands of greater South Africa overrate the interests of the single colony?

At present the line through the Orange Colony carries all the traffic to the Vaal Colony from Cape Town, Port Elizabeth, and East London. These three systems—the western, the midland and the eastern of the Cape Government Railways pour their traffic—passengers chiefly from the western, goods mainly from the midland and eastern—onto the main Orange River Colony line at Norval's Pont or Springfontein. For some time before the war the fact that this single line of 333 miles was inadequate to the demand made upon it was amply demonstrated. Indeed, a wholesale extension of crossing sidings was decided upon, to be followed eventually by a doubling of the line for considerable lengths.

Ever since it was constructed in 1892 by the Cape government as the northern section of the railway system, the line from the Orange River bridge to Mid Vaal River bridge (to give the official names) has been remarkable for its revenue capacity and earning power. In 1892 the net receipts were equal to £9.11.3 per cent. on the invested capital, in 1893 to £8.19.1 per cent., in 1894 £10.11.6 per cent., in 1895 £14.14.0 per cent., and in 1896 to £15.12.0 per cent. Then the line passed into the control of the Orange Free State government.

With the pacification of South Africa there is bound to be a tremendous accession of trade, traffic, industrial activity. The traffic from Cape ports to the Transvaal has demanded some improvement in carrying capacity from the end of the Cape system. In the future this demand will be all the more insistent. Of course the first obvious remedy is to double the Orange River main line throughout. But are there not better remedies? Cannot new tracks be opened up without grave disadvantage to the old route? Would it not be wiser to defer this widening, and instead make a new line from Klerksdorp to Fourteen Streams, 50 miles north of Kimberley on the western section of the Cape lines? As the crow flies the actual distance is about 140 miles, and the engineering detours which would probably be found necessary should not increase this to more than 150 miles. The cost of this new

THE RAILWAY STATION AT PRETORIA.

construction should not greatly exceed that of doubling nearly 350 miles in the Orange River Colony. Besides possessing important military advantages—and for a while it will certainly be necessary to have an eye to these—this new line would give the shortest route between Cape Town and Johannesburg. Between these two places is probably the most valuable through passenger traffic in South Africa. By this new line the distance between the two industrial capitals of South Africa, Johannesburg and Kimberley, would be reduced to about 300 miles. At present a traveller wishing to go from the Rand to the Diamond City is obliged to travel due south to Naauwpoort Junction (435 miles) then north-west to join the western system at De Aar (85 miles) then north to Kimberley (140 miles). Thus the total distance from Johannesburg is 660 miles. The republics might set their faces against railway developments which would have shortened such circuitous routes as these. But these and like anomalies will be swept away now the development of the sub-continent is being carried out under Imperial British auspices, now British brains will have something to say in respect of new schemes and development.

In my estimation the construction of the Klerksdorp-Fourteen Streams line comes within the class of lines of primary importance. For years it has been proposed to build a new line south of the existing one along the mines from Boksburg to the west of Johannesburg. The Rand Tram, as it was originally styled, can only be called moderately convenient as regards supply of coal and stores to the gold mines. For the convenience of the deep-level and second deep-level companies a new line about a mile to the south is required.* Indeed, it

WARMBATH STATION. A TYPICAL BUILDING ON THE PRETORIA-PIETERSBURG LINE.

is not looking too far ahead to express the opinion that before many years have passed a third line will be imperative for the economical development of the deepest-level areas. Both these lines would deal almost exclusively with coal, goods, and general-supply traffic for the mines. Passenger traffic, if any, would be meagre. Some of the outcrop mines would be more conveniently served by the new southern line than the present one.

The existing line from Krugersdorp on the west to Boksburg on the east, traversing the principal mines and extending to a distance of about 40 miles, might be reserved mainly for passenger traffic. With

* This line has been in part graded by the military authorities.

THE PRETORIA-PIETERSBURG LINE AT VYGEBOOMPOORT.

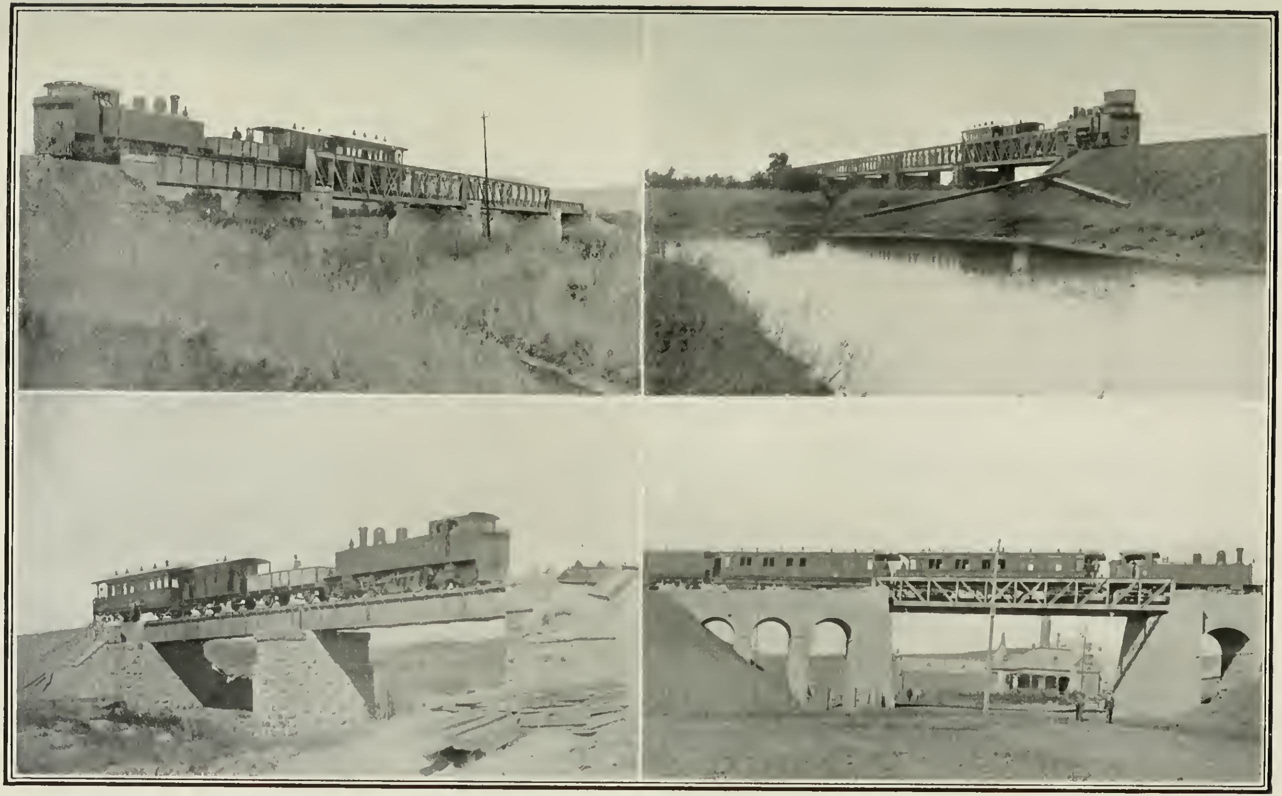
very great advantage it might be converted into an electric line. Increasing population along the mines will demand far better travelling facilities than were available in the past. A regular half-hourly stopping service, with the addition of hourly fast trains stopping only at Boksburg, Elandsfontein, Jeppes Town, Johannesburg, Roodepoort and Krugersdorp, would probably prove adequate and satisfactory for some time to come. Locomotive and passenger stock "released" when the electric-traction arrangements were completed could be transferred to the new lines. At Brakpan, a few miles beyond Boksburg, the Rand Central Electric Works have had established for some years a large plant supplying current along the reef. Power for the electric line here suggested could be obtained by largely increasing the plant of that company, a course likely to be as convenient as any other.

Among railways projected by the late government was one from the farming and tobacco-growing district of Rustenburg to Pretoria. When the line was under discussion the general feeling in Johannesburg was that it would have been preferable to have brought it to the mining centre than to the government capital. Both objectives have special points of merit, and of course Johannesburg forms distinctly a larger produce market than Pretoria. With the changed circumstances of the country it may be deemed better to carry the line (should its construction be decided upon) to Pretoria. This would give a direct connection with the line thence to Middelburg and Delagoa Bay. Moreover, the military advantage of this route as giving a portion of a second east-and-west iron road through the new colony, to be completed as mentioned below, must not be ignored. Volksrust-Johannesburg-Klerksdorp is the first or southern of these east-to-west branches already constructed and to be completed by the proposed line to Fourteen Streams on the Cape Colonial border. Eventually the Rustenburg line could be extended through Zeerust, Ottoshoop, Malmani to join the Cape line at Mafeking.

There is no necessity, for the present at any rate, to canvass the question of northward extension of the Pretoria-Pietersburg line beyond Pietersburg. Industrially or agriculturally there are no reasons for such a step. What would be advisable, however, would be to prolong the line eastward to Leydsdorp, through the Haenertsburg gold area. This course would be preferable to carrying out the original scheme of the Selati Railway, which, commencing at Komati Poort had its objective at Leydsdorp.

AN ENGINE ON THE PRETORIA-PIETERSBURG RAILWAY.

It is not necessary here to advert at length to the disastrous history of the Northern Railway of the South African Republic, or Selati Railway. Of the 217 miles, only 71 have been completed and it has never been utilised for traffic for the simple reason its terminus was "nowhere." But the portion of line already constructed can be utilised as part of a route to the Pilgrim's Rest gold field, lying somewhat north-east of Lydenburg, to which railway communication will doubtless be given by means of a junction with the eastern line of the Netherlands Railway either at Belfast or Machadodorp. Such a line was



BRIDGES ON THE PRETORIA-PIETERSBURG RAILWAY.

Above on the left is the Aapies River bridge; to the right of it, the bridge over Pienaar's River; on the left below, the Groot Nyl bridge, and on the right, the bridge over Potgieter street, taken as the first train was crossing it.

proposed by the late government. Lydenburg is the centre of an important gold-bearing region, being the second in point of output in the Transvaal. Undoubtedly the mining prospects are good—perhaps better than those of any other outside district in the new colony.

THE OLD PARK STATION, JOHANNESBURG, NOW A THING OF THE PAST.
Waiting for the visit of Sir Hercules Robinson.

Some time before the war commenced the government of the South African Republic granted a concession to a private company for a line from Ermelo to Machadodorp on the Delagoa Bay line, a distance of some 65 miles. *En route* this line would open up important coal fields in the district of Carolina. It has hitherto been impossible to exploit this coal field remuneratively owing to the absence of railway facilities. That there is a future before it is unquestionable, as the coal in parts is considered superior to the product of the Middelburg mines generally conceded to be the best coal used in the country. With its terminus at Ermelo the utility of the projected line is not great. It would be of marked advantage to continue the line southward for 60 miles or so in order to form a junction with the Johannesburg-Charleston (Natal) line somewhere between Standerton and Volksrust. Besides giving a very fair route—"excellent" compared with the existing one—between Durban and Lydenburg and Barberton, it would form a second north-and-south line directly connected with Natal as the other with the Cape. As such its advantage and point for military purposes will not be lost sight of. This line south of the Delagoa Bay railway should connect directly with that on the north of it to Lydenburg.

For some years people interested in the development of the Middelburg coal district have advocated the construction of a line from Boksburg, in the East Rand to Balmoral a few miles west of Middelburg town. This would avoid the long detour through Pretoria and enable their coal to be put on the Rand market at a cheaper rate. The point that it would open up other coal fields *en route* has not been accorded the importance it deserves by the Middelburg owners, who would be the first to feel the effects of exploitation of newer areas nearer the Rand market. Though this line would be useful, particularly as shortening the distance from the Rand to Delagoa Bay, its construction cannot be regarded as of prime necessity.

In the extreme south-east corner of the Transvaal it is proposed to connect Vryheid, formerly the capital of the new republic, with the Natal system at Dundee. The line from Dundee to the Buffalo River is under construction by the Natal government, while that on the north had been commenced (as a State line) by the late government of the South African Republic. From Vryheid to Buffalo River is 39 miles and the contract was let for £292,000.

THE PRESENT PARK STATION, JOHANNESBURG.
(Copyright by Barnett.)

Either immediately or in the near future, nearly all the lines mentioned will form part of trunk routes, and this is in itself sufficient reason for the adoption of the normal gauge of South Africa, viz., 3 feet 6 inches. Where land can be taken free of cost, and with fairly cheap labour, the cost of building standard lines should not really be much in excess of that for light lines of 2 feet 6 inches or less. The experiences of the narrow 2-feet gauge adopted at first on the Beira Railway has been such as would surely prevent its serious consideration elsewhere. Of course it must be remembered the Beira line is a "severe" one, having a ruling gradient of 1 in 50 with four-chain curves. In a report of a few years back, Mr. Elliot, general manager of the Cape Government Railways, records that only 20 tons per day could be hauled on the narrow-gauge Beira line as compared with 160 tons on one of normal gauge. Three days instead of one were required for the transport of goods on the 220 miles from Beira to Umtali on account of the restricted speed of the locomotive. Eight times as many trains were required, greatly hindering the working of the line. Indeed, no less than 72 "men-days" were required for a load of 160 tons, which could have been taken by three men (one driver, one stoker and one guard) in a day on the Cape Colonial system. Mr. Elliot added the opinion that with more modern locomotives better results might be obtained. Even so, narrow-gauge lines of 2 feet and 2 feet 6 inches will prove unsatisfactory. Why, the 3 feet 6 inches gauge has been found inconveniently narrow! Competent and influential engineers, among them Mr. Theodore Reunert, of the well-known Johannesburg firm of Reunert & Lenz, have indeed discussed the advisability of increasing the gauge of the existing main lines of the Cape Colony. But this would in all likelihood be found out of the question on the score of expense. In spite of experience elsewhere and against the consensus of engineering opinion, the Cape government has in certain new lines "sanctioned a departure from the principle that all railways should be of 3 feet 6 inches gauge." America is teaching the management of English railways the economy of full well-laden trains hauled by the most powerful locomotives. Needless to say that idea is not consonant with the provision of light narrow-gauge lines.

In the foregoing sketch of a scheme of railway development for the Transvaal no attempt at any hard-and-fast exhaustive plan has been put forth. Regard has, moreover, been had to the requirements of the immediate future. For instance, in time to come, as the country develops, it may be necessary to have a direct route from the Rand to Rhodesia. But for years the projected extension of the Rustenburg line to Mafeking should meet every requirement of the industrial population. By over six hundred miles would it reduce those longest railway journeys in South Africa—from Durban to Bulawayo and Lourenço Marques to Bulawayo. It will be seen that in the schemes put forward military requirements are not lost sight of. As it happens, both industrial and military demands, or military and industrial demands, whichever takes the first place, are fairly met by the same new railways. There would be two parallel lines running north-and-south and two east-and-west. By means of these troops could be rapidly moved to any centre of disturbance in the southern half of the new colony. The wilds of the northern districts are left alone, but this district is so rugged and mountainous, so thinly populated, that no new railways can be advocated from an economic standpoint. Any lines far north of Pietersburg would be tremendously costly to construct, and could only be taken in hand under the sternest military requirements. Let us hope they will not be necessary.

In the tables below will be found a schedule of the existing lines in the Transvaal and one of those sketched in the present article:—

EXISTING LINES.

Netherlands South African Railway Co.:	Miles.
Eastern Line, Pretoria—Komati Poort	295
Barberton branch, Kaapmuiden—Barberton	35
Southern Line, Pretoria—Elandsfontein	37
do. Elandsfontein—Johannesburg	10
do. Elandsfontein—Elsburg	4½
do. Elsburg—Vaal River	36½
Rand Tram, Springs—Elandsfontein	21
South Western Line, Johannesburg—Klerksdorp	117
South Eastern Line, Elsburg—Natal Frontier	160
Pretoria Pietersburg Rwy. Co.:	
Main line, Pretoria—Pietersburg	178
	894
Selati Railway, Komati Poort—(Useless at present.)	71

NEW LINES PROJECTED.

In construction:	
Imperial Military, Vereeniging—Johannesburg	34*
Concessions granted by late Govt. S. A. R.:	
Private Co., Machadodorp—Ermelo	65
do. do. Lydenburg	70
Late S. A. R. Govt.:	
Vryheid—Buffalo River† (State line under construction)	39
Klerksdorp—Fourteen Streams‡	150
Southern Reef-line (Johannesburg)	20/25
Pretoria—Rustenburg	65
Rustenburg—Mafeking	155
Present terminus Selati Ry.—Pilgrim's Rest	(?) 30
Springs—Balmoral	55
Pietersburg—Leydsdorp	45
Ermelo—Junction with line to Natal	65
Approximate total, projected lines	795½

* Approximate cost £7,000 per mile.
† To join Dundee Branch Natal
‡ Forming direct route Johannesburg to Cape Town and western province.

Without surveys and estimates it is possible to do no more than guess at construction costs. But as an average it would be fair to take the cost at £8,000 per mile. And if the cost of superintendence and labour is coming down, there is no reason why that figure should not be made to include equipment on a moderate scale. On this basis all the lines scheduled above would involve an eventual capital outlay of £6,360,000. But if we divide lines of primary necessity from those of secondary importance, we have a total of 445½ miles in the former class. The smaller scheme on the same basis would figure out at £3,560,000. For this sum would be completed the four lines already surveyed and sanctioned by the late government, viz., the Lydenburg, Ermelo, Vryheid and Rustenburg lines; the Vereeniging-Johannesburg line in construction; and the two immediate necessities, the Klerksdorp-Fourteen Streams and the Johannesburg South Reef line.

The finance of the scheme may be thus recapitulated:—

For buying up the Netherlands Railway,* say..................	£8,000,000
" " the Pretoria-Pietersburg Railway, say...........	1,500,000
" " the Selati line (+70).........................	?
895 miles (+70) for.......................................	£9,500,000
Cost of construction 445½ miles new lines, say*................	3,560,000
Total cost old and new lines *minor* scheme 1,340½ miles (+70)..	£13,060,000
Cost of acquiring existing lines as above.......................	£9,500,000
Cost of construction 795½ miles new lines, say..................	6,360,000
Total cost old and new lines, *major* scheme, 1,690½ miles (+70)...	£15,860,000

Briefly, for the sum of thirteen and a half millions the new colony could own about 1,400 miles of railway opening up the country in a fairly satisfactory manner. For three millions more a system of nearly 1,800 miles could be provided for, opening up adequately the mineral and agricultural resources of the country. The total area of the Transvaal has been estimated at 119,200 square miles. At the end of 1899 the Cape government system of railways had a total open mileage of 1,990 miles, the capital cost of which had been close upon £21,000,000. The area of the colony is 276,567 square miles. Private lines additional to those owned by the government bring the total railway mileage up to about 2,500. Natal owns 518 miles of line, of which the capital cost including equipment has been £7,694,118. The area of the "Garden Colony" irrespective of Zululand and Amatongaland is 20,851 square miles. It will be seen that the projected larger scheme would give to the Transvaal Colony one mile of track to every 66¼ square miles of territory. In the Cape Colony the existing relation is one to 110½ and in Natal one to 40¼. In both these colonies large extensions are in progress.

* The report of the Concessions Committee points to a figure considerably less, but the actual amount has yet to be determined.

MONEY-MAKING MANAGEMENT FOR WORKSHOP AND FACTORY.

By Charles U. Carpenter.

IV.—THE STOCK DEPARTMENT AND ITS SYSTEMS.

Mr. Carpenter's articles began in THE ENGINEERING MAGAZINE for February, 1902. In his first and second papers he dealt with the general principles of factory organisation, and with a concrete description of a highly successful example. His third paper discussed the departmentalising of the works, and the organisation of "systems" for dealing systematically with every phase of factory operations. He now takes up those systems in detail, beginning with stock and stock tracing. The next article will deal with costs. It will be interesting in this connection to consult Mr. Falconer's articles in this number and the preceding issue of the Magazine.—THE EDITORS.

THE importance of an accurate system for handling and tracing stock can be realized when consideration is given to its proper functions. The system in stock ordering should provide such checks as to prevent the possibility of the factory being delayed by reason of the non-receipt of stock either from outside manufacturers or from its own producing departments. The placing of orders in the factory should be so regulated as to enable the entire factory force to work to the best advantage at all times and at the same time keep down all unnecessary investment in stock and machinery. The stock keeping should provide a perpetual and accurate inventory and place a check on the use of stock by assemblers as well. This latter, together with the system of scrappage to be described later, will prevent the waste of stock through carelessness of the workmen, or the desire to conceal errors. This waste amounts to a surprisingly large sum in most establishments. The subject of stock tracing is of such importance that I deem it worthy of distinct and separate consideration. It is a part, not only of the stock system, but of the piece-work and inspection systems, as well.

Different phases of stock. At least two different conditions must be met by any stock system that is designed to be at all universal in its application. In the manufacture of such articles as bicycles, sewing machines, and cash registers, it is necessary to make very quick deliveries. The product being somewhat standardized, it is possible and indeed necessary to carry in the stock rooms large quantities of finished product ready for the market, and also finished parts upon which the assembling rooms can draw at will to fill various orders.

Under such conditions the management, together with the stock department, can determine how many days supply of stock should be carried in the bins. Then, with these data, the stock department can place the orders in the factory regularly, giving due consideration to the length of time required to get stock through the factory and into the finished stock room.

This, however, is not possible in the manufacture of large pumps, engines, generators, etc. In such cases delivery is not and generally can not be made quickly and the parts must come through on "special orders." Naturally, it is of great importance that, under such conditions, the parts be put through the factory in the shortest possible time owing to the large investment tied up in the work. The systems given will, with slight changes, take care of both situations equally well. Consideration will first be given to the handling of large amounts of stock which can be carried in stock rooms in a finished condition, as far as machining is concerned, ready to be assembled into the finished product.

Stock rooms. These should be well-lighted and dry. It is a great mistake to neglect the location of the stock rooms, as large values are there represented which deserve close attention. They should be located with special view to ease of handling and transportation.

Storing stock. All stock, wherever possible, should be stored in well-built bins, properly numbered. If it is impossible to store it in the bins, a special place for each kind of stock must be set aside and no other kind of stock should ever be put there.

Calculating amounts of stock by count and weight. All stock rceived or delivered by the stock keepers must be weighed or counted to provide for the accuracy of the records and to prevent excessive deliveries. To facilitate this work a pair of "counting scales" can be used to good advantage. Computing large amounts of stock for checking up piece-work tickets, or for stock calculation, can be done with the aid of such scales in one-fifth of the time required by the ordinary methods. They are also very accurate.

Boxes. All stock, wherever possible, should be carried in substantial boxes. The boxes should be numbered on both ends and have a tin pocket attached for the stock-tracing card which will be described later.

Trucks. Substantial four-wheel trucks with ball bearings are very effective adjuncts in the transportation of stock on factory floors. A regular trucking force can be organized from which very good results can be secured. All stock carrying should be done by such an organized set of men, taking this work entirely out of the hands of the several departments.

Information necessary for placing orders. Proper, definite and full data regarding the nature of, and specifications for, all stock, are necessary for the stock department before orders can be placed with outside manufacturers, or in the factory. This is also necessary in order that the factory force may work intelligently and with a minimum of errors.

The important specifications for new stock should be given by those most familiar with the new product. This must invariably be in writing and should be prepared by the designer or inventor, together with the head of the tool room. The following data should be given for each part:

I. Name of piece, or number. It is important that this be uniform throughout the factory.

II. Full specifications of raw stock to be used.

III. Wherever possible, the dimensions of finished parts.

IV. Full list of mechanical operations through which the stock should go, and all drawing numbers.

V. All pattern numbers.

VI. Full list of all tools and gauges to be used.

VII. List of most important points to be watched in machining and gauging, with the proper limits to be observed.

VIII. The number of parts of this particular stock used to each machine.

Copies of this should be sent to all foremen who handle the stock in any way so they may thoroughly familiarize themselves with the requirements. Often, they will submit suggestions involving important changes that result in great economy and a better product.

The stock department upon receipt of such reports will have all necessary information to enable them to place orders with manufacturers, or with the factory.

Stock system. Three rules must be rigidly observed before the success of any stock system is assured. First, a requisition (form to be described later) must be presented before stock is delivered to any one; Second, only the stock clerk or stock tracer should have authority to give or deliver stock to any one; Third, stock must be secured from stock room only, except when urgently needed, and then the stock tracer alone should secure the stock from the machining departments. Indiscriminate "helping one's self" *must be prohibited.*

The natural divisions of the stock system are as follows:—

I. Stock ordering.
II. Stock keeping.
III. Stock tracing.

These three divisions are sub-divided as follows:—

I. Stock ordering:—
- a. From the outside manufacturer.
- b. Into the factory for machining, or the production of parts.
- c. To the assembling rooms for partial or final assembling of the product.

II. Stock keeping:—
- a. Providing check on stock received from outside manufacturers to certify tô bills.
- b. Storing and keeping of raw stock, finished parts (not assembled) and assembled stock, and providing a perpetual inventory for each.
- c. Supplying check on assemblers for stock used.

III. Stock tracing:—
- a. Directing the machining of stock so as to keep all machinery operating as much of the time as possible and to prevent delays to assemblers.
- b. Tabulating records, giving history of each lot of stock and providing data whereby its location in the factory can be shown immediately.
- c. Directing the transportation of stock in the factory.

By applying the foregoing sub-divisions to actual practice, we find their natural order to be as follows:—

First—Stock is ordered from outside manufacturers.

Second—Stock is received from outside and checked as to quantity and quality.

Third—This stock is stored in stock rooms and a perpetual invoice is kept.

Fourth—Factory is ordered tó manufacture certain parts from this raw stock.

Fifth—The stock is traced in its course through the factory of machining and inspecting.

Sixth—The finished parts are received and stored in the stock rooms and perpetual inventory provided.

Seventh—Assembling rooms are ordered to assemble the parts.

Eighth—A final positive check is kept on the assemblers.

Records. The life of any system lies in the nature of the records that are used; these should be as few in number as possible. Careful examination of the records given will show that they are very simple and contain only such information as the order clerk of the stock department should always have on hand. These records are but three in number. First, the Raw-Stock Order Record; second, the Finished-Stock Order Record; third, the Stock-Tracing and Cost Sheet. These should be upon substantial cards, there being one record for each kind of stock, and should be filed in a card index according to their number or name. It is of course necessary that such records contain very full and explicit information concerning the stock. The order record, in particular, should have full data concerning all orders, together with the correct inventory of the amount of stock on hand at all times. They must also provide some means whereby the order clerk, or the stock department, is automatically notified when the stock in any bin is down so low as to presage a dangerous shortage. This is done by establishing certain limits at which the stock in the bins should stand at all times. When the quantity of stock in the bins reaches this point, it indicates the condition of this stock to be dangerous and an investigation of the records must be made to determine whether or not more orders must be placed, or the orders already placed, rushed. This limit may be termed the "order limit." A further limit termed the "rush limit" may be used to indicate a specially dangerous condition and that especial attention must be given to *rush* it to avoid delays. This rush limit should be about one-half the quantity of the order limit, and it indicates that the quantity of the stock is in very bad condition. The quantity of stock designated as the order limit depends upon the number of parts required per machine and the time required to get it through the machine rooms.

The other forms used are largely to simplify the system and reduce the chances of error to a minimum. They are the foremen's order for the production of parts, the stock-tracing card, which gives a full description of every necessary operation, and the requisition for stock.

The first record to consider is the raw-stock order record. The form of such an order, designed as an index filing card, is shown on the next page.

Page_____ RAW STOCK ORDER RECORD.

Specifications ____________________

Name of Mfr. ____________ Am't used per Mo. ________

Pattern No. ________ Drawing No ________ Bin No ________

Order Limit ________ Where used ____________

Rush Limit ________

Date	Ordered	Receiv'd	Ord'r'd in Factory		Delivered	Inventory	Order Limit Reference	Check No.
			Quantity	Purpose				

Note carefully the different items: full specifications, name of manufacturer, pattern number, drawing number, bin number, what parts are manufactured from it, order and rush limits, and amounts used per month. These are general data, information concerning which the stock department or order clerk should have at hand always. The order clerk secures this information from the written notification. The words at the head of each column describe the functions of the column clearly. The dates of all transactions are placed in the date column. The order and received columns give data regarding orders for raw stock, either from the foundry belonging to the firm, or from outside manufacturers, and the amounts received. Next is the divided column for orders placed in the factory for finished parts. The two sub-columns, quantity and purpose, are self-explanatory. In the purpose column may be placed the number of the piece ordered, if the stock is numbered instead of named, or the page and line number of the finished-stock order record. The delivered and inventory columns need no explanation. The check number indicates at all times the stock keeper who received and delivered stock. The order-limit reference column is used simply for the convenience of the order clerk.

Owing to the fact that foremen can seldom begin work on stock as soon as ordered, the stock for such undelivered orders, though still in the bins, should be deducted from the amount on hand (as shown by the inventory column) for the purpose of comparison with the order limit. It is clear that this is necessary, as otherwise several calls for undelivered stock may be made at any time and the amount in the bins reduced to a very dangerous condition before additional orders are placed.

The order clerk is notified in writing by the stock keeper of all receipts and deliveries of stock; he is thus in a position to fill out the different columns as indicated. He must make it an invariable rule to complete the entire record as soon as such data come from the stock keeper and then compare the amount in the order-limit reference column with the amount of the order limit, as indicated at the top of the card. Thus it can be immediately determined whether additional orders should be placed anywhere, or unfilled orders should be rushed. Further, by comparing the amounts in the inventory column with that in the order-limit reference column it can be seen immediately if any of the foremen have an unusual number of orders for stock on which they have not started work.

Methods of placing orders in the factory, with the foremen, for the manufacture of parts and of giving the stock-tracing department the necessary information regarding them:—The three forms necessary for this part of the system are the ones mentioned before, viz: the foreman's order (in duplicate) for the production of parts, the stock-tracing card, and the stock-tracing and cost sheet, which should contain practically the same information. The original of the foreman's order, properly filled out, is sent to the foreman, the duplicate together with the stock-tracing card is sent to the raw-stock keeper, while the stock-tracing and cost sheet is sent to the stock tracer. These forms will serve as a check for accuracy upon both foremen and stock keepers, and when returned to the order clerk will furnish him all the information necessary to fill out his records. They will also serve as a notification to the stock tracer of the nature and date of all orders and also the date when the raw stock required to fill these orders is finally delivered to the foremen.

Foremen's order for the production of parts:—The proper time for placing orders with the foremen is determined from the finished-stock order record (a form to be described later) in precisely the same manner as is done in the case of raw stock from the raw-stock records. As stated above, these foremen's orders should be in duplicate. They should contain name of part ordered, number of pieces wanted, full specifications and quantity of raw stock needed together with pattern numbers, a list of the machining operations together with the drawing numbers, the number of the raw-stock record, and rush notices and the signature of the order clerk.

As previously stated, the original is sent to the foremen and the duplicate together with the stock-tracing card is sent to the raw-stock keeper. The stock keeper, as soon as he receives the duplicate, examines the condition of his stock, which serves as a safeguard against errors. When the foreman is ready to begin work he signs the original order and sends it to the stock keeper. Wherever possible, the stock keeper secures the necessary boxes for the stock, puts the box numbers on the original and duplicate of the foreman's order and the stock-tracing card. After signing the original and duplicate, he sends the former to the order clerk and the latter to the stock tracer. The order clerk then has the necessary information to enable him to make the proper entries on the raw-stock order record. The stock tracer is thus notified of the delivery of raw stock to the foreman and, after entering the proper box numbers and date of delivery on the stock-tracing and cost sheet, sends this duplicate to the foreman, who retains this as his record. By following this closely it will be seen that there is a perfect check on all parties concerned.

Stock-tracing card:—The stock-tracing card is deserving of close attention, owing to its close connection with the entire system described and to its possibilities even with other systems. In this system every box of stock is accompanied with its own stock-tracing card. Even where it is impossible to handle the stock in boxes, the card can still be used to great advantage.

STOCK-TRACING CARD

Box No ______________ Date ______________

Name ______________

Am't Ordered ______________ Order No. ______________

Operations	Drawing Numbers	Amount Delivered	Time Del'd	Due Date	Inspector	Amount Lost	Amount Sent Ahead
I							
II							
III							
IV							

This card should contain box number, date of order, name of stock, quantity ordered and order number. In the main body of the card should appear a full list of the mechanical operations, the drawing numbers necessary, number of pieces delivered from one operation to another, time delivered, due date, name of inspector, number of pieces lost, and quantity of stock sent ahead of the main order. At the bottom of the card is the place for the receipt of the stock keeper. Its value, both for reference and as a record, is apparent.

The objection is sometimes made by the inexperienced that these cards will be lost in going through a large factory. This depends entirely upon the manner in which the mattter is handled. Make the rule that the last department handling a card is responsible for it; that no man can get his time ticket o. k.'d for payment until the stock-tracing card is produced; that every foreman is responsible for all stock and cards in his department. If these rules are carried out the foremen will not receive stock unless it is accompanied by a card. Rules can also be made effective to keep the cards reasonably clean. In one factory, connected with the writer's experience, there are handled yearly over one hundred thousand of these cards, calling for many million pieces of stock, and the number of cards lost per year will not be over 100, a number so small as to be inappreciable. Even when lost the stock-tracing and cost sheet will supply all information necessary to make out a duplicate.

Stock-tracing and cost sheet:—This sheet will be fully shown under the description of the stock-tracing system. Its importance can be appreciated from the statement that upon it depend all records as to time consumed, costs, and location of stock. This record is filled out by the stock tracer. Upon the delivery of the stock (when finished) called for on this record to the stock room, the sheet is sent with the stock, is receipted by the stock keeper and then sent to the order clerk of the stock department. This furnishes the order clerk all necessary information regarding the delivery of stock to the stock rooms.

Finished-stock order record:—The only record needed to complete the system is that which is designed for the ordering and keeping of finished stock. This is developed along precisely the same lines as the raw-stock order record. However, in the case of finished stock, the deliveries to the assemblers are generally in much smaller quantities and much more numerous than those of raw stock. Consequently, it is usually well to put the inventory record upon a separate card, called the bin invoice card, and attach this to the regular order record. A form for the index card adapted to this record is shown on the following page.

Page______ FINISHED-STOCK ORDER RECORD

Name of Part____________________ Raw St'k page______

Specifications of Raw Stock________________Amt. per 1000 parts

Operations											
Drawing Nos											

Order Limit Rush Limit Am't per Mo.

ORDERED		Del'd to Factory		RECEIVED IN FINISHED STOCK ROOM					
Date	Amount	Date	Amount	Date	Amount	Date	Amount	Date	Amount

This record should be in card form, each card being properly numbered. It should contain name of stock, specifications of raw material and raw-stock record page, list of operations and list of drawings, where used, bin number, amount used per month, amount per order, amount of raw stock per 1,000 parts, order and rush limits. These important data are secured as shown on page 197. In the body of the record should appear the quantity of stock ordered and delivered to the foremen, together with the dates; also, the quantities of stock received in the stock room, together with the dates.

To complete the finished-stock order record, the entries for finished stock received in the stock rooms must be made. These data are secured, as stated before, from the stock-tracing and cost sheets which are sent to the stock keeper with the stock, receipted by him and in turn sent to the order clerk in the stock department. The order clerk, by comparison of dates, can readily tell to what order these receipts should apply and give credit to the proper order. He thus is always informed as to the exact condition and dates of outstanding orders.

Invoice card:—The invoice card should be attached to the finished-stock order record, as stated above. This card should contain:—name of stock, where used, order limit, rush limit, page number, bin number. The body of the card should show all receipts and deliveries of stock by the stock keeper together with the date, check number and inventory.

Page No ______ BIN INVOICE CARD

Name ______________________________

Page (Raw Stock) ______________ Bin No. ______________

Order Limit ______________ Where used ______________

Rush Limit ______________

Date	Received	Delivered	Inventory	Chk. No.	

The manner in which the order clerk is notified of all receipts of stock has been fully described.

Delivery of stock to the assembling rooms is made only on requisition on the stock keeper. This requisition is then countersigned by the stock keeper and sent to the order clerk, who secures from it all necessary information as to the delivery of stock. He then makes his inventory and compares it with the limits, and if the quantity of stock proves to be near the danger point, he examines the attached record and easily determines what action is necessary. Either more orders may have to be placed, or the stock tracer notified to rush this particular stock.

Requisition:—The requisition referred to is simple in form. It should contain the name of stock, quantity desired, for what used, and space for signature of foreman and stock keeper.

In some factories it is considered advisable to have the inventory of the stock carried at the stock bins. This can be effected by having the stock keeper keep a duplicate of the invoice card at each bin and make the proper entries on them for receipts, deliveries, and inventories. This, however, means a duplication of records. The plan of keeping the invoice card at the bin and the order records in the office, is frequently adopted. In this latter case the stock keeper alone must be depended upon to make the proper entries and comparisons with the order and rush limits. He must then report to the order clerk the condition of the stock when it reaches this stage. In the large factory referred to, this last plan is the one adopted, owing to the large number of different kinds of stock carried and the many receipts and deliveries of stock made during the day. This requires but little time on the part of the stock keeper.

System for ordering and carrying in stock partially assembled parts:—It is often found very advantageous to assemble and carry in stock certain parts of a machine which are of particular intricacy. An explanation of this part of the system is not at all necessary, as the records and forms would be developed along practically the same lines as those already described. The orders in such cases would be sent to the assembling rooms.

Ordering the final finished product:—This is a comparatively simple matter. When the orders come in they must, of course, be recorded in the office. They can then be transmitted to the assembling rooms either directly or, better, through the stock department, so that any special features may be noted and stock correspondingly ordered. The stock department can then send the orders direct to the assembling rooms and the assembling rooms secure their finished parts for assembling from the stock room by requisition.

In the case of large work which requires special orders and the securing of special raw stock, the orders should invariably go through the stock department before going into the factory. Much trouble will also be avoided if the details of the finished product are carefully compared with the original signed order before shipment is made, to insure that no errors have been made and that the product is exactly as ordered.

Number of men needed and costs of system:—The three great factors in favor of this system are, first, the absolute check on all stock at all times; second, the avoidance of expensive delays by compelling the placing of orders for stock at the proper time; third, the small expense of carrying out the system. The first two points have been fully covered. The last can best be answered by citing a case from experience. In the one referred to there are issued each year about one hundred thousand orders for stock, aggregating many millions of pieces. Over nineteen thousand orders and thirteen thousand kinds of stock must be watched constantly. This large amount of work is handled by one assistant head of the stock and cost department and seven clerks. The work of keeping up the records is so simple that high-priced men are not at all necessary. In most establishments one or, at the most, two clerks are all that will be needed to insure the results stated.

THE GROWTH OF ECONOMY IN MARINE ENGINEERING.

By Walter M. McFarland.

III.—THE INTRODUCTION OF MULTIPLE-EXPANSION ENGINES.

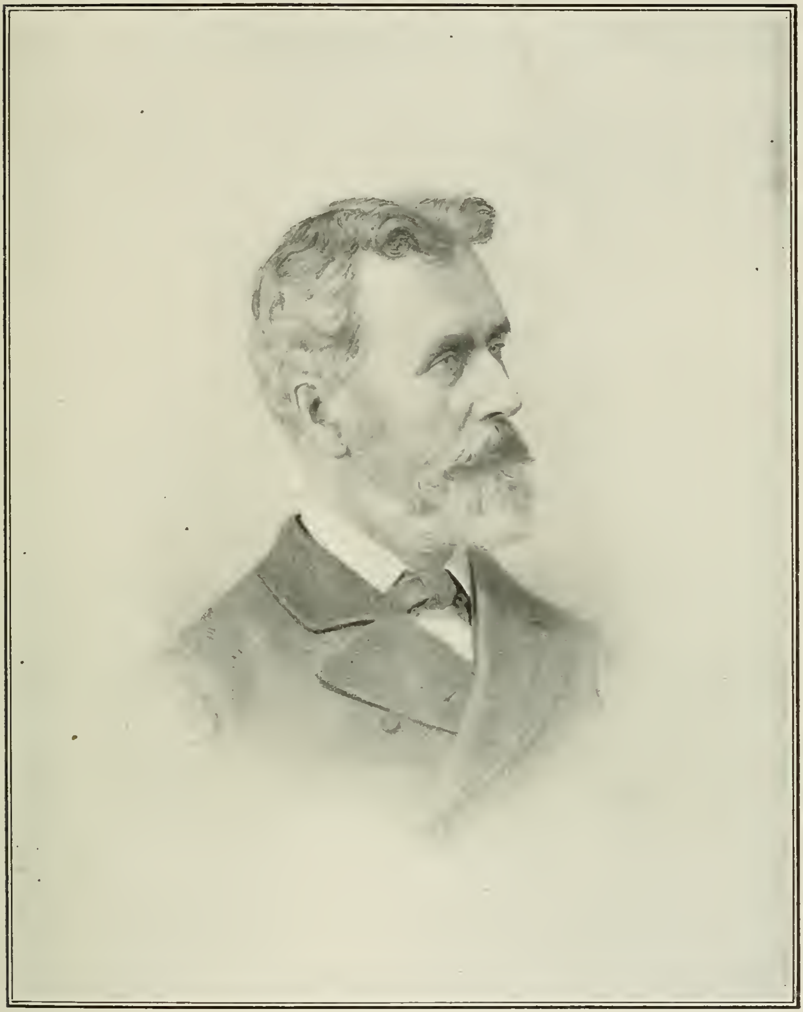
The first of Mr. McFarland's most interesting articles in this series appeared in March, and dealt with the very early history of marine engineering, from the invention of the steamboat through the period of the simple engine—the age of Watt, Fulton, Haswell and Isherwood. His second paper took up the development of the compound engine with higher steam pressures, and the contributions of Elder, Loring, Emery, and Rankine. In this third review he traces the rapid rise of economy following the publication of their investigations and the appearance of the multi-expansion engine. A fourth article next month, discussing the very latest advances in marine steam economy, will conclude the study.—THE EDITORS.

IN the case of the triple-expansion engine, as in that of so many other improvements in machinery, the invention or first use preceded by a considerable period the general introduction of the type. In some comments upon an article about multiple expansion engines at the Engineering Congress in Chicago in the year 1893, Mr. James Howden, widely known for his work in connection with forced draft, stated that he had taken out a patent as far back as November, 1860, for a triple expansion engine using steam of 150- to 200-pounds pressure. He says that he thinks it quite possible that the idea may have occurred to some one else at an earlier date, but he was unable to find any record of it. It may be mentioned, in passing, that in 1880 a board of United States naval engineers tested the machinery of the yacht Anthracite, which had triple-expansion engines designed by Mr. Loftus Perkins. The first completely successful use of the triple-expansion engine, however, was in the case of the steamship Aberdeen, whose machinery was designed and built under the supervision of Dr. A. C. Kirk, of the firm of R. Napier & Sons of Glasgow, in 1881.

In the Aberdeen we have the distinct feature of the steam passing through three cylinders successively, thereby differing from the three-cylinder compound engine, in which, after passing through the high-pressure cylinder, the steam was admitted to the two low-pressure cylinders at the same time. The reason for the superiority of the triple-expansion engine is perfectly plain from the previous experience of the advantage of the compound engine over the simple one. The Michigan experiments by Isherwood had shown that in a single cylinder, if expansion was carried beyond a very moderate amount, excessive liquefaction occurred. The compound engine enabled the number of expansions to be carried much further on account of the division between two stages, but in the later compound engines, where the cylinder ratio was as high as four and one-half to one, it was found that an expansion suitable to the high-pressure carried would have involved excessive liquefaction in the high-pressure cylinder. The triple-expansion engine divided the expansion into three stages, thus making the number of expansions in any one cylinder small and within the limits where liquefaction was not serious. The introduction of the triple-expansion engine was very rapid and there was no such opposition to it as had occurred with the compound engine. Practice and theory had come together, or possibly it would be more accurate to say that theory had come to take account of all the details of practice, so that there were none to claim that by simply carrying higher pressures and making the cylinder ratios greater, the compound could compete with the triple-expansion engine.

It is somewhat difficult to give figures having real value which will show the exact percentage of increased economy of one type of engine over the other. To do this would require an elaborate comparison of actual average performances extending over long periods, which are as a rule impossible to secure. If we take the best results in the simple engine as three pounds of coal per indicated horse-power hour, and in the compound two pounds per indicated horse-power hour, we would have an increased economy of 33 per cent. About the best result with triple-expansion engines is 1.5 pounds per indicated horse-power hour. which would represent 25 per cent. gain by the triple-expansion over the compound. As a matter of fact, however, simple engines in ordinary practice rarely got a horse power for as little as 3 pounds of coal, and very few compounds cost less than 2.5 pounds of coal per indicated horse-power while in ordinary average cruising it is probable that the triple-expansion engine gets a horse power for 1.8 to 2.0 pounds per hour.

The first use of triple-expansion engines for naval vessels was also by Dr. Kirk's firm in the case of the British cruisers Australia and Galatea. These vessels as originally specified were to have three-cylinder compound engines, but his experience with triple-expansion engines in merchant vessels led Dr. Kirk to offer to guarantee a somewhat greater horse power for the same weight if permitted to use



DR. ALEXANDER C. KIRK.

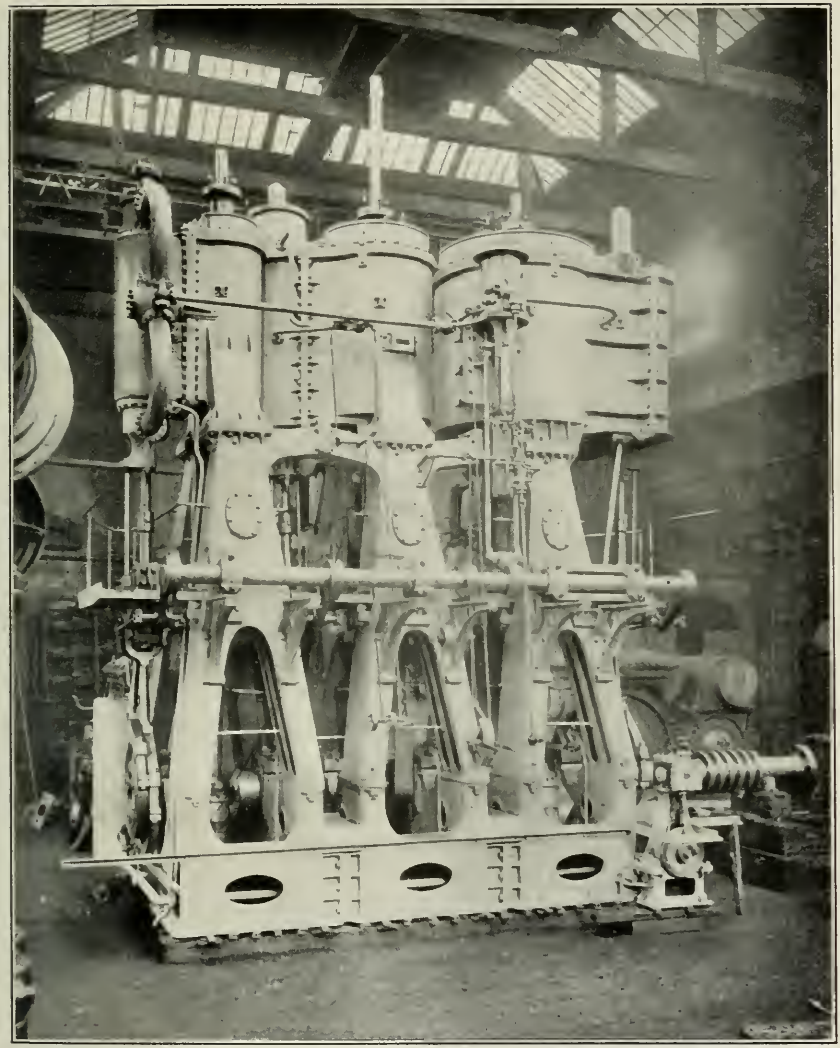
Designer of the first completely successful triple-expansion engine. By courtesy of Messrs. Wm. Beardmore & Co., successors to R. Napier & Sons, Ltd., with which firm Dr. Kirk was connected.

triple-expansion engines. Permission was granted to use engines of this type, and these two vessels made their steam trials in 1887 and were entirely successful. Since that date there has hardly been a war vessel designed anywhere which has not used triple-expansion engines.

There has been a close relation between the development of the marine steam engine and the improvement in materials. Steam pressures with the compound-engine were kept down for a time by the inability to procure boiler plates of sufficient dimensions, but the great improvement in the manufacture of open-hearth steel enabled the higher pressures, which were used at the end of the compound period, to be used safely. The Aberdeen used steam of about the same pressure as the last compound ships, namely, 125 pounds, but it was soon realized that if the full benefit of the triple-expansion principle was to be obtained, higher pressures should be used, and in a very short time they went to 150 and 160 pounds, the steel makers meeting the demand for the thick plates of the large dimensions which were necessary. Along with the increase in steam pressures and the gain in economy there had been progress along other lines, and the sizes and speeds of the ships had increased so that the machinery of the express steamers in the Trans-Atlantic service had become of very large size. For a time the larg-

THE STEAMSHIP ABERDEEN, MESSRS. GEO. THOMPSON & CO.'S ABERDEEN LINE.
Engined in 1881 by R. Napier & Sons, Glasgow, with the first successful triple-expansion marine engines. By courtesy of Messrs. Wm. Beardmore & Co.

est vessels with the most powerful engines afloat were the steamships Paris and New York of the American line and the Teutonic and Majestic of the White Star line, but these were eclipsed by the Campania and Lucania, which were not only larger vessels but had engines of 30,000 horse power. These vessels are 600 feet long, 65 feet 3 inches beam, and 25 feet mean draught, with a displacement of about 18,000 tons. The maximum horse power of their twin-screw engines is 31,-



TRIPLE-EXPANSION ENGINES OF 2,700 INDICATED HORSE POWER FOR THE STEAMSHIP ABERDEEN.

Built in 1881, by Messrs. R. Napier & Sons, now Messrs. Wm. Beardmore & Co., Glasgow, by whose courtesy we are enabled to present this photograph.

000, which on trial gave a speed of over 23 knots. Each engine has two high-pressure cylinders 37 inches in diameter, one intermediate 79 inches in diameter, and two low-pressures 98 inches in diameter, stroke 69 inches. There are twelve double-ended boilers and two single-ended, the double-ended boilers being 18 feet in diameter

Name of vessel	Meteor	Fusi Yama	Colchester	Tartar	Iona
Date of trial	1888	1888	1889	1889	1889
Type of engines	Triple	Compound	Compound	Triple	Triple
Cylinder diameters, inches	29.4, 44, 70.1	27.3, 50.3	(twin) 30, 57	26, 42, 69	22, 34, 57
Stroke, inches	47.9	33	36	42	39
Revolutions per minute	71.78	55.59	86.5	70.0	61.1
Aggregate indicated horse power	1994	371.3	1979.7	1087.4	645.4
Heating surface, square foot	6648	2257	5820	5226	3160
Grate surface, square foot	208	52	220	161	42
Ratio heating surface to grate surface	32.0	43.4	26.5	32.5	75.2
Steam pressure in boilers, pounds	145	56.8	80.5	143.6	165.0
Coal per hour per square foot grate surface	19.25	18.98	26.1	11.93	22.4
Coal per hour per indicated horse power	2.01	2.66	2.90	1.77	1.46
Feed water per square foot of heating surface per hour	4.49	3.48	7.39	....	2.73
Feed water per pound of coal	7.46	7.96	7.49	....	9.15
Feed water per pound of coal from and at 212° Fah.	8.21	8.87	8.53	....	10.63
Feed water per indicated horse power per hour	14.98	21.17	21.73	....	13.35
Weight of machinery, including water per ind. horse power, ton	0.20	0.27	0.20	0.27	0.31
Indicated horse power per ton of machinery and water	5.00	3.70	5.00	3.70	3.21

MARINE-ENGINE TRIALS BY THE RESEARCH COMMITTEE OF INSTITUTION OF MECHANICAL ENGINEERS.

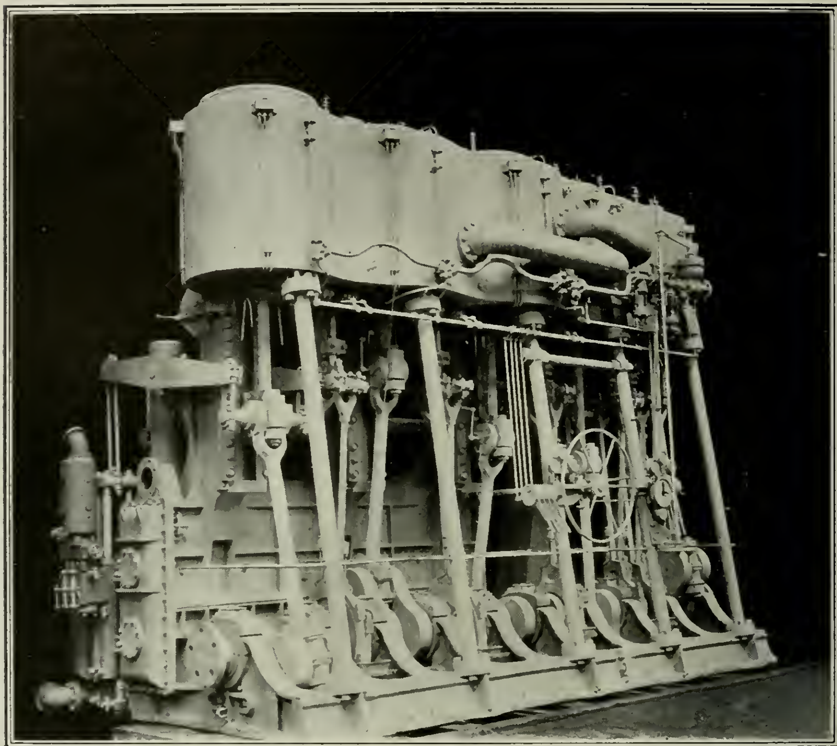
and 17 feet long with a working pressure of 165 pounds. Some of the plates in these boilers are 20 feet long, 7 feet wide, and 1.53 inches thick.

The most reliable data of the economy of triple-expansion engines come from the tests of the steamer Iona by the Research Committee of the British Institution of Mechanical Engineers. The Iona was one of a large class of freight steamers of the same tonnage and machinery which were built expressly for great economy. The machinery was designed by the Central Marine Engine Works at West Hartlepool, and is a remarkable example of what can be done in the way of turning out highly efficient machinery at moderate cost when modern manufacturing methods are employed. As I have remarked elsewhere in discussing the question of American competition with English manufacture, this machinery was at the very head of its class, for the reason that it was manufactured in thorough accord with modern methods. In the annexed table are given data of the trials of the Iona, as well as those of some other triple-expansion and compound engines, and it will be seen that a horse power was obtained for 1.46 pounds of coal. The steam per horse power was also very low, being about 13.35 pounds per hour. The great economy in coal per horse power is due even more to the boilers than to the engines, as the evaporation per pound of coal from and at 212 degrees Fahrenheit was 10.63 pounds. This was possible on account of an unusually high ratio of heating to grate surface (75 to 1) and the use of moderate forced draft, which, as will be mentioned later, tends to a slight increase of economy.

The success of the triple-expansion engine and the possibility of carrying still higher pressures led to an early introduction of the quadruple-expansion engine, where the pressures went up to over 200 pounds. The St. Louis and St. Paul of the American line, built by the William Cramp & Son's Ship and Engine Building Co., have twin-screw quadruple-expansion engines carrying 210 pounds pressure. More recently the steamer Deutschland, with the largest engines actually afloat, also has quadruple-expansion engines. The Deutschland is 663 feet long, 67 feet beam, 28.5 feet draught and 23,200 tons displacement. She has twin-screw quadruple-expansion engines, each having two high-pressure and two low-pressure cylinders, with one first and one second intermediate cylinders, the cylinder diameters in inches being high-pressure, 36.6; first intermediate-pressure, 73.6; second intermediate pressure, 103.9; low-pressure, 106.3; piston stroke, 72.8, and the steam pressure 213 pounds.

While, as will be stated shortly, the greatest economy thus far known in marine engineering has been obtained with the quadruple-expansion engine, it should be stated that this type has not displaced the triple-expansion as the latter did the compound engine. So far from its being generally conceded that the quadruple-expansion engine is more economical, many designers believe, and carry out their belief, that the triple-expansion engine can be used with as great economy as the quadruple up to pressures of 250 pounds. Thus far no experiments have ever been made which attempted to measure the economy of the engines alone of the two types in large sizes, and, as will be noted presently in the case of the remarkably economical quadruple engine, there were so many other factors conducive to economy in the case of these particular ships, that the remarkable result in these cases cannot be regarded as definitely demonstrating that the quadruple engine at the pressures thus far carried is really more economical than the triple.

The vessels which at present have the record for the most economical machinery are the steamers Inchdune and Inchmarlo, whose machinery like that of the Iona, was built by the Central Marine Engine



FIVE-CRANK ENGINES AS FITTED ON BOARD THE STEAMERS INCHDUNE AND INCH-MARLO. CENTRAL MARINE ENGINE WORKS, WEST HARTLEPOOL.

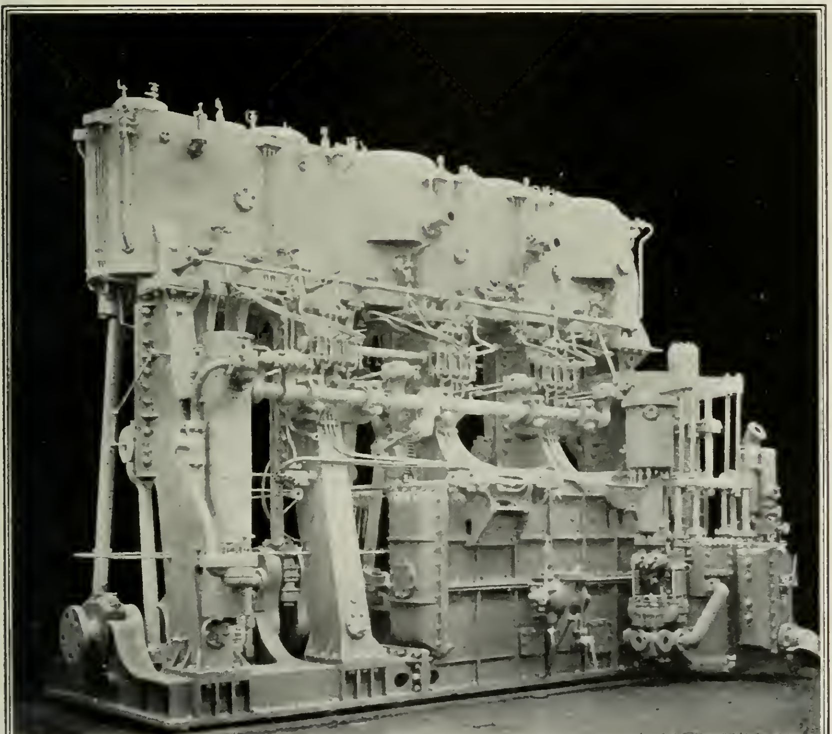
The vessels were built by Messrs. Wm. Gray & Co., Ltd., for Messrs. Hamilton Fraser & Co., of Liverpool. They are 360 by 48 by 29 feet, of 8,898 tons displacement. The engines have cylinders 17, 24, 34, 42 and 42 inches diameter by 42 inches stroke. Working pressure, 267 pounds per square inch. By courtesy of Wm. C. Borrowman, Esq're, General Manager of the Central Marine Engine Works.

Co. of West Hartlepool. The engines are not of great size, the aggregate indicated horse power being only 1,600. The steam pressure carried is 267 pounds. There are five cylinders, two being low-pressures, but the expansion being in four stages. The cylinder diameters are 17, 24, 34, and 42 inches, the stroke of all pistons being 42 inches. The coal per horse-power on trial trip from Hartlepool to Dover was the unprecedentedly small amount of 0.97 pounds. In this machinery everything which would contribute to economy has been adopted. The steam is superheated to a temperature of about 500 degrees Fahrenheit, and all the cylinders, except the high-pressure, are jacketed both on the barrel and on the ends. The feed water is heated to a temperature of about 370 degrees and moderate forced draft of the induced type is used, while the boilers are fitted with Serve tubes. The economy attained in this machinery of getting a horse-power for about one pound of coal is certainly remarkable, and it makes a record which it will be difficult for other designers to excel, if, indeed, in vessels of large power it can be reached.

It may be well here, as we have now given the most economical result which has been attained, to recapitulate the economy as expressed by the cost of a horse power in coal and water at different periods. It will be understood, of course, that the figures are simply close approximations and the years selected are for convenient periods.

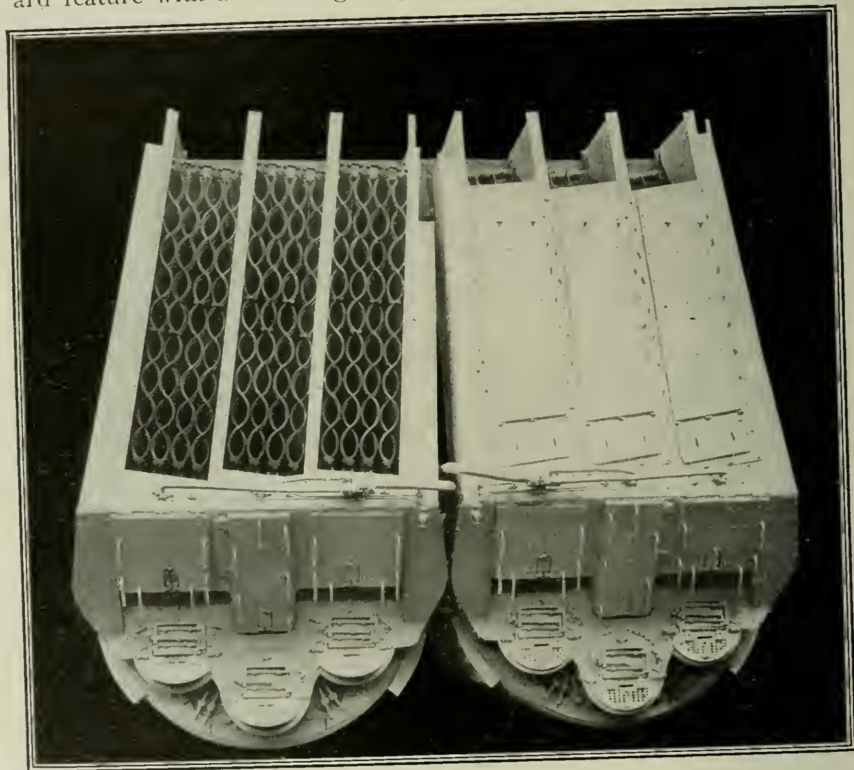
COST OF A HORSE POWER IN STEAM AND COAL.

	STEAM.	COAL.
1825	60 pounds	10.0 pounds
1850	40 pounds	5.9 pounds
1875	20 pounds	2.5 pounds
1900	11 pounds	1.0 pounds



REAR VIEW OF MUDD'S FIVE-CRANK ENGINES FOR THE INCHDUNE AND INCHMARLO.
By courtesy of Wm. C. Borrowman, Esq're, General Manager of the Central Marine Engine Works, West Hartlepool, builders of the engines.

We have thus far been considering almost entirely economy as measured by the coal expenditure per horse power, but, as we have previously remarked, economy in weight is also a most important feature, particularly in war vessels, as will be discussed under the next division. For the present it is interesting to discuss more fully the subject of forced draught; inasmuch as that has now become a standard feature with all the large highly powered merchant steamers, as



BOILERS OF THE INCHDUNE AND INCHMARLO.

Fitted with "Central" patent superheater and Ellis & Eaves system of induced draft. Working pressure, 267 pounds per square inch; guaranteed coal consumption, 1 pound per indicated horse power per hour. By courtesy of Wm. C. Borrowman, Esq're, General Manager Central Marine Engine Works.

well as war vessels. The reduced boiler weights to be secured by the use of forced draught appeal more strongly at first to the naval designer, who is always badly handicapped by weight limitations, and the earliest use upon an extended scale was in torpedo boats, where weights are cut down to the very lowest point. The method of applying forced draught, which has been used almost exclusively in war vessels, is to enclose the whole fire room and blow in air under a moderate pressure, usually not exceeding about four to five inches of water in torpedo boats and not more than two inches in large naval vessels. In naval vessels, which are not only subdivided by water-tight bulkheads, but usually have a protective deck in addition, this is really the simplest method and requires few additional fittings. Experience had shown, even with natural draught, that the economy of evaporation fell off as the rate of combustion increased, and, as might have been expected this result was much more noticeable under forced draught. Two tables are given herewith, one showing a series of tests of a water tube boiler (Thornycroft) on the U. S. S. Cushing at rates of combustion from 7.5 to 66 pounds per square foot of grate, and the other

THORNYCROFT BOILER OF U. S. S. CUSHING ("SPEEDY" TYPE).

Air pressure in inches of water	*0.00	0.5	3.0	4.0
Steam pressure, pounds	250	250	250	250
Coal per hour per sq. ft. of grate	7.58	24.12	40.23	66.32
Evapn. (f. & a. 212°) per pound of coal	11.90	9.72	8.84	6.51
do. do. per sq. ft. of heating surface.	1.40	3.63	5.51	6.70
I. H. P. per 100 sq. ft. of H. S. on basis of 17 lbs. of steam (f. & a. 212°) per I. H. P.	8.25	21.40	32.30	39.45
I. H. P. per ton of boiler and water on same basis	18.35	47.60	72.10	87.80

* Blowers discharging into open fire room.

EXPERIMENTS ON SHORE WITH A BABCOCK & WILCOX BOILER (MARINE TYPE) WITH AND WITHOUT HEATED DRAUGHT.

Heating surface, 1,950 sq. ft.; grate surface, 54.7 sq. ft.; H. S: G. S. 35 to 1. Trials, six hours each.

Kind of draught used		Hot	Hot	Hot	Cold	Cold
Boiler pressure, pounds		200	200	200	184	200
Feed temperature, Fahr.		110	110	110	110	110
Average air pressures in inches of water	Chimney	—0.48	—0.40	—0.27	—0.33	—0.42
	Flue	—0.22	—0.26	—0.26	—0.09	+0.07
	Furnace	+0.15	—0.04	—0.24	+0.08	+0.43
	Fire Room	+1.05	+0.70	0.00	+0.48	+1.03
	Ash Pit	+0.48	+0.30	—0.12	+0.48	+1.03
Temperatures. Fahr.	Air in Fire Room (entering heater)	91	83	161	99	91
	Air in Ash Pit (leaving heater)	290	273	311	99	91
	Gases in chimney by Pyrometer	657	545	488	...	...
Moisture in steam, per cent		0.43	0.65	0.58	0.49	0.57
Coal per hour per sq. ft. of grate, pounds		28.48	21.92	12.41	25.02	33.15
Refuse in coal, per cent		10.3	9.8	10.8	9.7	8.2
Water evaporated	Per pound of coal, actual conditions	8.22	8.56	9.40	8.02	7.62
	Per pound of coal, f. & a., 212°	9.55	9.94	10.93	9.30	8.54
	Per pound of combustible, f. & a. 212°.	10.65	11.02	12.25	10.30	9.31
	Per sq. ft. of H. S. per hour, f. & a. 212°	7.63	6.12	3.81	6.53	8.24
	Per sq. ft. of G. S. per hour, f. & a. 212°	271.9	218.1	135.7	232.7	294.6

tests of a Babcock & Wilcox boiler, where there is not so great a variation in the combustion, but where the reduction in economy is still quite noticeable.

An interesting instance of history repeating itself is furnished by the estimates of the cost of power in naval vessels with triple-expansion engines and forced draught in the early days of the "new navy" of the United States. It was a repetition of what had occurred when the compound engine was introduced. The "fairy tales" of getting a horse power at full power per 1.6 pounds of coal and at low power for as little as 1.2 pounds were believed by some naval men (not engineers) and official documents contained tables with these figures used in computing the "radii of action."

It is almost needless to say that Admiral Melville utterly discountenanced such figures, and as soon as he had an opportunity had the coal measured on several full-power trials under forced draught. This was the first time it had ever been done and the results were very different from the estimates,—about 2.6 pounds per indicated-horse-power hour instead of 1.6.

This was in 1890 and with closed fire rooms. Since that date, with more economical machinery, better results have been obtained, but in no case yet has as low a figure as 1.6 pounds per indicated horse-power hour been obtained for maximum power.

Besides the production of forced draught by a closed fire room, another method, which has been used to a slight extent in naval vessels and very largely in merchant vessels, is known as the "closed ash-pit system." Here the air under pressure is blown into a casing which surrounds the furnace and ash-pit. Mr. James Howden, who has done so much in developing this method of forced draught, provides for heating the air on its way to the ash-pit, and his system is used almost entirely on the large merchant steamers, where it has given great satisfaction, not only in the increase of power but in giving this increase with economy. It has been somewhat difficult to get exact figures of the cost of power in vessels with this system, as compared with similar vessels using other methods, but in 1897 some small gunboats in the United States navy offered a chance for comparison. Two twin-screw vessels were alike in other respects, except that one had cylindrical boilers fitted with Howden draught, while the other had water-tube boilers. The cost of power in the two cases was 1.72 pounds per indicated horse-power hour for the ship fitted with the Howden system and 2.18 pounds for the other, thus showing a decided economy for that system. The coal was the same in both cases, and of excellent quality.

Another system which has been used to some extent is known as "induced draught," where large fans placed near the base of the smoke pipe draw the heated gases through the boiler and discharge into the smoke pipe. This system is fitted to the steamers Inchdune and Inchmarlo, which have been mentioned above.

In the table given opposite, which is taken from an article published by Admiral Melville about two years ago, the weights of boil-

Name of vessel.	Date.	Weights in tons. All machy. and water.	Main and auxy. engines only.	Boilers and water.	Water in boilers.	I. H. P. per ton. All machinery.	Engines only.	Boilers and water.	Kind of boilers.
H. M. S. Warrior.....	1861	898.2	421.6	476.6	171.7	6.09	12.97	11.47	Box; horizontal fire-tube
U. S. S. Wampanoag...	1865	1250	612.0	638.0	157.7	3.24	6.62	6.35	Box; vertical water-tube
H. M. S. Devastation..	1872	972	484.2	487.8	125.8	6.84	13.73	13.64	Box; horizontal fire-tube
U. S. S. Trenton......	1876	976	497.0	479.0	121.5	2.47	4.86	5.04	Cylindrical; single-end
H. M. S. Inflexible....	1878	1366.4	654.2	712.2	187.4	6.21	12.96	11.9	Oval; single and double-end
*U. S. S. San Francisco	1888	914	433	481	125.5	10.63	22.44	20.2	Cylindrical; double-end
U. S. S. Minneapolis..	1891	1920	694	1226	331.7	10.87	30.06	17.0	“ “ “
U. S. S. Oregon........	1892	1068.4	436.4	632.0	143.2	10.38	25.46	17.6	“ “ “
H. M. S. Prince George.	1896	1326.6	623.8	702.7	165.2	9.26	19.7	17.3	Cylindrical single-end
H. M. S. Terrible......	1897	2224.8	1076.4	1148.3	48.7	11.53	23.8	22.3	Belleville water-tube
†U. S. S. Cushing......	1889	54.5	24.5	30.0	3.5	32.29	71.8	58.7	Thornycroft water-tube
†H. M. S. Ferret......	1894	123.6	59.4	64.1	11.5	36.30	75.2	69.7	Normand “ “
†H. M. S. Janus........	1895	120.0	49.0	70.7	7.9	31.58	77.3	53.6	Reed water-tube
†H. M. S. Desperate....	1896	128.0	61.5	66.5	7.7	45.30	94.3	87.2	Thornycroft water-tube
†H. M. S. Quail.......	1897	144.3	68.6	75.7	11.3	41.97	88.4	80.1	Normand “ “
H. M. S. Diadem......	1898	1436.7	688.3	748.4	39.0	12.01	25.1	23.1	Belleville “ “
†U. S. S. Foote........	1897	50.8	24.5	26.3	4.0	47.22	98.0	91.2	Mosher “ “
†U. S. S. Farragut.....	1898	[illegible]	56.8	63.2	10.5	46.67	98.6	88.6	Thornycroft “ .
†U. S. Destroyers......	1898	189.1	89.8	99.3	15.9	42.30	89.1	80.6	“ “
†U. S. Torpedo Boats..	1898	79.7	35.5	43.8	6.6	37.62	84.5	68.6	“ “
H. M. Cressy...........	1898	1800	858.0	942.0	49.3	11.67	24.5	22.3	Belleville “ “

*All after this date have forced draught.
†Torpedo vessel.

WEIGHTS AND CAPACITIES OF BOILERS AND ENGINES OF WAR VESSELS.

ers per horse power at different periods is shown, and by the dates it is easy to see the marked effect of forced draught in reducing the boiler weights.

A method of increasing the total economy which has been tried at intervals from the very earliest periods is the obvious one of heating the feed water. In land machinery, where the engines work non-condensing, the obvious method of accomplishing this is to heat the feed by means of the exhaust steam. This, of course, is inapplicable where the engines are condensing, although to a moderate extent where the auxiliaries are independent of the main engines this can be done. The method which in recent years has had the most vogue is to heat the feed by live steam. At first sight this seems very much like the process of attempting to get rich by taking money from one pocket and putting it in the other, but the fact of an actual increase of economy has been demonstrated, and the explanation which is given by some of the best engineers who have investigated the subject is that the function of the boiler should be simply to impart the latent heat required to form steam from the water, the feed being supplied at about the temperature due to the steam pressure. Feed-water heaters of this type are being used to a considerable degree on the later steamers, and are included in the equipment of the Inchdune and Inchmarlo.

As already mentioned, in these steamers the steam is superheated. This is accomplished by passing it through superheaters placed in the uptakes of the boilers before the hot gases go through the air heaters for the forced draught. As was mentioned in an earlier article,* superheating has been tried at various times, and has always been abandoned after a certain amount of use, on account of the rapid deterioration of the superheaters. We understand corrosion and how to prevent it better now than in the past, and it seems probable that with intelligent care the superheaters can now be made to give a reasonable endurance. Economy due to this cause is undoubted.

In discussing economy on the side of weight of machinery a most important place must be given to a development of the last ten years in the introduction of water-tube boilers. There has been so much discussion of this subject in the technical press in the last few years that we need not go into the detail that would be appropriate in an article on this subject alone. It may be mentioned, however, that the earliest use in a practical way was in torpedo vessels, where the tubes were of small diameter and consequently quite thin, so that a large amount of heating surface and great boiler capacity could be provided on very little weight. Water-tube boilers with large tubes have, however, in the last decade become recognized as a necessity in war vessels. The table already referred to gives data on water-tube boilers of several types on different ships, so that the reduction in boiler weigths due to this type of boiler can be readily seen.

Water-tube boilers have not as yet been largely introduced in the merchant service, although some enterprising British owners have used the Babcock & Wilcox boiler and a number of steamers on the Great Lakes of North America also use this boiler. The Belleville boiler, which has been used so extensively in the British navy, has

* See The Engineering Magazine, March, 1902, page 844.

also been used in the French navy and for a long time has given satisfactory service in the vessels of the Messageries Maritimes.

There has undoubtedly been a feeling among the designers of the machinery for merchant vessels that as the limit of pressure for shell boilers has apparently not yet been reached, (the Inchdune and Inchmarlo carrying 267 pounds have cylindrical boilers), and as the working of these boilers is so thoroughly understood by the engineering personnel who are in charge of them, there is not the same inducement to abandon their use for water-tube boilers as in the navy, where weight is of such great importance. The recent adverse criticism of the Belleville boiler in the British navy will probably tend to confirm this opinion, although I have long believed that the water-tube boiler is certain to supersede the shell boiler before many years.

Messrs. Normand and Sigaudy have proposed a modification of the small-tube boiler to adapt it for large naval vessels and merchant steamers by a slight increase in the diameter and a considerable increase in thickness, and to me it seems that this ought to remove one of the main objections to water-tube boilers, which has been the probability of early wearing out due to corrosion. As a matter of fact, the principal use of water-tube boilers has been in naval vessels, where the circumstances are such as to aggravate the natural rapidity of corrosion owing to the normal use of only a portion of the boiler power, the other boilers remaining idle. All experience has shown that a boiler will last much longer under constant use with reasonable care than when used intermittently. During the next decade there will be an opportunity to test thoroughly the longevity of water-tube boilers in naval vessels, and, if they prove satisfactory, it seems almost certain that shell boilers will be displaced in favor of the later type.

An adjunct to the boiler equipment of modern vessels which has some effect in increasing economy is the evaporator. Although the effect of scale on heating surfaces in reducing the evaporation was undoubtedly greatly exaggerated when it was a common feature, there can be no doubt it should never be allowed to be deposited in modern boilers with their high pressures and the high temperature of the metal. This, of course, means that nothing but fresh water should be fed into the boilers, and in vessels making long cruises where it is inconvenient to carry a reserve supply of fresh water the evaporator enables this to be done. The evaporator is really a small boiler in which the heat is supplied by steam of moderate pressure passing through the inside of a nest of tubes, the salt water being on the outside. There will be, of course, a great deposition of scale, but the design of the evaporator anticipates this and provides for its ready removal by so arranging the nest of tubes that it can easily be taken out of the shell and the scale cracked off. These evaporators are sometimes made on the "multiple effect" principle so familiar in sugar boiling, the steam evaporated in the first effect going through the nest of tubes in the second effect. This will be mentioned again in connection with the distilling ships for naval fleets in the next article.

I have now traced in a general way the progress of economy from the first quarter of the last century, when the coal per horse power was ten pounds, down to the beginning of this century, when it has fallen to one pound, and have pointed out the steps which have contributed to secure this economy. The tremendous increase of speeds in war vessels in recent years and some of the peculiarities of the conditions obtaining in such vessels have not been mentioned thus far, as it would have interfered somewhat with the continuity of the general discussion. The consideration of the methods adopted in recent years to secure economy on naval vessels, together with a few other points bearing upon the subject of economy, both in fuel and weight, will form the last article in this series.

THE OPERATION OF THE MODERN GRAIN ELEVATOR.

By Day Allen Willey.

Mr. Willey's paper will be read with special interest as a sequel to Mr. G. H. Hull's notable article in our March number laying bare the mischievous and trouble-breeding fallacy of "over-production." A very few years ago we were hearing often of an "over-production" of wheat, or corn, or oats. But of late years we hear nothing of such an absurd and impossible occurrence. And this is obviously because transportation facilities and scientific systems of storage have rendered it both practicable and profitable to take care of any temporary surplus of the staples of agriculture. In like manner, scientific cold storage has made an "over-production" of fruit, or eggs, or butter, a thing of the past. The next long stride in the forward march of industrial progress will be accomplished when we prove to the producers of the great staples of the industrial world—coal, iron, steel, copper, tin, lead, and crude rubber—that they are talking nonsense when they talk or think of "over-production." Such a thing has never yet occurred—never can occur! These form the very basis of all manufacture, all wealth. They are non-perishable and can be stored at trifling cost as compared with agricultural produce. For these reasons Mr. Willey's paper supplies a timely and valuable object lesson to the producers of the raw materials of the industrial world.—The Editors.

THE grain trade of the United States has been materially influenced within the last decade through the changes made in the method of transporting and storing the various cereals. The remarkable increase in the acreage devoted to such staples as wheat and corn in the great fields of the West has rendered the old-time method of storing on the premises obsolete. Provision must be made for an increase in a single season of, perhaps, three hundred million bushels of corn, alone, to say nothing of fifty or one hundred million bushels of wheat and the same quantity of oats, for it must be remembered that the farmers of the United States to-day are sowing corn fields aggregating over eighty million acres—ten million more than ten years ago—and harvesting two billion bushels and over in a season. Their wheat fields cover forty million acres—four million more than in 1890—and even the oats area is nearly thirty million acres, an increase of 20 per cent.

It may be impossible to sell such a crop immediately except at a loss. If sold by the farmer, the speculator or middle man may decide to hold it for an upward turn of the market, for the grain yield has now reached a point where in ordinary seasons it far exceeds the demand for domestic consumption and must be kept in bulk awaiting the foreign outlook. Therefore the imperative necessity for storage facilities has resulted in the development of the elevator system in America on a scale unknown elsewhere in the world.

On a Dakota, Kansas, or Nebraska farm where the harvest field may cover 500 or 2,000 acres, only a small portion of the yield is threshed and placed in the barn bins. The bulk is carried to what are termed railroad elevators located in convenient towns. These vary in capacity from 10,000 to 100,00 bushels according to their location in the producing district, and from them the transportation company loads its cars for the domestic or foreign market. But the district elevators as they might be called, represent only a fraction of the space for storage which now exists in the United States. Before it is loaded on shipboard at tidewater, a cargo may pass through four or five different buildings, be transfererd from car to vessel and back again to car, as the modern processes employed facilitate its handling.

Elevators are divided into two classes, receiving houses and transfer houses. All of the first-named structures are located on shore, but at cities on the American Great Lakes and along the Atlantic seaboard can be found floating elevators by which the contents of the lighter or canal boat are discharged into the hold of the ship.

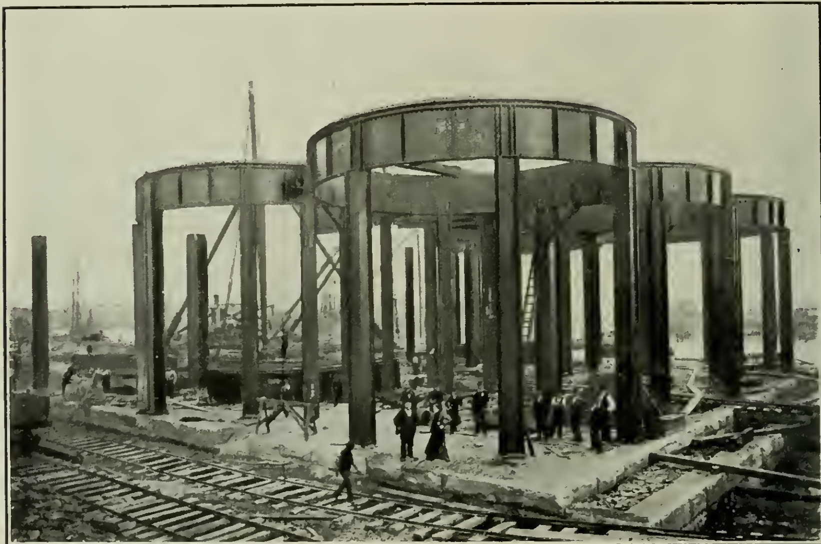
The transfer elevators are usually located at the water side, as they are intended for moving grain from vessel to car and vice versa. If they are marine elevators the plans provide for running the grain cars directly into the structure, track being laid along the ground floor of the building. If the location is such that this plan is impracticable, the track is laid along the side, and from openings in the buildings project the receiving legs or spouts, which are from 15 to 25 feet in length, hinged, so that they can be hoisted against the side of the building when not in use. The end of the spout is carried into the car by the feeder, who moves it from place to place as the contents of the car are emptied. With the spouts in modern use all of the grain with the exception of a few shovels full can be taken out so that the only manual labour required is that of the feeder. As an ordinary leg will elevate from 9,000 to 10,000 bushels an hour, a trainload of thirty or forty cars representing 1,500 tons can be passed into the building in this time if it have the average number of receiving spouts.

As in the storage elevator, the grain is conveyed to the top compartment, to be held until it flows into the cleaning hoppers, thence to the scales, thence to the distributing or marine legs. The latter are much larger than the receiving spouts, as one is allotted to serve a hatchway. They have an average capacity of from 20,000 to 25,000

SETTING MASONRY PEDESTALS FOR THE FOUNDATIONS OF A GREAT TANK-BIN ELEVATOR.

bushels an hour, and are of course adjustable, although the cargo must be properly trimmed by the stevedores. So rapidly does one of the elevators transfer its contents, that the first of a carload of wheat may be deposited in the hold of the vessel on the other side of the structure before the last bushel has left the car itself.

The storage elevators are divided into bins of various sizes, with a view of distributing the weight as evenly as possible upon the foundation of the building, and also equalising the side pressure on the walls. In the wooden structure the bins are square in shape, extending from the top to the ground floor, and are usually massed in the center of the building. As much of the machinery as possible is installed in the cupola, with the exception of the power plant which, in the steam-driven elevator, is generally located in a separate building as a precaution against fire and as a matter of convenience. The plan followed in the elevator construction of today is usually to locate the distributing department next to the bins, above it the scale room, above this the cleaning garners, the shafting and other transmitting machinery being placed at the top. In receiving grain the same method is employed as in the transfer elevator, the contents of the car being carried to the top of the building. In this process and in transmission to the other compartments the systems employed include suction through wood or metal conduits to which are attached exhaust fans thus creating a partial vacuum, or the use of conveyers. The latter are generally composed of endless belts carrying buckets made of sheet metal which fill and discharge automatically as the belt



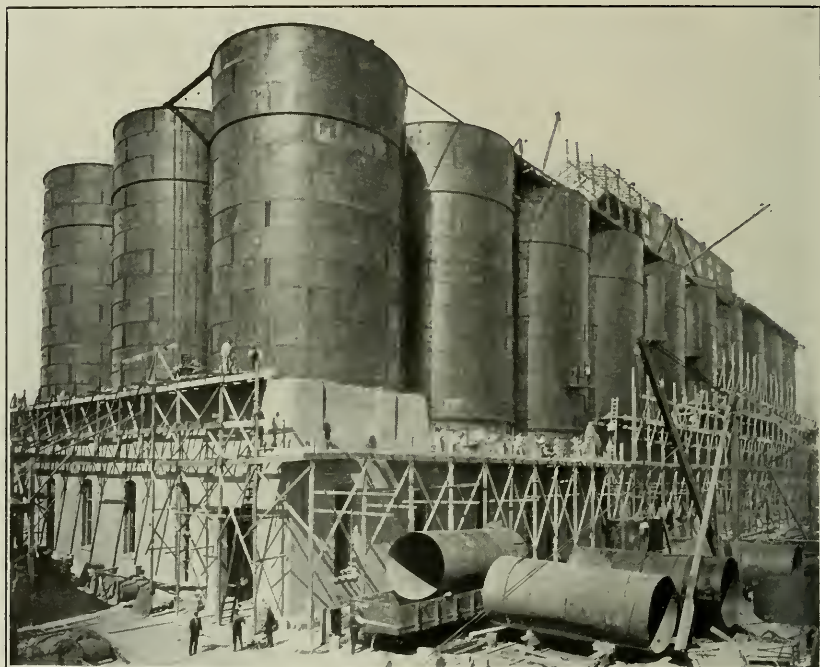
ERECTION OF STEEL FRAMEWORK FOR BIN TANKS.
Showing the concrete foundations on which they rest.

moves. The belts are used also for carrying away the screenings from the cleaning machinery. The dust and other fine particles are usually removed by an air current produced by a fan and conveyed outside of the building through special spouts. It may be said here that the transfer capacity of the machinery is so adjusted to the different departments in a modern elevator that it is not necessary to stop the machinery at any time to regulate the movement of the grain. The modern method of cleaning the grain is to pass it by belts or gravitation over rapidly moving sieves, which separate the foreign matter which may remain after the treatment. The weighing floor is provided with a series of bins and scales, each of which usually has a capacity of from 10,000 to 15,000 bushels. As fast as a bin is filled, the weight is registered automatically and a door in the bottom is released, allowing the grain to flow into the storage department or into one of the transfer spouts as desired. The house is provided with two sets of scales, so that while one portion of the grain is being cleaned, weighed and stored, another portion may be loaded on shipboard or into the cars without interfering with the other process. During the entire operation the only manual labor needed in adjusting the spouts, and stopping and starting the machinery. Consequently a modern steam elevator, having a capacity for transferring 100,000 bushels of grain in an hour, can be operated by a force consisting of engineer and fireman, the spout tenders, and a half dozen hands to guard against possible accidents in the different departments. The trimming of the vessels is not considered a portion of the elevator work. In elevators where steam is the power directly applied, the main driving belt extends from the engine room to the machinery floor in the upper part of the building, turning a line shaft and pulleys belted to the fans and conveyors. In some of the recently constructed elevators electric motors are employed. These enable operation of one sec-

LAYING THE FOUNDATIONS AND SUPPORTING COLUMNS FOR THE LARGEST STEEL ELEVATOR IN THE WORLD.

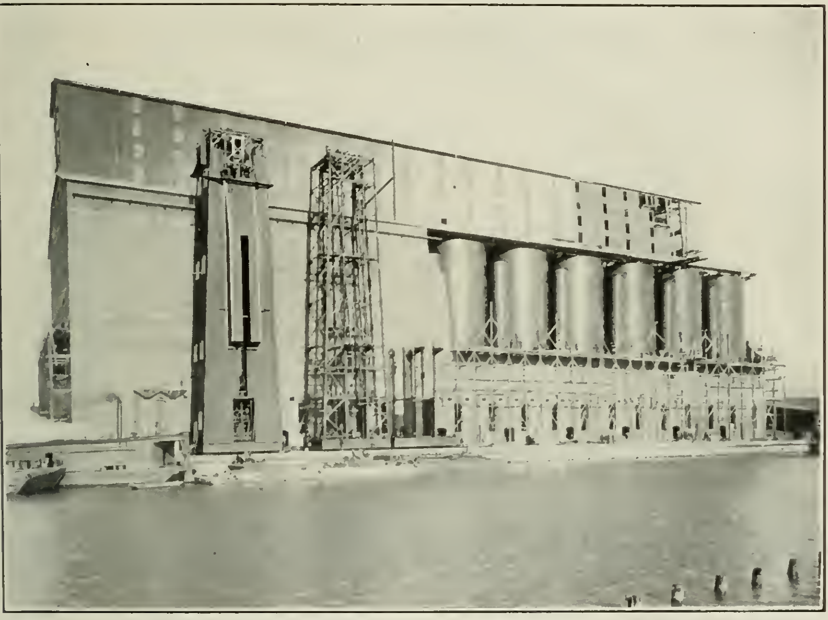
tion of the apparatus if desired independently of the others. These motors are belted to the legs, fans, and conveyor pulley.

The tendency in modern storage house construction is to increase capacity. Ten years ago a million-bushel elevator was considered large; but the structures which have recently been erected a railway terminals and at important harbours range from 1,500,000 to 3,000,000 bushels storage capacity and some of them have facilities for loading at one time three steamships, each of 7,000 tons carrying capacity. The great weight to be sustained by such structures and the progress made in the erection of steel buildings has caused steel to be employed with very satisfactory results in some of the elevators recently built on the Great Lakes. One of these elevators, reputed to be the largest storage house in the world, having a total capacity of 3,100,000 bushels, was erected by the Great Northern Railroad Company at its terminals at West Superior, Wis., and is used for handling corn, wheat and oats. As it represents the latest ideas in elevator construction, its principal features may be alluded to in this article.



SYSTEM OF TANK-ELEVATOR ARRANGEMENT AND CONSTRUCTION, SHOWING OUTER STRUCTURE OF BRICK.

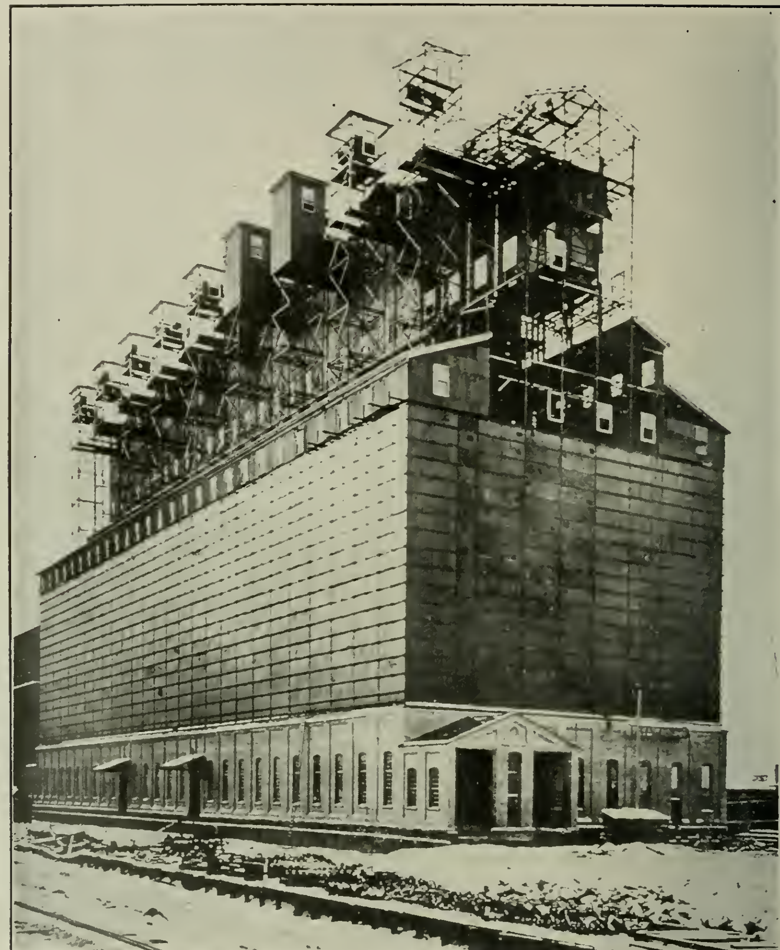
The steel framework rests upon 280 columns of the same material, in turn supported upon concrete pedestals and piling. The outside walls of the lower portion consists of brick resting on stone foundation. The storage compartments are rectangular bins, each 85 feet in height and varying from 6,300 bushels to 24,900 bushels capacity. The bins are made of steel plates 5 feet in length and ranging from 5/16 to 3/16 of an inch in thickness. The arrangement of the floors is similar to that in the ordinary elevator, but in operation the cars are hauled into the building in trains of nine each by a cable system. As the grain passes from the cars into the hoppers it is taken by endless-belt carriers from the hoppers to the top of the elevator, where it falls into the garners, thence into the scale hoppers, and thence to the scales. From these it drops through a swinging-turn-head into spouts, from which it is taken by a belt conveyor and handled longitudinally of the building and delivered into the proper bin. If it is to be cleaned it falls through the bin to one of the cleaning legs, which



ELEVATOR WITH OUTER BRICK WALL PARTLY COMPLETED.
This exhibits the arrangement of the tank bins and the steel framework of the elevator.

elevates it. Thence it passes over the sieves of the cleaning machines, returns again to the top of the house, and down into a bin. Before being sent to the shipping bins the grain is weighed a second time. A novel feature of the equipment is a system of automatic shovels, there being one for each car. Each set of nine shovels is so placed on a hanging track that a shovel can be "spouted" to any one of the cars. Each line of shovels is run by two sets of rope drives. Yard room is provided for 160 cars at one time and the empty cars can be quickly discharged by means of a transfer table to the 12 yard tracks which are provided.

In providing power for the various processes, the plan was followed of utilizing individual motors as much as possible in order to

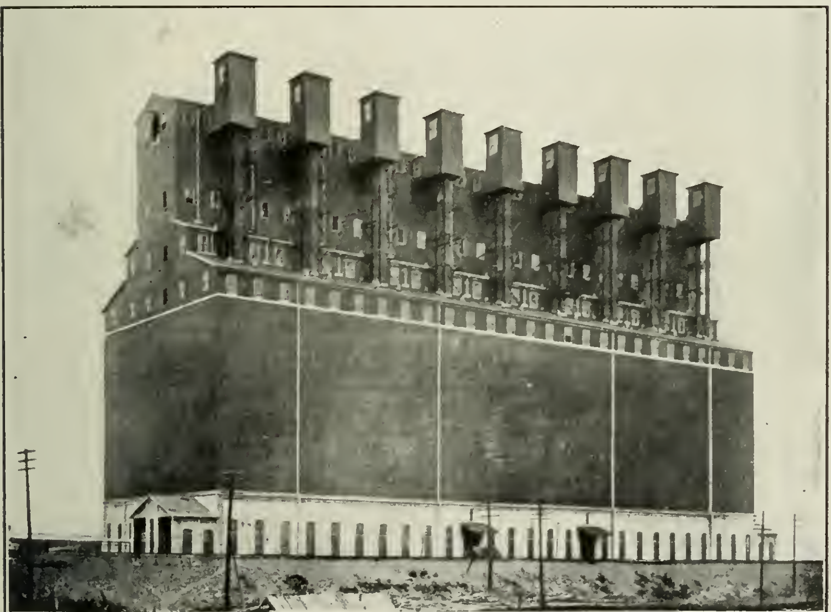


COMPLETING THE SUPERSTRUCTURE, SHOWING THE FRAMEWORK OF THE TOWER FOR HOISTING AND CONVEYING MACHINERY.

obtain greater economy in power distribution. Electricity is depended upon entirely, even the cable system for hauling cars into the building being operated by a 100-horse-power motor. Each conveying belt, cleaner leg, fan, and power shovel is operated by an individual motor ranging from $7\frac{1}{2}$ to 100 horse power, requiring a total of 2,070 horse power. The elevator loads 300,000 bushels of grain in twenty-four hours on board vessels and unloads six hundred cars during the same period.

The storage facilities of several other lake ports have recently been increased by the building of elevators, which consist of a series of cylinders of boiler plate, each of which is separated into bins of requisite size. In some cases the cylinders are enclosed in a shell of brick, although several have been built at Buffalo and elsewhere without this casing. As in the structure at West Superior, the bulk of the machinery is located in a cupola above the bins. The grain is placed on shipboard either by the spout method, or by the conveyor system installed in wooden galleries extending from foundation to roof.

By the elaboration of the conveyor belt an elevator can be constructed at a distance of 500 to 1,000 feet from the wharf front yet transfer its contents quickly and without difficulty. The endless belts are connected with the discharging bins and carried to the wharf front



THE ELEVATOR AS COMPLETED, READY FOR SERVICE.

in closed galleries. Along the wharf is constructed another conveying system divided into convenient sections, and each provided with marine spouts. Each section of the wharf conveyor is fed by a conveyor belt from the elevator, so that one section can be operated independently of the others or all operated at one time, according to the number of vessels to be served. An example of this method is shown at New Orleans, where a storage and transfer house of 1,500,000 bushels capacity is being constructed by the Illinois Central Railroad Company. The building, which is of frame design, is located over 500 feet from the river front and is to be provided with four lines of

INDEPENDENT ELECTRIC MOTORS DRIVING SUCTION FANS.

belt conveyors running through double belt galleries and connecting with a series of wharf conveyors aggregating 2,000 feet in length constructed in four sections of 500 feet each. Each section will have a loading capacity of 20,000 bushels an hour. The elevator is being built of wood suported on a concrete foundation, and will receive grain by means of automatic steam shovels unloading the cars which are run into the building on depressed tracks. It will be operated entirely by steam power.

This plan of transferring grain has several advantages, as the elevator can be erected on a site which might be vacant and serve its purpose without interfering with buildings which might be located between it and the harbor. At ports where the shore of the river or bay is so soft as to require an expensive artificial foundation to sustain the weight, the building can be placed inland on a firmer and less costly site. Another advantage of the plan followed at New Orleans is that the damage caused by flooding the banks during high water is likely to be avoided. In rivers like the Mississippi, which are subject to great and rapid increase in depth special precaution must be taken to guard buildings near the shore from the possibility of such freshets.

THE STATUS OF THE NAVAL ENGINEER.

By Charles M. Johnson.

The Engineering Magazine's attitude on the question of the status of the naval engineer is inspired by an earnest desire to see justice done the profession, and a logical adaptation made of naval organization to modern conditions. This motive placed us in the front of the advocacy of the Personnel Bill, and animates our continuance in the campaign to make that bill as effective in administration as it was in conception. Mr. Johnson's excellent paper is presented as an object lesson, to show the powerful effort which is being made for a similar cause in the British Navy.—The Editors.

THE present condition of the engineering branch of the British Navy is so bad that I can conceive of no lower depth of unsatisfactoriness to which it could possibly attain. The unsatisfactoriness to which I refer is not that seen from the standpoint of the engineer officer; that were to take far too limited a view of the question; but it is that seen from a far higher standpoint, that of the national needs, and the security of the State. Taking this point of observation, we are able to get a little above the clouds which must of necessity surround—and to a certain extent obscure—the lower position. It may be objected by the other side:—"How can you, as a naval engineer, take up an impartial position on a question which so closely interests and affects the class to which you belong?" I am not going to waste the valuable space placed at my disposal by the editor in trying to prove my impartiality; the best proof of the possession of that virtue will be the contents of the pages which follow.

The engineering branch of the British Navy is suffering in efficiency from three causes:—the want of training, the want of a sufficient and efficient staff, and the want of adequate rank and authority. I propose to deal with the whole question by the elucidation of the three points given above, taking them in the order in which they stand.

Training. It cannot be necessary for me to demonstrate to the readers of The Engineering Magazine the inseparable bonds between training and efficiency. As practical and professional engineers they know, equally as well as I do, that efficiency in the handling of machinery can be acquired only by constant practice and experience—in other words, by training. We see the perfection of this probably in the "steaming staff" maintained by the various engineering and ship-building firms throughout the world almost exclusively for the purpose of putting the ships and machinery they build through their official trials.

They do not take men at haphazard out of their shops for such duties, but carefully select them from time to time, as opportunities afford, from observation of their behavior and their technique—if I may so term it—in the engine room and stokehole; so that in the course of time the manager has obtained a corps of steam-trial experts, which he knows may be trusted to get the very last ounce of steam out of the boilers, and the last quarter of a revolution out of the propeller. In this case, the experts are always dealing with the products of one firm, and the tricks and peculiarities of the type of engines and boilers they turn out will in nearly all cases be of the same nature; hence these men acquire such dexterity and skill in the handling of their firm's boats that it takes the ship's crew some little time, even with old and skilled hands, to get anything like the same results out of the machinery, either as to speed or economy. But in the British man-of-war, the engineer has much greater odds against him. In the first place, the machinery of the ship he is to-day called upon to take to sea may be of a type and make altogether new to him. In the next place, his staff will certainly be inadequate in point of numbers. In the third place, that staff will probably consist, as to one-third, of absolutely raw hands, some of whom may never have been in an engine room or stokehole when fires were alight and the engines moving. And this condition applies not only to the stokers, but also to the artificers. Let us take an imaginary example—H. M. Battle-ship Sphinx completed last year, having gone through all her official trials with credit to her builders and to the firm which engined her. She is newly commissioned for the China station. Being a first-class battle-ship, her engine-room complement consists of the following ranks and ratings:—One chief engineer, five engineers or assistant engineers, fourteen engine-room artificers, twenty-two chief and leading stokers, and one hundred and twenty-four stokers, and stokers second class. We must analyse this staff a little, and see what proportion of trained men it contains. There is first, the chief engineer, and his first lieutenant, the senior engineer; they are, of course, fully trained and experienced men, and it may be that two of the assistant engineers also have had a couple of years' sea experience—not training; then, out of the fourteen engine-room artificers there may be five with eight to ten years' service, and possibly other five with two to seven years' service. Of the twenty-two chief and leading stokers, there will probably be twelve thoroughly experienced good men; whilst of the remaining ten, one-half may be considered of little value, and the other half as men of ordinary ability. Of course all leading stokers must have had five or six years' service before they can be rated "L. S." Of the one hundred and twenty-four stokers and stokers second class, one-third to two-fifths will certainly be raw recruits who have never been to sea, and whose only training has consisted of pitching stones and sand into a cold furnace and steaming a boiler to run auxiliary engines. To sum up:—out of an attenuated staff of one hundred and sixty-six officers and men, quite one-fourth consists of untrained raw recruits.

Now it is this want of a proper system of training the officers and men of the engineer department which I wish most particularly to emphasise. The question which I have so often asked of the general reader, I now ask of professional men, who will have no difficulty in answering: "What is the use of possessing the largest and finest navy in the world, if its value is seriously discounted by the want of 'trained' officers and men to handle its ships?" No expense is spared to train the officers and men of the sailor branch—(and rightly so)—for the important duties they have to perform, but is it wise, is it just to the country, wholly to neglect that part of the ship's crew upon which must ultimately depend the success or failure of the conflict?

Reverting to the crew of the Sphinx as above dissected, it will be seen that two assistant engineers are debited as "untrained" or only very partially trained. The training of these young officers in engine-room or watch-keeping duties is limited to a short period of steaming, and the examination and adjustment of the machinery of a small gun-boat at Devonport, during the last six months of their studentship. The course consists partly in steaming the vessel in the basin at Keyham, and partly in the Channel. But the actual time under steam is very limited, on account of the time which has to be devoted to scholastic work; so that this training is disconnected and of little real value as a preparation for engine-room watch-keeping duties. Again, it is limited to one small steamer, to one make of engines, and to one class of boiler, while the naval engineer may have to deal, in the course of his service afloat, with a dozen types of engines and boilers.

The engine-room artificer is in even worse case, for there is no training at all, provided for his class. In nineteen cases out of twenty, the engine-room-artificer recruit is a workman from the bench or forge, utterly unacquainted with engine or boiler, except from the building or repairing side, and in many cases, innocent even of that. It is quite possible that he may never have seen either a pair of marine engines or a boiler, until he finds himself in the engine room or stoke-hole of a ship in one of the reserves; and it is also possible that that may be the limit of his experience of marine engineering, until he is drafted to H. M. S. Sphinx as part of the engine-room complement which is to take her to the most distant part of the world, and keep her going in full state of efficiency for three years.

The stoker recruit, like the engine-room artificer, has in very few instances any idea of a marine engine or boiler. He may possibly know the difference between a locomotive and its tender, but he will not know the blow-off cock from the regulator, nor the reversing lever from the brake. In many instances, he will have come from the fishing boat or the plough-tail, from the builder's yard or the livery stable; he is, in fact, utterly innocent of any knowledge appertaining to the calling he has undertaken to pursue. For years engineer officers have endeavoured to convince the Admiralty of the necessity of training for the stoker second class, but without avail, until within the past year or so they have inaugurated a burlesque system of training for these men which is so utterly ridiculous that I wonder their lordships were not ashamed to sanction it. That course of "training (?) is as follows:—

On joining the service, the stoker recruit passes for the first three months into the hands of the seaman drill-instructor, by whom he is taught to march, to do all kinds of physical drill, to use a rifle and cutlass, to pull an oar, and all that is necessary for a blue-jacket to know as his preliminary training. At the end of the three months in the sailor's hands, the stoker recruit is handed over to the engineer department, and undergoes four weeks' training as follows:—

First week—Shovel drill with stones.

Second week—Shovel drill with stones.

Third week—Light fires in boiler, attend fires, run auxiliary machinery, etc.

Fourth week—Make packing and gasket, trim lamps.

During this training, the recruit is also instructed in a "Manual" specially written for his benefit. This manual gives the names and explains the uses of the principal parts and fittings of the engines and boiler, the names and uses of the various tools and stores used by the engineer, and instructions as to what it is necessary to do, and to remember, when raising steam. At the end of this four weeks' drill the stoker recruit is returned to the depot for disposal; which means that next week he may be drafted to H. M. S. Sphinx as "part complement." Observe the difference in value in the two trainings, as appraised by the executive mind. For the duties which at most can but be subsidiary duties, the time allotted for trainings is three months; for those for which he has joined the naval ranks, and which are to constitute his life's work, one month is thought sufficient, and even that short period is wasted, or partly wasted, in a travesty of training.

The value of a first-class battle-ship is about a million sterling. The value of all the ships in the British Navy is in the vicinity of one hundred millions. The cost of maintaining a thorough system of training for engineer officers and men would not exceed one-tenth of one per cent. per annum on that amount. As we cannot get the full value out of our ships without this training, would it not be a wise investment of national capital to incur that cost? As there is the possibility of failure in war without this training, should not the British taxpayer insist on the elimination of that possibility, thereby affixing the stamp of his policy of insurance?

Inadequate staff. If, in addition to the want of an efficacious system of training assistant engineers, engine-room artificers, and stokers, the value of British naval ships be further discounted by insufficiency of numbers, my readers will recognise the unfair position in which the engineer officer finds himself, when called upon to take one of His Majesty's ships to sea for a three years' commission. In however high a state of efficiency the machinery, boilers, auxiliary machinery, steam-boats, water-tight doors, hydraulic appliances, and double-bottom compartments may be on leaving the home port, the chief engineer knows full well that deterioration dates from that day. He will do his best, and his officers and men will loyally assist him as far as it is in their power so to do, to keep things right and in thorough working order; they will generally submit cheerfully to work more hours than any other men in the ship; to forego leave and other privileges, when there is work to be done, which must be left undone if they do not sacrifice their pleasures to the "exigencies of the service." But all this loyalty and all these self sacrifices do but minimise the evil; they cannot wholly prevent it. Then on arrival at the port which is the headquarters of the station to which the ship is allocated, with a fairly long list of defects to make good, the engineer finds that he has to send his men on leave, the same as the rest of the ship's company—which is of course quite right, though very inconvenient at such a time; and when the leave is over, the captain, under orders from the commander-in-chief, tells the chief engineer that one-half or one-third of his men must be sent ashore to drill. It is useless to represent to the captain that the work of preparing the ship again for sea will thereby be delayed. All that the captain can reply is, "I am only carrying out the station orders." An appeal to the commander-in-chief would probably invoke the reply: "The station orders are to be obeyed." What the engineer feels is, that he is unfairly handicapped by these orders. He says rightly enough: "Let me get the ship ready again for sea, and after that take my men, and drill them according to the station orders." But that is not the way in the navy. The executive officer is supreme, and having the power to get his work done first he uses it. The engineer is responsible to the captain for getting the ship ready for sea, but it seems to be no part of the captain's business to help the engineer.

There is no more difficult task than that of demonstrating to the lay mind that the number of officers and men allowed to the engineer department of a ship of war is insufficient for the duties to be performed and the work to be accomplished. Little as it can help to an appreciation of the real inadequacy of the staff, yet it may be as well to give here a list of the engineer's duties and responsibilities as laid down in Chapter XXVI of the Queen's Regulations and Admiralty Instructions of 1899:—

"The Engineer officer is to have charge of, and to be responsible for, the maintenance in a state of efficient working order, and as far as may be of readiness for immediate use, of all that is placed under his charge, including:—

(a) The machinery and boilers of the ship and her boats.
(b) All auxiliary machinery, except electric motors, for whatever purpose fitted.
(c) All pumps, with the cocks, valves, and pipes belonging to them.
(d) All distilling apparatus.
(e) All gun mountings.*
(f) Propeller-lifting apparatus.
(g) All steam and hydraulic pumping and other engines for loading and working the guns, for supplying ammunition, and for turning turrets, barbette platforms, etc.
(h) All ventilating engines and gear, except the motors of electrically driven fans.
(i) Capstan engines, shafting, spindle of capstan, and windlass and steam-steering engines and gear as far as the rudder, with spare gear for the same.
(j) Hydraulic jacks, with the exception of those in the gunner's charge.
(k) Steam winches and gear for hoisting torpedo and other boats.
(l) All water-tight doors and sluice valves, including horizontal trap and flap doors as well as vertical hinged doors.
(m) Steam fire-engines and all pipes, cocks, and valves in connection with the fire-main.
(n) Instruments and gear (not electrical) for telegraphing signals in connection with the machinery.
(o) Whitehead torpedoes and submerged discharge tubes and gear.*
(p) All air-compressing machinery, reservoirs, separators, and charging-columns.
(q) Electric-light engines and dynamos.*
(r) All flooding gear, including pipes, cocks, valves, and other fittings.

(s) All such other parts of the hull, double-bottom, and exposed iron surfaces, as may be in his charge.

(t) Ice-making machines.

* These items have, by a recent order of the Admiralty, been wholly or partially transferred to the gunnery and torpedo lieutenants. These officers have, however, to be trained as mechanical engineers before taking over their new duties. It does not therefore appear probable that these duties will pass out of the hands of the engineer officers at an early date.

After toiling through this formidable list of duties, the non-naval man may naturally ask what is left for the rest of the officers and men to do? Well, not much of any importance—chiefly keeping the ship, boats, guns, anchors and cables, masts (if there be any), and the outside of the hull, turrets, and superstructure, clean and well painted. The rest of the deck work consists mostly of drills of various sorts, firing at a target once or twice a quarter, a good deal of soldiering when in harbour, and care of and stowage of provision. And to do this work be it remembered there are from three to four times as many of men as are allotted to the engineer. The basis of calculation for the engineer department is the number required to steam the ship at a little more than one-half the full-power of the engines, developed during her official trials. The utter inadequacy of this complement is seen whenever a ship has to do her quarterly trial. It is then found that to develop only four-fifths of her natural-draught power for twenty-four hours only, it is necessary either to put the stokers in two watches or to obtain assistance from deck. But in time of war, no captain would think of cruising about with any of his boilers out of use; he would take care that all his boilers were alight, and that he could have full power on his engines whenever he demanded it—certainly within fifteen or twenty minutes. It is also certain that at such a time the captain would be very unwilling to spare any men from deck to assist in the work below. In fact, according to the "Watch and Quarter Bill"—which shows the station of every man and officer in action, one-third of the engineer staff should be at their quarters on deck, not in the engine room at all. Well, we say, what is the use of keeping a ship in time of peace, on a complement which will not be able to fight her in time of war? There is not a ship in the British navy to-day which has an engineer complement sufficient to maintain her in a state of efficiency. If that be the case in time of peace, what will be the condition of the navy in time of war? It is no use blinking these facts. It will be too late to call on Lord Selborne, or Mr. Arnold-Forster, then, to give the ships adequate engineer staffs. They will not be able to get either the officers or the men who will be needed. If they are not in store they cannot be purchased outside. The requisite engineers, artificers, and stokers, must be obtained now; must be trained and drilled, now. Suppose that Britain should find herself confronted by another European power to-morrow, or next week, or next month; do the readers of this journal imagine that the Admiralty could immediately commission all the ships she possesses? If so, let me ask how it comes about that a ship is waiting at Pembroke dockyard to-day* for a navigating party to bring her round to Portsmouth to complete her for sea? Remember, there are dozens of ships in the various fleet reserves, ready in all respects for sea except that one item—of so little importance (?)—that there are no men of the engineer staff to man them. If the men to man these ships were in depot, there would be no difficulty in making up a navigating party of engineer ratings to bring the Drake round from Pembroke. So it comes to this:—that not only are there not a sufficient number of engineer officers and men in the ships in commission, but there are not men enough, (even on the Admiralty basis of complement,) to put into the ships in the fleet reserves; and as ships without men are valueless, it is no use going to the taxpayer with the pitiful cry that Britain ought to have more ships, because France or Russia is building within ten per cent. as many ships as she is. She must first of all be sure that the ships she has are fully efficient in every respect, and that at the outbreak of war she is prepared to the last stoker recruit; and after that it may be reasonable to talk of increasing the number of ships.

There is little doubt that the Admiralty are under the optimistic conviction that if war broke out, they would have very little difficulty in filling up the ranks of the engineer branch from outside sources. If it be a question of numbers only, without any reference to fitness as regards qualifications, Yes. We who are old enough can remember how the gunboats were officered and manned in the engineer department for the Baltic and the Crimea. How the Admiralty had to go hat in hand, with a recruiting officer in full uniform with a big brass band playing and flags flying, to all the factories and gas-works throughout the country, picking up all and sundry who could aspire to claim acquaintance with a furnace, a boiler, or an engine. What a tag-rag and bob-tail lot they were, and what infinite sport they afforded to *pukkah* engineers of the navy, when these were not too greatly exasperated with their fathomless ignorance to be able to appreciate the humour of the situation. These men were brought into the navy on pay of 12s. 6d. per day, and put under the orders of naval engineers receiving only 7s. 6d. per day, although to have obtained that rate of pay meant at least six years' service, or its equivalent. I

* 20th Feb., 1902.

believe also that these men received a bonus or sum of money to provide their outfit. The traditions of the Baltic and of the Crimea doubtless cling about the Admiralty still—at least, it would appear so, if one may judge from the strictures of a gallant admiral who took exception to the figures which I quoted in some articles I wrote about the end of 1900, in connection with this subject. Admiral Freemantle said: "If Mr. Johnson, or those he quotes, mean to imply that we have not enough stokers to man all the ships we could possibly commission, I reply that they have no knowledge as to what these ships are, or how far we are prepared to man those required." Here the admiral hints that 'we' (he was not an Admiralty official at that time [nor is he now,] but he lets us know that he is in the confidence of the board,) have got a trump card up "our" sleeve which is beyond the ken of all outside the charmed circle. But as most of us know, quite as well as any admiral can know, the sources which remain to be tapped, I think we are quite as well able to judge of the results of those sources when tapped. As to not knowing what ships are likely to be required if war should break out, I think the admiral would find no difficulty in getting that out of the "man-in-the-street." Every ship we possess and as many more as we can lay our hands upon! Now, that the Admiralty would succeed in getting the *number* of men they wanted in time of war can hardly be doubted; but of the *quality* of the men raised and *their cost to the country*—these are among Admiral Freemantle's trump cards, up the Admiralty sleeve.

In concluding this part of my subject, I will cite some instances which I hope will prove conclusively to the minds of my readers that engineer complements for the ships of the navy when filled up according to Admiralty schedule are not sufficient for the independent working of the ships. Take the ships which accompanied the Ophir in her tour with the Prince and Princess of Wales:—If Admiralty complements are sufficient, why was more than forty per cent. of engineer staff added to their crews, before they started on the voyage? And why, when a newly commissioned ship proceeds on her commissioning trial at natural-draught power, is it found to be necessary to send a steaming party to assist her own complement, during that trial? Is it not the consciousness on the part of the Admiralty officials, that with the Admiralty complement alone the required results could never be got out of the engines and boilers?

Inadequate authority. I come now to the third cause of imperfect efficiency, which environs the engineering branch of the naval service, viz., the want of military control and command in, at least, their own department by the engineer officers. I say, in at least their own department, although I see no reason why they should be thus "cabin'd, cribb'd, confin'd" in the exercise of this indispensable adjunct of efficient handling of large bodies of men on board ship; being of the same opinion as the late Admiral Charles Fellowes, that the engineer officer should have the authority necessary to enable him to give an order to any man in the ship, without the danger of that man daring to disobey, or even to question the order.

At the present time, as during the sixty years which have elapsed since steam was first introduced into the navy, the engineer officer is in the civil branch of the service. Being a civilian, the naval engineer has no power to reward zeal, energy, or competence, nor to punish idleness, neglect of duty, or insubordination. The good or the bad man must in either case be sent upon deck to be dealt with by the executive officer; and the very fact that his own immediate officer has not the power to mete out punishment nor reward is more firmly imprinted on the subordinate's mind every time he is sent up to the executive officer. This condition of affairs cannot be conducive to the development of discipline among the rank and file of the engineering department, however much the officers of the military branch may seek to minimise and depreciate its real power in order that the engineers may not invade the sacred precincts of the military cordon. The following extracts from the writings or speeches of executive officers on the subject will show, that while some of them are contemptuously agreeable, others are bitterly antagonistic; and but a solitary individual is sympathetically in favour of the proposal that the engineers should be given military or executive rank and command, strictly limited however, to their own department:—

"But their claim to 'executive rank' involves a far higher pretension than this. . . . . It is a demand for power to 'punish their own men.' This matter is discussed as if anybody is competent to punish." *(Capt. A. C. C.)*

"Already the engineers are calling out for executive rank and titles. This is quite natural as they see that they do most of the work, and that the maintenance of our modern ships in a state of fighting efficiency is the business of mechanics and not of sailors. I do not think the engineers will get their wish just at present, but this agitation is a sign of the times which must not be ignored, and it is not difficult to see that unless our executive—both officers and men—receive a more mechanical training than they do at present, they will be gradually ousted by the engineers and artificers." *(Rear-Admiral L. C. P. F.)*

"Why should not these engineers have executive rank? It is merely taking command of a certain number of their men, which at present they do as much as any so-called executive. Then why not call them executives as, of course, they play a very important part in the ship? If it pleases them to be called executives, and we get better work out of them in consequence of calling them so, and they achieve, as they think, a better position, it will hurt nobody and will content them." *(Admiral Sir J. O. H.)*

"And now let me touch on the vexed question of the position of the engineers, and suggest that the time has arrived to accord them executive rank. Their duties are purely executive and should be recognized as such, and the recognition cannot, in my opinion, clash in any single instance with the other executives as their sphere of duty is so clearly defined, and an engineer would as little expect to be put in charge of the navigating or officer of the watch's duty as would these officers of being put in charge of the engines. Then as regards power of punishment for delinquencies committed by stokers in the engine and boiler-rooms, why should not chief engineers have the same power of minor punishment allowed them as a commander, second-in-command, a first lieutenant, etc.? If this were permitted it would tend largely to improve the chief engineer's position and strengthen his authority." *(Ibid.)*

It is apparent even in the last and most favourable of these quotations that the concession there made is the result of unwilling conviction. Nothing is so bitter to human nature as to have, or to fear to have, to relinquish the post of honour in favour of a new claimant, or even to share part of the honour with him. And this is what the executive branch of the navy has had sitting on its chest like a night-mare for the last forty years. Yet, had they looked the question fair and square in the face, they would have seen that there was little cause for panic or alarm. What the engineer officers are asking for is the power and authority to deal with their own officers and men, in the matter of rewards and punishments, without the interference of any executive officer, other than the officer in command. As to succeeding to command, that might be advisable under certain conditions, under peculiar circumstances, when it would be to the direct advantage of the service that the command should devolve upon the engineer. It is not the purpose of this paper, however, to enlarge upon this somewhat remote phase of the subject, but rather to show cause why the engineer must be invested with executive rank and authority if, in the next naval war in which the country is involved, she is to come out crowned with victory. Omitting the supreme command, the handling and fighting of the ship in actual war, and deducting from the remaining duties which have to be performed those devolving upon the engineer as detailed on page 238 preceding, we see that the most important of the residual duties consists in handling the guns and firing the torpedoes, and that even these duties cannot be efficiently discharged except in absolute dependence upon the engineer. So that, as Admiral Fitzgerald wrote in his very able article entitled "Training of Seamen in the Royal Navy," (*National Review,* June, 1900) :—

"Almost everything is now done on board a man-of-war by machinery; manual labour is nothing; and the tendency is to increase the machinery, and to do nothing by hand which can be done by steam, electricity, or hydraulics. Not only the motive power, but the fighting power of our ships is all machinery. In the old days 'Jack' could repair all ordinary damages himself. . . . . Now he has practically nothing to do with the up-keep of the ship, ... and the ship can only be kept as a going concern by the engineers, E. R. A.'s, etc., etc. . . . . These men and these alone can maintain for one week, or for one day, the fighting efficiency of a modern battleship or cruiser, or even a torpedo-boat destroyer. . . . ."

Admiral Fitzgerald recognizes to the full the importance of the engineer, and the enormous responsibilities devolving upon him. Great responsibilities demand commensurate power and authority for their efficient discharge. Can it be considered that adequate rank and authority have been bestowed upon the engineer, when it is possible that the senior fleet engineer on the list may, under certain conditions, be subordinate to a young sub-lieutenant, or even to a warrant officer? Instances have occurred in the British fleet reserves where the orders of the fleet engineer have been set aside by the warrant officer in command. On appeal to the captain of the naval depot, the engineer could obtain no redress because, said the captain, the warrant officer represents me. What an undignified—not to say degraded—position for an officer ostensibly holding the rank of commander in the navy, and that of lieutenant-colonel in the army, to be placed in! The very mention of such a possibility should be sufficient to condemn the regulations which render it possible; and still more, the administration responsible for the retention of such antiquated and old-time regulations. In peace, such an anomalous position, however irksome and distateful to the engineer, may not result in any considerable amount of harm to the service. But the *raison d'etre* of the navy is as a fighting machine; and to be in all respects prepared for war, it is necessary that the administration and discipline of the navy shall be upon the war basis in time of peace, so that it shall not be necessary on the declaration of war to make any changes in the system under which it has hitherto been administered. Some fifteen or twenty years ago, the men under the chief engineer's orders belonged to the executive of military branch of the service, the engineer then, as now, being in the civil branch. It was about this time that considerable prominence was given to the engineers' claim for executive rank and titles, both in parliament and in the press, owing to the fact that the committee of 1875, of which Admiral Sir Astley Cooper Key was president, had reported in 1877 in favour of giving executive rank to the engineer; and the friends of the engineers thought that when advocated by an Admiralty committee, consisting of three officers of the executive branch and only two engineers, the Admiralty would have no hesitation in adopting the report. The Admiralty, however, refused to adopt that part of the report, and have done so to this day. Then it was that the anomaly of a civil officer being in charge of men of the executive branch became such a powerful lever in the hands of the press and of members of Parliament in advocating this reform; and at last in self defense, and to destroy this valuable weapon in the hands of persistent pleaders that justice might be done to the engineers, the Admiralty entirely revised the lists of the executive and civil branches of the navy. The artificers and stokers were removed from the executive, and placed on the civil list. Sooner than do justice to the engineers they preferred to do an injustice to a large and loyal body of men against whom they had no charge, whom they had always found of the greatest service when called upon to assist the deck hands, and who, they were bound to admit, were among the must valuable men in the service.

It is often urged by executive officers that executive rank is not necessary for the engineer, as he already controls his men efficiently. This is begging the question. The engineer controls his men simply by force of circumstances; but he desires that he should be put in the more logical position of being officially endowed with the authority and power which under existing conditions he is obliged to grasp.

Whilst this question of the naval engineer is one of interest to all civilian engineers, it should be of even greater importance to the taxpayer, who looks upon the navy as the national policy of insurance. The taxpayer may rest assured, however, that the navy will not be in a fully efficient condition until these three things are established within its *régime*, viz:—

(a) The immediate introduction of a thoroughly efficient system of training in sea-going ships of all engineer ranks and ratings, before allotment to commissioned ships as part-complement.

(b) An increase in the engineer staff in all ships, to such an extent that with the staff in three watches, it shall be able to steam the ship at not less than the natural-draught power for as long as her coal lasts, and at the same time be able to manipulate every auxiliary engine or machine, in action, without any assistance from the deck.

(c) The investment of the engineers with executive rank power, and authority "corresponding to the greatness of their present trust, and to the weight of their enlarged responsibilities."*

* Sir E. J. Reed's letters to the "Times," 1877.

THE FALSE WITNESS OF THE TEST BAR.

By Robert Buchanan.

The possible, but generally neglected, economies of the foundry afford one of the most promising fields for improvement of practice and reduction of costs in engineering manufactures. The Engineering Magazine will shortly announce a comprehensive series of papers, now in preparation, dealing practically with advanced and economical foundry management. Meantime a strong interest attaches to Mr. Buchanan's article questioning the soundness of the usually accepted standard for judging castings.—The Editors.

THE production of castings, the acceptance or rejection of which depends on tests—tensile or transverse, or both of these—considerably increases the responsibility of the people engaged in such work. It may be granted at once that the necessity of having iron of a quality which will give satisfactory tests, naturally results in a closer attention being given to the mixing of irons than would be the case were the castings, or bars representing them, not subject to test. In spite of the fact that cast iron equals in importance any other metal whatsoever, it has suffered a most serious neglect, few efforts being made towards a due understanding of it. This neglect may arise in some degree from the infinite number of modifications which the elements—iron, silicon, phosphorus, manganese, sulphur and carbon—may cause, and each modification still be classed as cast iron. If cast iron had a more definite limitation of composition, such as steel has, and if it were not so easily melted and cast, then we would have been forced to acquire a more precise knowledge concerning it.

Notwithstanding the facility with which cast iron may be melted and cast, the infinite variety of services which it renders us makes it incumbent upon us to see that full use is made of the best qualities of the metal, and that under the seeming simplicity of some of the operations employed, there is not room for serious error.

The test bar has always, I believe, been considered as affording a true index of the quality of the casting—that is, of course, when the test bar is cast with similar metal, and from the same melting of metal as the casting, though not necessarily both run at the same moment of time. The day was, and not so long ago either, when it was thought good, smart work to proffer, for testing purposes, test bars not of the same mixture or melting of iron as was used in the castings. The desire was to have satisfactory tests, such as it was feared could not be obtained by ordinary cupola melting. Possibly to keep down the cost of the mixture charged into the cupola was one of the reasons for this doubtful procedure, but I believe the predominating reason was a disbelief in the foundryman's own ability to produce, by cupola melting, an iron suited to give the necessary tests. Another affecting cause may have been the fact that cast irons giving the highest tests are not the most easily machined. By giving castings easy to machine, and by supplying test bars ample for the tests required, a little lapse of memory regarding the doubtful origin of the test bars was all that was necessary to please the machinists and inspector alike. Such devices are, however, the refuge of none but the incompetent and unfit, and are such as have made the name of test bar the occasion for the sceptical smile, and, when good tests are made, the sceptical question: "Is it a genuine bar?"

Leaving such chicanery to the contempt which is its due reward, let us address ourselves to a consideration of the questions: Do cast-iron test bars give a true indication of the quality of the castings they represent, and if not, to what extent do they mislead?

By mixing irons of known composition, and knowing fairly well as we now do the changes which the metal undergoes during the process of melting, we can tell, within a small margin of error, the chemical composition of the metal as it stands fluid in the ladle. With iron in the molten condition one's power to alter or change it has practically ceased, except in two directions—one, the casting temperature, the other the rate of cooling. That these are of the utmost importance as affecting the quality of test bar and casting I hope to shew.

Grey pig iron has a total carbon usually over 3 and under 4 per cent., and of this, the combined carbon ranges from practically *nil* to 0.50 per cent., the remainder being graphitic carbon. Such is the condition of the carbon in iron when in the solid condition, but in molten iron the carbon is believed to be wholly in the combined form, and we may by slow cooling cause the separation out of the greater part of the carbon as graphitic carbon, or by quick cooling retain a large percentage of the carbon in the combined form.

I have cast metal into a casting which cooled in a few minutes, and kept some of the same metal so as to cool through a period of 120 hours. The combined carbon dropped from 0.508 per cent. in the quickly cooled metal to 0.020 per cent. in the slowly cooled metal, with proportionate increase in the graphitic carbon. Casting in chills is an example of the effect of quick cooling upon the retention of the carbon in the combined form. These instances show the two extremes in either direction, but varying effects are produced by intermediate rates of cooling, although acting upon a metal of uniform initial quality. The carbon itself is inert as regards taking the graphitic form, but is influenced in that direction by the silicon. The "rate of cooling" is another way of expressing the period of time, be it less or more, through which the silicon is allowed to act upon the carbon by causing it to separate out as graphite, before the temperature of the metal drops too low for such action to be effective.

To some degree silicon may be neutralised by sulphur, but in grey cast iron such a neutralising can only be very partial. Sulphur undoubtedly has the power of causing the combined carbon to retain that form and so cause hardness, but any hardening of the iron so caused is exceeded by the direct hardening of the sulphur itself. If castings are heavy and so take a considerable time to cool, the silicon under such conditions will gradually reduce the percentage of combined carbon, notwithstanding the presence of sulphur. If combined carbon be present in very minute quantities, then such castings are soft and weak from excess of graphitic carbon. Greatest general strength is obtained when combined carbon is present from 0.5 to 0.6 per cent., other constituents being normal. Seeing that a fairly definite percentage of combined carbon is necessary in the best and strongest irons we can produce, it follows that we must vary the percentages of silicon as the castings are light or heavy. Light castings cool quickly and so the silicon is kept high. In a heavy casting, cooling through as many hours, perhaps, as the other does minutes, the silicon is kept low. For greatest general strength each should finish cooling with somewhat similar percentages of combined carbon.

The mixing and casting of iron is successful only in so far as the product conforms to the chemical and physical laws governing the constitution of a mixture suited for a particular purpose. Bearing these things in mind we may now consider whether test bars give a true indication of the quality of the casting they represent, and if not, to what extent they mislead.

The following observations refer of course to test bars cast from similar metal to that which goes into the castings. The test bars may be cast separately or may be run from the casting itself, in which latter case the test bar cools along with the casting. When test bars are run separately they are almost invariably cast hotter than the castings they are to represent, and this has a material effect on the strength of the test bar. This is in favour of the test bar as compared with the casting, which is usually cast dull. The reason foundrymen cast heavy castings with iron below the hottest and most fluid condition, is because they desire to avoid the "searching" action of hot iron by which the carbonaceous material of the mould would be burned out, and the iron still have enough fluidity left to take the place of the burnt-out carbon. The result would be a rough casting. One other reason is, a widespread belief that hot iron readily causes "scabbing" of the mould, and another reason is, that where "feeding" a casting is required, casting "dull" shortens the period required for feeding. Foundrymen get very skilful in judging the temperature and fluidity of the iron so as to fill the mould perfectly and yet avoid the dangers mentioned.

In the following test a casting weighing 36 hundred weight was run, and attached to it and run by the metal when the mould was almost full, was a test bar "A"—41¾ inches by 2 inches by 1 inch. The bar was horizontal when run and was situated about 12 inches from the large casting. A bar "B" of similar size was moulded separately. The iron for bar "B" was taken from the large ladle holding over 2 tons of iron to run the large casting. It is desirable to take the iron for test bars from the metal in bulk; taking it direct from the cupola is apt to cause error, as pig iron alone or scrap iron alone may be caught in the small ladle. Getting iron from the large ladle ensures that what goes into the test bars is exactly similar to that which goes into the casting. The test bars separately cast were cast "hot," the casting and test bar attached cast at the temperature and fluidity of metal customary in such cases. I cannot say exactly what the difference of temperature between the two irons would be, but have to fall back on the shop terms, "hot' in one case and "dull" in the other.

(1) TRANSVERSE TEST—36 INCH CENTRES.

	Deflection.	Breaking stress.
Bar A, 2 inches by 1 inch, run from and cooled with large casting	3/8 inch	26½ cwt.
" B, 2 inches by 1 inch, cast separately	7/16 inch	31 "

Difference of breaking stress = 16.98 per cent.

Bar A had combined carbon 0.490 per cent., but bar B had combined carbon 0.450 per cent., combined carbon in the casting at heaviest part, a trace only. Probably bar A would have had less combined carbon if the "git" which connected it to the casting had not been broken while it was still hot. The bar thus cooled more rapidly than it would have done had the connection remained unbroken.

(2) TRANSVERSE TEST—36 INCH CENTRES.

	Deflection.	Breaking stress.
Bar C, 2 inches by 1 inch, run from and cooled with casting	......	25½ cwt.
" D, 2 inches by 1 inch, cast separately	......	28½ "

Difference of breaking stress = 11.76 per cent.
Combined carbon in C = 0.427 per cent.
" " " D = 0.415 " " or a difference of 0.012 per cent. less in the separately cast bar.

As shewing the differences which may exist betwixt a test bar separately cast and the casting it was meant to represent the following was noted:

	Combined Carbon.
Test bar separately cast	0.499 per cent.
Casting bored at heaviest part	0.101 " "
Difference	0.398 " "

In the casting the low combined carbon means a high graphitic carbon, and high graphitic carbon, as I have said, means weakness.

To make trial in another direction, it appeared that test bars cast from metal mixed to give soft grey castings with a thickness ⅛ inch or little over, would give too low results, the castings being really stronger than the test bar. In order that the light castings may be grey, silicon should be present from 2.50 to 2.60 per cent. Such a percentage will give a graphitic, open-structured area in the centre of a bar 2 inches by 1 inch, and so will weaken it. Test bars to indicate the quality of light castings, however, are not much used, but were they used oftener, some uncomfortable results would follow. Iron giving strong test bars would make light castings hard; iron which makes light castings soft would make weak test bars.

Iron of a quality to run light grey castings was caught in a ladle, and from it were cast two bars 41¾ inches by 2 inches by ¼ inch; then two bars of a similar length, 2 inches by 1 inch. These were cast with hot metal as it came from the cupola. When these were cast the remaining iron was kept in the ladle until it was judged to have just sufficient fluidity to run the two remaining bars, also 2 inches by 1 inch. The latter bars were so treated as to give an indication of the effect of casting with iron at a temperature lower than that of the iron when first obtained. Each of the bars mentioned was moulded in green sand and cast horizontally, being run from one end, and was allowed to cool in the sand.

(3) TRANSVERSE TEST—36 INCH CENTRES.

	Deflection.	Breaking stress.
Bar E, 2 inches by 1 inch (cast hot)		24 cwt.
" F, 2 inches by 1 inch (" ")	5/16 inch at stress of 20 cwt.	
	3/8 " " " " 21 cwt.	
	3/8 " " " " 23 cwt.	
	3/8 " full " " 24 cwt.	24¼ cwt.

NOTE.—Fractures had open structure at centre. Small bright crystals all over. Bored very soft.

	Deflection.	Breaking stress.
Bar G, 2 inches by 1 inch (cast dull)	¼ inch at stress of 20 cwt.	21½ cwt.
" H, 2 inches by 1 inch (" ")	¼ " " " " " "	20 cwt.

NOTE.—Bar H was a little under size and broke immediately after reading of deflection was taken. Fractures of both bars were less brightly crystalline than the bars cast hot, and had not the open structure at middle of bar. Bored very soft.

	Deflection.	Breaking stress.
Two Bars I, 2 inches by ¼ inch (cast hot)	5/16 inch at stress of 14 cwt.	15 cwt.

NOTE.—Area of the two bars = 1 square inch. This equals a breaking stress of 30 cwt. for a bar 2 inches by 1 inch. The two bars were put in the testing machine side by side, and the deflection would probably have been greater had there not been considerable torsion due to the thinness of the bars. Both bars broke at the one instant, one breaking 1½ inches from centre of pull and the other 2 inches from the centre, but on the other side of centre line. Fracture finely granular and lighter in colour than either of the other bars. Avery's transverse testing machine was used.

COMPARISON OF BREAKING STRENGTHS.

Bar F, 2 inches by 1 inch (cast hot) is stronger than bar G (cast dull) by	12.79 per cent.
Two Bars I, 2 inches by ¼ inch (cast hot) together are, area for area, stronger than bar F by	23.71 per cent.
Two Bars I (cast hot) are, area for area, stronger than bar G by	39.53 per cent.

These are astonishing differences to obtain from one ladle of iron, and are wholly due to different casting temperatures and rates of cooling. The thin bars bear somewhat the same relation to the bars 2 inches by 1 inch, which these bars bear to a heavy casting. Test bars are cast hot and cool quickly; the castings are run at a much lower temperature and cool slowly. The analogy needs no elaboration.

Tensile tests of two bars connected with and run from a casting but at differing distances from it, exemplify the effects of quick and slow cooling upon the strength of the test bars. I do not wish it to be concluded that such great differences always occur; but that the rate of cooling makes a great difference between test bar and casting in most instances, I have no doubt whatever. A large casting was run, and connected with and near to the heaviest part of the casting there was a bar designed for a tensile test. Another similar test bar was run from the casting but was further away, and so was less subject to the heat-retaining effect of the casting.

TENSILE TEST.

	Breaking Stress per square inch.
(1) Test Bar, furthest from casting	14 tons.
(2) " " nearest casting	5 tons.

The analyses of the two bars were practically identical except as regards the carbon.

	Combined Carbon.	Graphc. Carbon.	Total Carbon.
(1)	1.129 per cent.	2.356	3.485
(2)	0.671 " "	2.836	3.507

How are these great differences to be accounted for and to what are they due? I believe they are caused partly, in most cases, by the rate of cooling reducing the combined carbon to a point under that which gives greatest general strength, and in the case of heavy castings the combined carbon may almost wholly disappear. There is a double effect in the latter case, the combined carbon, which should add strength to the whole, appears as graphitic carbon, dividing the molecules of iron and so weakening the cohesion of the whole mass. The main cause of the great differences noted must, however, be sought for elsewhere, and is probably molecular disturbance, the result of casting at a comparatively low temperature and reduced fluidity. For best results then, it is necessary to cast hot, so that in the casting the molecules of iron, and the elements combined with the iron, may arrange themselves and so continue, undisturbed by any mechanical movement such as pouring.

In every test which I have made, the bar cast separate is strongest; the bar cast on, but furthest from, the casting, is less strong; and the bar nearest the casting is weakest. To which test bar is the casting most nearly related? Certainly to the weak bar. I am afraid that what has weighed most with founders in the past is less the making of strong castings than the production of satisfactory test bars.

In the United States recently, a committee composed of noted foundrymen, after many tests and much labour of a painstaking character, reported to the American Foundrymen's Association, making certain recommendations regarding the best forms and sizes of test bars, mode of casting, and how the tests should be conducted.

The tests are to be made upon bars cast separately. That the results will be misleading as to the character and quality of the castings they are supposed to represent, I have no doubt whatever. They may be true of a casting of similar weight and section—that is, of another test bar; they will not be true of a casting perhaps five hundred times the weight of the test bar, almost certainly cast at a lower temperature, and certainly cooling through a longer period of time.

If the ordinary tests are unreliable what can we use in their place?

There should be greater use made of the "test-to-destruction" of a certain percentage of the castings indiscriminately chosen from the day's melt, as is done with car wheels for American railroads. Where such a test is not possible or would be too costly, then test bars ought to be cast on the casting itself and not simply run from it. Such test bars should be cast of a size to allow for machining off and still be standard sizes as ordinarily used.

By these means a truer indication of the character and qualities of the casting would be obtained, and substitution of false test bars would be rendered well-nigh impossible. Such a system of testing would have the effect of a revolution, and by the demand for a high-class material there would be forced upon foundrymen generally the absolute necessity on their part of a better knowledge of the metal with which they work.

THE FACTORY OFFICE.

ITS RELATION TO THE STORES DEPARTMENT AND TO THE SHOPS.

By Kenneth Falconer.

The fundamental conception underlying Mr. Falconer's articles is that the factory office, completely equipped and properly managed, should itself be a productive department, with profit-bringing functions extending from the time quotations are obtained for raw material until the finished product is shipped and bills sent to the customer.

His papers, which will continue throughout two succeeding issues of the Magazine, are effective adjuncts to Mr. Carpenter's most interesting current series. They exhibit the possibilities of money-saving organisation in the office, as Mr. Carpenter's show the results of money-making management in the shops.—THE EDITORS.

A STUDY of the relation a factory office should bear to the other departments of a manufacturing business will perhaps result in greater benefit if the nature of factory accounting and the object of a factory office as distinguished from cost accounting and a cost department are first stated.

Factory accounting includes all, but is a much wider field than that which may be covered by cost accounting. The ultimate object of both is, of course, cost reduction, but cost accounting seeks to enable the management to reduce costs, and is largely confined to the productive departments, while, in addition to acting as a thorough and efficient cost department, the factory office should itself be a strong factor towards cost reduction, by exercising a close supervision and a partial control over all the departments except the selling and the financial. A cost department is a clerical recording instrument—a factory office an executive department; cost accounting is a passive influence—factory accounting an active force. An effective cost system may very properly be operated as a part of the general office work, but the best results of a system of factory accounting can be obtained only when it is under the sole control of a department entirely separate and distinct in itself, whose work alone it is.

Even where the accounting department of a factory is entirely distinct from the commercial office, its scope and usefulness is very often limited to clerical work, and extends only from the time orders for certain specified work or the manufacture of certain articles are put in hand, until completion or delivery to stock or shipping room. In other cases, in addition to clerical work and records, the factory office exercises during this period a greater or lesser control over the various works or manufactures as regards their claims for priority, or the relative urgency of their completion. In both cases it is assumed that during the progress of any work or manufacture any information regarding it should be instantly available upon application to the factory office, and on completion of orders their costs should be promptly made up and forwarded to the head office.

While these comprise a very important part of the proper functions of a factory office, they are yet only a part; and, no matter how completely and accurately done, the factory office whose usefulness is limited to these bounds is not being operated to its full capacity or at the highest degree of efficiency possible. Its information and data should cover all details, both direct and indirect, which in any way affect any department of the business, excepting only the selling organization and financial management. Its scope and authority, instead of being limited to the actual period of manufacture, should extend from the time a quotation is first sought with a view to estimating for certain work or for the manufacture of certain goods, until the work has been completed, or the finished article has left the possession of the company, whether it was made for an individual customer or was carried in stock for an indefinite length of time. Its records and results, instead of being confined to productive operations, should equally cover all material, equipment, maintenance, and operating accounts, and these to the utmost detail.

To operate a factory office on these lines would necessitate an efficient and well organized staff, though not necessarily a large one, and a thorough and complete equipment of modern filing devices and card indexes. Consideration of the effects in other departments will show that the increased expense would be more apparent than real; practically all the clerical work usually done in stores, shops, stock, or shipping room would be done in the factory office, thus leaving the heads of the other departments entirely free to attend to matters more directly concerning them, and enabling them to dispense with any purely clerical help they may have employed. The factory office being especially equipped for work of this nature its staff could handle it to greater advantage than the employees of any department where it is necessarily subordinate to work of another kind, and consequently to some extent, at least, regarded as a side issue.

All data of prices and quotations, all information regarding progress, location, and cost of work, all records of part completions and balance unfinished, of both manufacturing and shipping orders, being in the one office, it would not be necessary when complete information regarding the status of an order was required to make inquiries of any other department. It must be remembered it is not a question of obtaining full information regarding purchases or other transactions, but rather of the intelligent and systematic recording of such details in such manner that they may be most easily obtainable when required. The information itself reaches the company by various channels in the natural course of business, but its value is often lost owing to neglect of recording it. The additional expense necessary to keep it in easily accessible shape is very little, provided the department expected to do so is properly equipped for the purpose, and that the employee whose duty it is has free access to all sources of information.

This question of equipping and maintaining a factory office is the stumbling block that keeps so many manufacturers from enjoying the advantages that may be obtained by a thorough system of factory accounting. If those in control could see that the added expense would to some extent, at least, result in decreasing the operating expenses of other departments, if they would realize that the factory office is nothing more or less than a machine tool, turning out certain product day by day, and month by month—that in direct proportion to its efficiency and the promptness with which its results are obtained, is the value of the product—then they would realize that any facilities tending to increase the output or lessen the time required to do certain work are an economy as surely as in the case of a machine tool manufacturing material product. The difficulty of inducing managements to take this view seems to lie in the fact that the material output of the shops has a commercial value, while the equally real but less tangible product of the factory office in the nature of information and records has a value which cannot be expressed in figures, quoted on the market or listed as an asset.

Given such a wide field of operations, looked to for accurate data on so many subjects, and expected to provide and tabulate for the management such important and diversified information, it follows that the most efficient organization of a factory office and its operating along lines to secure the best results is a most serious question for the management of an industrial concern. More even than in other departments its cost is a less important question than its efficiency. Not that I would imply that it need be a costly depart-

Section	Index	Sub-Index
Metals	Steel	Tubing

No. **417** — Date, 17th March, 1902.

To **The R. JAXTON STEEL CO.**

Pittsburg.

Shipping Instructions: M. B. & Q. R. R.

30 lengths 3/8 Steel Tubing @

Form 1. CARD COPY OF STORES PURCHASE ORDER

The original is somewhat longer than the card copy, the additional space being used for the formal order and signature. The space at the extreme top bears, on the original, the firm's printed name and address.

ment, but rather emphasize the fact already stated, that its value depends entirely on its accuracy and the promptness with which its work is executed.

One of the most important functions of a factory office is acting as a bureau of information to the stores department, regarding market prices, current discounts, and the best sources of supply. In many cases circumstances are such that the purchasing can be done to greatest advantage by the store keeper instead of by agency of a distinct purchasing department. In such cases the factory office should be able to supply full information on these subjects. It should have accurate and systematic records of all quotations asked for or received by the company, and in the case of special goods being required, it is the factory office that should procure all information concerning them.

To attain these ends it should be furnished a card copy of all purchase orders issued by the stores, showing the prices and terms upon which the order has been given. By the use of carbon paper these cards may be written simultaneously with the original order. Until receipt of the goods they are kept by the factory office in a card index, arranged according to material. A reference to Form No. 1 shows that provision has been made for the clerk in charge of this index to indicate on the card the class of goods, and also the index and sub-index in which it is to be filed. This information, obtained from the body of the order, is entered on the card after it has reached the factory office. A careful use of different colored guide cards to indicate the section, index, and sub-index will result in full information regarding goods on order being instantly obtainable. In cases where the entire order cannot be written on a card, a copy of it is supplied, and the card reads: "As per copy of order herewith." This copy is then filed away in a guard book, and the page number noted on the card, which is placed in the index. The substance of any subsequent correspondence about an order or any promised date of delivery is noted on these cards, the mail being examined each day for such items. If quotations received are kept in a card index arranged on similar lines and with guide cards of colors to correspond, the factory office will be in a position to keep very close watch on the purchasing of stores. The trays for these indexes should be supplied with locked rods, permitting free examination, but preventing removal of cards by any unauthorized party. All invoices (and slips accompanying goods) received by the stores should be at once sent to the factory office after the quantities have been found correct. The factory office checks off on the card copy of order such lines as are received, remov-

Material	STEEL TUBING																			Unit Lengths
Description	JANUARY					FEBRUARY					MARCH					APRIL				
	1	8	15	22	29	5	12	19	26		5	12	19	26						
X X X 3/8																				
X X 3/8																				
X 3/8																				
X X 5/8																				

Form 2. STORES REPORT CARD

This card is ruled on the assumption weekly reports are desired—in most cases bi-monthly or even monthly would be frequent enough.

ing the card when the order is completed, and from this and the quotation cards checks the price at which the goods are billed. While the stores should of course have a free hand in the issuing of purchase orders, yet the source of supply should be chiefly determined, not by the factory office, but by the information, quotations, and records of past transactions there found.

As regards goods being manufactured in the shops for stores, the factory office should have always on hand all data regarding orders for them, their progress, quantity completed, etc. This can be done to great advantage by a card index, classified and operated on similar lines. On the factory office should be the responsibility of having such goods completed and delivered to stores without delay, also of seeing that goods ordered from suppliers are promptly forwarded. Failing receipt in either case within reasonable time, the factory office should institute inquiries and press for delivery, without waiting until the stores are completely out of the lines in question, and thus entailing vexatious and costly delays. In brief, the only transactions stores department should have with outside parties should be the actual purchasing. Other matters—obtaining quotations, watching the market for the best opportunity to purchase, inquiring concerning goods ordered, &c.—should be attended to by the factory office.

The factory office should keep close watch upon such lines of material, both purchased and manufactured, as are in most constant use. While this will be found of great advantage, care must be taken that the assumption of such duties by the factory office is not taken as lessening in the smallest degree the responsibility of the store keeper to keep proper quantities always on hand. The object is to enable the purchasing of such lines in the most suitable quantities, and at the best seasons, terms, and prices possible; also that a sufficient quantity of both rough and finished parts to provide for any probable demand for standard articles shall be always either on hand or in course of manufacture. This will necessitate close and accurate records regarding parts required for orders to assemble finished articles for stock.

The plan should only be applied to such lines as are known to be in constant and fairly regular demand. For purchased goods of this nature a card ruled as Form 2 is provided. The illustration given assumes that it is desirable to watch closely the quantity on hand, and the purchasing of certain sizes of steel tubing. On January 1st the approximate quantity in stores is filled in opposite each size, and the card filed in the factory office in a card cabinet behind a guide card bearing date January 8th. The cards filed under current date being examined each day, it follows that on January 8th the fact that it is desirable to know the amount on hand of this line of material is automatically brought to attention. The card is sent to the stores department, and the approximate quantity in stores again noted in the column under current date. On its return to the factory office reference to the records of stores on order, together with the information on the card, will show if a purchase is advisable. The card is then filed behind a guide card bearing date January 15th. Simple as it is, this plan systematically followed up is a great assistance to the judicious purchasing of staple articles, and to the carrying on hand of the proper and most advisable quantity.

For parts for standard articles of manufacture a somewhat similar card is provided, filed according to class of goods instead of date. Instead of quantities on hand this is used to keep records of the quantity of parts, both rough and finished, for which orders to manufacture are issued, also of the quantities which will be required to provide for stock orders for assembling the complete article as these may from time to time be put in hand. It will be seen that this is very like a stock-ledger account. Instead of the quantity received and issued it shows on the one hand the quantity the shops have provided, or are providing, and on the other the quantity the shops have drawn, or will require to draw, for assembling orders. The excess one way or another will show either a surplus provision to meet demands or an excess of demands to be met for assembling orders over the provision made therefor by orders for the manufacture of the necessary parts.

A comparison of cards No. 3 and No. 4 will show on the one hand an instance in which the number of parts ordered by the stores department is growing too large, and on the other a case in which a delay in providing the stock room with the finished article requiring this part will surely occur. The figures used are purposely made to show extreme cases in order to point out more plainly the risks that can be averted by the use of this plan, namely, of accumulating too large a stock of parts, or of failing to provide the quantity needed to anticipate demands certain to be made. In the one case stores are loading up with stuff the demand for which is lessening regularly, and of which they had more than enough at stock-taking to meet all demands to date. In the other case the stores department has not attempted to provide for half the quantity required for assembling orders. Should the sales room, knowing orders are issued for a further supply

Article No. 627. Pins for 6″ Door Butts							
Orders For Manufacture		Orders Requiring		Orders For Manufacture		Orders Requiring	
Order No.	Quantity	Order No.	Quantity	Order No	Quantity	Order No.	Quantity
Inventory	300	1024	50				
617	50	1938	30				
927	50	2954	20				
1154	50						

Form 3. Stores Supply Card.

Stores are accumulating far too large a supply in view of the decreasing demand.

Article No. 627 Pins for 6″ Door Butts							
Orders For Manufacture		Orders Requiring		Orders For Manufacture		Orders Requiring	
Order No.	Quantity	Order No.	Quantity	Order No.	Quantity	Order No.	Quan:
Inventory	200	1024	200				
617	100	1938	100				
927	100	2954	200				
1154	50	3128	200				

Form 4 Stores Supply Card.

Because parts have not been actually withdrawn from stores it is concluded the supply is ample. No provision is made for demands certain to arise and which are perhaps being delayed for some good reason and in the belief that when made stores department will be able to supply them in full, without any delay.

of the finished article, let their stock run pretty low, one or two sales might wipe out the available supply, and a long delay result before further orders from customers could be filled.

To the shops the factory office stands in a dual position. To each it should represent all other shops and departments, in so far as clerical work or records are concerned. To all the shops it should represent all customers for whom work is being done or goods manufactured. It should be able on demand to inform the drawing office, assembling room, or erecting shops how many of the various parts or articles about which they may require information are either in stores, in process of manufacture, or on order for outsiders, as well as the probable date of completion, or receipt of the latter. It should always be the source of communication between the superintendent or any of the shop foremen and a customer. If the shops require details regarding work or manufacture from either the management or a customer, they should be asked for and reach them through the factory office, and should either the management or a customer make inquiries regarding any work in progress they should be addressed to and answered by the factory office.

The harm done to a manufacturing business by unauthorized promises of delivery, which invariably result from allowing customers to make inquiries direct to the foremen of the shops, is in direct proportion to the failure to fulfil such promises. Completion or delivery should never be promised unless such promises are reasonably sure to be kept. Once made, however, they should be rigorously adhered to, even at the cost of having to refuse other work. This policy may result in the loss of some orders, but the ultimate gain when it is recognized the business is being conducted on this principle will more than compensate for any failure to secure orders, or expense, or loss of a profit resulting. This statement is made altogether as an axiom of business policy, without regard to the moral side of the question.

As regards work done or material supplied on equipment, operating, or maintenance accounts—in fact on any internal or working account of the company save only those purely financial in their nature—the factory office should have as complete, accurate, and detailed records as they have regarding the manufacture of any article or execution of any contract for a customer. This result can only be obtained by enforcing an iron-clad rule that no work shall be done, expenditure incurred, or material delivered by any shop or department except upon authority of a written order, which must reach the parties or shops concerned from or through the factory office.

EDITORIAL COMMENT

THERE is a good deal of ignorance regarding the Isthmian Canal yet to be dispelled. Probably it is too much to expect the average citizen to make any intelligent study of the question, or to have any better foundation for his position than hearsay, prejudice, or the dicta of his daily paper. But it is shocking to be told that the president of the National Association of Manufacturers has taken "the position that the people really cared but little whether the Panama or the Nicaragua route should be chosen, so long as some decisive action should be taken by Congress which would advance the matter to the point of actual undertaking of the construction of an interoceanic waterway." It seems incredible, but it is officially announced as his view of the situation—and it is solely because it is official, and by implication has the influence of the Association behind it, that it is worthy of comment.

It matters but little, then, whether we choose a practical or an impracticable scheme, if only we choose quickly. It matters little whether we select a good and serviceable route or a difficult and unserviceable one, if only we "take some decisive action." It matters little whether the interoceanic waterway, if completed, will serve the commerce of the world or be a costly failure, if only we actually begin its construction. Look you, what a fine impatience is here! *Vogue la galère!* Leap before you look! Wrong or right, just go ahead! So shall the wisdom of the fathers be rewritten; but, the blind leading the blind, shall they not both fall into the Nicaraguan ditch?

IT is sometimes curious to observe how the use of a term, originally of reasonable appropriateness, within certain limitations, will become extended far beyond its original usage, and often by default be allowed an altogether meaningless application.

Thus, for example, the term "horse power," originally coined by Watt to enable a public, as yet unfamiliar with any true conception of mechanical energy, to form some idea of the capacity of his engines, is now employed to indicate what are in reality nothing more than certain arbitrary trade sizes. So far as the steam engine is concerned, the horse power, while having little or nothing to do with the power of horses, does mean a definite number of foot-pounds exerted in a given time. Engines, however, generally include the use of steam boilers, and hence the term horse power early became attached to the boiler, and ever since the beginning of steam engineering there has been discussion as to the area of heating surface, grate surface, flue section, etc., etc., corresponding to a horse power, while, strictly speaking, the term horse power in the sense of foot-pounds of energy can only be arbitrarily used at all in connection with a steam boiler.

A boiler is primarily an apparatus for the evaporation of water into steam, and while the steam is intended generally for the production of power in an engine, yet until it is so used, the apparatus in which it is generated cannot be said to have a horse power at all. A boiler should really be described by the weight of water which it is capable of converting into steam of a given pressure, per unit of time, regardless of the use to be made of the steam after it is generated, while the economical performance should be in terms of the fuel used per unit of water evaporated, whether the steam is to be used for power, for heating, or for whatever purpose.

This term horse power is even extended to include commercial sizes of feed-water heaters, superheaters, condensers, and a number of other appliances, all used in connection with the conversion of heat into power in a more or less remote sense. All this is to be deprecated as tending to confusion between seller and purchaser, and some basis for such devices should be made, depending either upon actual dimensions or, preferably, upon the number of heat units transmitted. There is no reason why all such apparatus should not be constructed upon such a scientific basis, as regards dimensions and approximate performance, as will enable the real value to be determined by the test of dimensions, or by trial, beyond any question or controversy.

* * *

Maps are usually fairly well understood, and within reasonable limits nearly every one is able to draw correct conclusions as to distance or direction from the ordinary charts or geographical maps available for general consultation. When large distances are under consideration, however, or when the area under discussion extends beyond ordinary limits, there is sometimes a lack of grasp which permits serious misapprehension, especially in popular articles and discussions.

Thus the usual Mercator projection, in which the world is represented upon the developed surface of a cylinder, while reasonably correct so far as the usual middle latitudes are concerned, gives very distorted ideas about routes and distances when polar regions are under consideration. In such cases it is always safe to consult a globe, as the most reliable source of information, although a good polar map, when available, will be found useful.

Thus, by taking a globe, and stretching a thread from the mouth of the Columbia river to the port of Manila, in the Philippines, it will be seen that the shortest or great-circle route passes through the Aleutian Islands, and close to the Japanese coast, leaving the Hawaiian islands far to the south. The importance of Dutch Harbor, as compared with Honolulu, is thus clearly seen, and the advantages of the northern route, with its short stretches and important commercial connections for a Pacific cable, are apparent. These features are especially interesting in connection with the leading article of the present issue, and an examination of a globe will make the importance of the Alaskan coal deposits much more readily realized.

* * *

The visit of an earnest British economist and student of industry to this country, to prepare for an extended tour of inspection by two considerable parties representing British industrial interests, is significant of an aspect of British character which is too little appreciated by American competitors. Britain is slow to waken, but thorough when aroused. There is now working in British engineering plants a spirit and a movement of reorganization and re-equipment which is splendid in its courage and startling in its activity. The great technical schools at Manchester, Birmingham, and Sheffield are crowded to double their capacity with students—not dilettanti, but working lads, eager even after a day's work in the shops to spend the evening learning the principles of their trade. England is being modernized. Let no overconfidence lead American manufacturers to belittle her future importance as an industrial rival.

REVIEW OF THE BRITISH PRESS

Problems of Electric Railways.

The success of the electric tramway in many parts of the world has led to the active discussion of the possibility of the replacement of steam by electric power for main line railways, and in view of the different conditions involved, the paper of Messrs. Swinburne and Cooper, recently presented before the Institution of Electrical Engineers is opportune.

As a matter of fact most of our experience in electric traction has been derived from the equipment and operation of comparatively short lines, mainly urban, in which the operative conditions are peculiar, and form no correct basis for the discussion of the equipment of main railway lines. The electric railway may and probably will come, but it will not be a sort of glorified tramway, with single, or perhaps double cars running at frequent intervals, or at sight. The problem is a different one, and should be considered on its merits.

One of the characteristic features of the urban line is the extremely varying load, involving the necessity for providing for temporary increase in capacity for certain hours. Besides this the frequent number of stops renders the question of acceleration and retardation a matter of much importance.

Regarded from the commercial side, the great cost of the permanent way and equipment of urban lines, renders the operative cost a smaller proportion of the total than is the case in main lines, and hence the greater electrical cost of rapid operation is still profitable. These questions of speed, acceleration, and retardation are examined in detail in the paper, with diagrams showing their relative importance and influence upon the entire operation of an urban electric railway.

Taking up the question of electrical pressure, and character of system, the advantages of high pressures are emphasized. The usual tramway pressure of 500 volts has the advantage of being safe, but it is more expensive than a higher pressure. So far as the element of danger is concerned, however, it can be provided for. We do not prohibit the use of locomotives because men are sometimes run over; people have learned to understand that and keep out of the way. In similar manner people will learn to keep away from electric wires, and such danger should not militate against the use of economical pressures, such as 2,000 volts. Examining the constant-pressure system used on urban tramways, it is clearly shown that, in some one of its improved forms, preferably the series constant current system, this is most suitable for such service.

Passing to main lines, the problem is seen to be radically different. Both goods and mineral traffic are to be dealt with, as well as passengers, these involving widely different speeds. Facilities for shunting have also to be provided, and sidings would introduce great complications, rendering it probably more economical to operate them by steam, or by accumulator locomotives than to include them in the main-line network.

Considering the financial side of main-line traction, it appears that the capital expenditure on existing British railways is less than one-tenth of that required for the construction of the Central London Railway per mile, so that the capital account becomes of far greater relative importance.

In considering the traffic which passes over a main line, it appears at once that it is very much smaller per mile of route than on urban lines. That is, the main lines are not worked to their full capacity as urban lines are, and cannot create traffic to the same extent. Hence the great capital outlay must be borne by a far less intensified system of operation. A comparison of operative costs shows that there is not a great opportunity for saving in electric operation over steam, although it is probable that some minor economies might be effected.

So far as increase in traffic is concerned, such an increase would probably result on the suburban portions of a main-line system, but it does not follow that there would be a large increase on main lines proper. The success of electric traction on main lines must therefore depend largely on a reduction of running cost. In other words, the question of all-over efficiency of distribution is much more important on main than on urban lines. It is wholly a financial question, and it follows that neglecting any increase in traffic, the reduction in running costs must be enough to pay for the extra capital. It is too often assumed that electric traction on main lines is necessarily advantageous, but such is not the case.

Of course it is imperative, in the first instance, that the traffic should be above a certain figure, otherwise the running costs will be increased rather than diminished.

The paper contains an interesting analysis of the relative suitability of various systems for main line traction, showing the advantages of the constant-current system. Alternating and three-phase currents are both considered unsuitable, being ill-adapted for the varying speeds and controls. Altogether it appears that the main-line problem is not yet ready for serious treatment, but that when it does come up it must be entirely upon its own requirements and conditions, and not as a development of present tramway methods.

Improvements in Passenger Steamers.

In the pressure of competition for passenger traffic on ocean steamers various lines of improvement have been followed, including not only higher speed, but also larger and more convenient rooms, saloons, smoking rooms, libraries, together with handsomer and more artistic decorations. To these have been added improved service, music, elaborate cooking, and all that can be supposed to attract the better paying class of patronage.

In this progress it has become apparent that British steamers have been surpassed by the German and French Atlantic liners, with the result that by far the larger number of passengers now crossing the Atlantic use the French and German lines, and a comparatively small proportion patronize the English boats. It was to investigate the causes of this action that a paper was presented before the North-East Coast Institution of Engineers and Shipbuilders recently by Mr. C. James, and his paper forms very interesting reading.

Mr. James first takes up the historical side of the question, showing how in the earlier steamers the first-class cabins were generally placed aft, the saloon being in the center, with the state rooms next to the ship's sides, and leading directly off the saloon. This plan was objectionable for many reasons, and gave way to the use of short alleyways between the rooms, giving entrance apart from the saloon or corridor. In the larger vessels, constructed with this arrangement the rooms are arranged in blocks of four, the inner rooms depending for light and ventilation upon hipped skylights fitted in the sides of the deck houses and casings. These inner rooms have never been popular, and are poorly lighted and ventilated.

In considering the various methods by which accommodations on passenger steamers may be rendered more comfortable and attractive Mr. James rightly believes that first attention should be given to the state rooms. Frequently too much attention is given to the arrangement of the saloons, smoke room, social halls, library, etc., and excessive expenditure lavished on their furnishings and decorations, it has been advanced that this might with advantage be curtailed, and the money be more usefully and effectively spent on the state rooms, the absurdity of luxuriating in a palatial saloon during the day only to retire to a cramped up, dark and indifferently ventilated state room at night being only too apparent. Besides this, passengers in the throes of *mal-de-mer* have perforce to spend more of their time in their cabins than in the saloons, and high art decorations, though possibly things of beauty, yield but little joy or comfort to the seasick passenger.

As a result of practical experience in steamship equipment Mr. James makes some eminently sensible suggestions. Primarily these depend upon greater liberality of space. A moderate increase in height between decks adds enormously to the comfort of passengers, and the addition of a foot or two to the length renders the berths much more comodious. Larger wardrobes should be fitted than are usually given, and the upholstery should be portable and not covered with velvet or plush, the idea being to remove everything which could add to stiffness or the accumulation of dust.

The Bibby arrangement of "tandem" state rooms is commended, this giving the inner rooms an ell , extending to the side of the ship and providing access to a port, this rendering them more desirable than the outer rooms. State rooms fitted on the sides of the deck houses are also in much demand, and are most comfortable and convenient, especially in hot climates.

Altogether Mr. James believes that the superior attractions of the Continental lines may be met, not by the use of elaborate decorations and extravagant upholstery, but by liberality in the allotment of space, and by the most judicious use of that space for the real comfort and convenience of travellers, and in that view of the situation he will undoubtedly be joined by many travellers who cross the ocean frequently enough to prefer comfort to display.

The Magnetic Properties of Iron.

With the development of electric machinery it has become most necessary to obtain as full information as possible concerning the magnetic and electrical properties of the materials employed in con struction, and among these materials iron and its alloys play very important parts.

For a number of years an important series of researches has been conducted by Professor W. F. Barrett, and Mr. W. Brown, in connection with Mr. R. A. Hadfield, the well known steel manufacturer, and now we have a very interesting account of these investigations in the form of a paper presented before the Institution of Electrical Engineers by Messrs. Barrett and Brown.

In all 110 specimens were tested, these being divided into three classes, containing respectively one, two and three or more other elements alloyed with the iron. The specimens were selected from a large number as complying with the requirements as to uniformity and soundness. The test pieces were rolled into rods of circular cross section, half a centimetre in diameter and 106 centimetres long, and were tested for conductivity and magnetic permeability in the ordinary rolled, or unannealed condition, after which they were very carefully annealed and then thoroughly tested again for conductivity as well as for their various magnetic properties.

In the paper itself the results are given in detail, both in tabular form and in curves, and these must be consulted for complete information. Some of the special conclusions drawn by Professor Barrett, however, may be given here, as indicating the character and value of the work.

So far as conductivity is concerned, it appears that the conductivity of iron is in all cases diminished by alloying it with another metal, even though that metal be itself a better conductor than iron, except perhaps in the case of an alloy of iron and copper, in which the conductivity remained practically unchanged. The production of increased resistance in an alloy appears to have no connection with the conductivity of the constituents of the alloy, certainly it is not due to the greater specific resistance of the added metal.

Among the alloys of commercial value attention is called to the alloy of 25 per cent. of nickel and 5 per cent. of manganese, which has a specific resistance of 97.5 microhms and a comparativelv low temperature coefficient. This is especially applicable for the construction of artificial resistances, and in this respect it resembles the alloy containing 15 per cent. of nickel and 5 per cent. of manganese, already known under the names of rheostene and resista, and used by various makers.

In examining the specific resistances of various alloys of iron Professor Barrett notices the interesting fact that the specific resistance follows the same order of increase as the specific heats of the various elements, and that the atomic weight appears to decrease as the resistance of the alloy increases. This correspondence appears to be more than a chance coincidence, and may throw some light on the obscure question as to what determines the remarkable increase of resistance in a good conductor, like aluminum, when it is alloyed with iron.

The effect of heat treatment is important in connection with the electric and magnetic properties of iron alloys. Annealing is found in all cases to diminish the specific resistance of the alloys; and the effect varies somewhat in accordance with the degree of rapidity of cooling.

As might have been expected, the alloys of iron and nickel exhibited very interesting magnetic properties, as did also the iron manganese carbon alloys, while the already observed effect of tungsten in imparting to steel a high remanence and coercitive force was fully confirmed. Steel for permanent magnets should contain from 5 to 7 per cent. of tungsten.

Among the experiments may be noted especially the valuable alloys of iron with silicon and with aluminum. Thus the silicon iron alloy containing 2½ per cent. of silicon gives as good results as regards low hysteresis and high permeability as the best Swedish charcoal iron.

In the light of the authoritative and exhaustive investigations it should be practicable for builders of electrical machinery to secure as reliable information concerning the electrical and magnetic qualities of their materials as they have already possessed as to their strength and elasticity. There is little doubt that in future records of materials of construction their electrical and magnetic properties will be included as a matter of course in connection with the results of other physical tests, as being of equal practical value and importance.

Workshop Records.

Works management, and the problems growing out of it continue to attract interested attention, and among the recent contributions to this department of engineering practice we note the paper of Mr. George Parker, recently presented before the North-East Coast Institution of Engineers and Shipbuilders, discussing the existing methods of workshop records, with special reference to the use of cards and files instead of books.

After calling attention to the fact that the conservatism of British firms has led them to proceed very slowly in the adoption of the more modern methods of shop accounting and cost keeping, Mr. Parker proceeds to examine the subject at length.

So long as a firm continues to make large profits the need of efficient workshop records does not come acutely home, but as soon as competition begins to tell, and these profits decrease and perhaps disappear altogether, the question naturally arises: How and where, if possible, can the cost of production be reduced? This question, a thoroughly efficient system of workshop records alone can satisfactorily answer.

A system of workshop records should have three objective points in view, viz.:—

(1) The tracking of the state of progress and cost of products through the factory;

(2) The lessening of the costs of production; and

(3) The determination of a price at which the factory products may safely be offered on the market;

And in order that these may be accurately arrived at the following records must be kept:—

(1) Records of orders for work to be done;

(2) Records of labour or work done;

(3) Records of material, raw, in progress, and finished; and

(4) Records of establishment charges.

Each of these latter groups of records Mr. Parker examines in detail, showing their relative importance, and the most satisfactory manner in which they may be executed.

The records of orders, under the older methods were kept in a number of books, accessible only to the manager and his clerk, but under the more modern system all these records are kept on cards, which are filed systematically in such a manner that they may be collected with the other records when the work is completed. Labour records formerly kept by the cumbrous system of time checks, are now kept partly by machinery, as regards the time of arrival at and departure from work, and partly by job order or piece order cards, following the work through the shop and forming, when complete, a portion of the whole records of the work.

Records of material involve the keeping of a rough store and a finished store, distinct accounts being kept with each of these exactly as if they were independent establishments from which material was being bought and to which finished goods were being sold except that the records are kept in terms of quantity instead of price.

The question of establishment charges is one concerning which much has been written and in which there is a great variety of practice. The old method of charging everything which could not be charged directly to orders to an establishment charges account, and then dividing this up among all the productive orders according to some percentage system is now replaced, in many works, by a list of different headings under which everything is charged that can properly be separated as belonging to different orders.

There are, however, many other items coming under the heading of establishment charges which are only obtainable from the commercial books, such as rent, rates, taxes, office expenses, etc.; or arrived at in an arbitrary manner, like depreciation. In some businesses it is also advisable to keep the selling expenses entirely separate from the working expenses, especially where a firm manufactures largely for stock and is in fact a dealer in, as well as a manufacturer of, its products.

The subject of depreciation is so important that it would require a separate paper of itself in order that full justice should be done to it; for on the manner in which it is treated very often depends the success or failure of a business. All firms recognise that depreciation must be provided for, but very few agree as to the amount which is necessary to cover it, or as to the manner in which it is to be computed.

Taking into account all the various details of establishment charges there is no reason why the question of oncost should not be charged in an equitable manner to the product at each stage of its manufacture. There are many different methods of determining oncost, but they all belong to one or other of three classes.

1.—By a percentage on direct or productive labour, based on past or current records.

This is the method in most general use in this country, although owing to its overburdening highly-paid skilled labour and under-burdening cheap unskilled labour it gives in many cases far from reliable results. This disability may be somewhat minimised by adopting a different percentage for each class of work.

2.—By an hour rate based on the average number of hours of productive labour.

This is the method usually adopted in America, and except in shops where there is a great diversity in the size and cost of individual tools it will be found to give very reliable results, the loss incurred on cheap labour as in the "percentage method" not having to be made good at the expense of work requiring dearer labour but less time. Some accountants and managers recommend that this rate should be recalculated every month, but this will generally be found to give more trouble than it is worth. Probably the best method of varying this rate is by a sliding scale based on the average number of men in productive work. This plan is used in several American shops, the foreman's time-stamp being utilised to stamp the job cards with the number of men in productive work each day.

3.—By a machine hour rate, supplemented by an overhead hour rate for those charges which it is impossible to allocate to the machines.

This is far and away the most scientific method, for it enables the machinery used to be taken into account in costing work, and this is a most important advantage, especially now that machinery is becoming to be more and more used in every branch of industry. Many will object to this method as involving too many complications, and except in shops where there are both very large and very small machines it may hardly repay the trouble of installing it, although on the other hand the information afforded will be an undoubted advantage.

The Protection of Workmen.

With the increasing use of machinery in all departments of industry, and the employment of less skilled operatives in attendance it has become more and more important that the probability of accidents shall be reduced to a minimum. In this connection the papers presented at a recent meeting of the Institution of Mechanical Engineers are of interest, and treating of a common subject in general, they may well be noticed together. The papers referred to are those of Mr. W. H. Johnson, on the guarding of machine tools; of Mr. Henry D. Marshall, on the fencing of steam and gas engines; of Mr. Henry C. Walker, on the protection of lift shafts; and of Mr. Samuel R. Platt, on textile machinery.

The conditions of a perfect guard are enumerated by Mr. Johnson as follows:

1st. It must fence the tool efficiently; in other words, it must protect workmen from all dangerous moving parts of the machine, and thus satisfy the factory inspector.

2nd. If possible it must be attached to or near the tool, as if loose a careless workman will remove it and not replace it, so that it ceases to act as a guard.

3rd. At the same time it must be so constructed that a workman can move it on one side to oil the machine, adjust a belt or change wheels and bring it back into position with a minimum of time and trouble.

4th. While sufficiently strong it must not be heavy or clumsy.

5th. The guard must not prevent the operator seeing through it unless it is intended to act as a cover to keep chips of metal out.

In examining detailed examples of guards for different kinds of tools, Mr. Johnson naturally calls attention first to the housing of gear wheels, this protection now being generally provided by the builders. Small gear trains may readily be housed with cast-iron covers, but for large gears light and effective coverings may be made of planished sheet iron. In most other cases the dangerous parts of machine tools are best guarded by frameworks of wire netting, but such nettings should be constructed in accordance with the experience of the users of the tools, and not left to the untrained judgment of the wire worker. In regards to the protection of circular saws shown by Mr. Johnson, it appears to guard as well as practicable against the accidental cutting of the workman, but it should be remembered that a very frequent cause of serious accidents with circular saws is that of the catching of pieces of wood in the teeth of the saw just as the cut is finished, the loose block in such cases being thrown violently back over the saw against the operative, striking him in the head, often with fatal consequences. A heavy plank, hinged from the ceiling and hanging low enough to protect the man without obstructing his vision of the work, forms an effective guard.

The guarding of steam and gas engines, discussed by Mr. Marshall, is one which has been considered for a long time, and in well appointed establishments is generally well effected. Engine rooms should be so arranged that no operatives need pass into or through them, so that the chief protection needed is that for the actual attendants. Apart from the provision of a rail or screen about the crank and connecting rod, the principal points requiring attention are the provision for lubricating the moving parts, and the arrangement of suitable safety starting gear. Mention should have been made ot the high degree of safety attained by the various forms of enclosed engine, such as the Willans & Robinson, the Westinghouse, and others, no moving parts appearing except the fly wheel and belt pulley, and all lubrication being effected automatically. This form of design is also well adapted to gas engines.

Accidents with lifts are usually due to leaving the doors open or by starting the car while people are entering or leaving, and hence nearly all safety appliances involve some interlocking device by which the door cannot be opened except when the car is at its exact level, and by which the car cannot be started until the door is closed. To these may be added the various forms of automatic platform gates, which close the shaft at every floor except during the passage of the car, these effectually preventing a fall of more than one floor in any case. Accidents with lifts are exceedingly few, and with reasonable care may be guarded against very successfully.

Textile machinery contains numerous opportunities for possible accidents, but present designs include good protection against injury to the attendants.

It has been found by experience that the operatives themselves are not favourable to the use of guards over the moving parts of machines, and hence it is necessary to construct the shields so that they cannot be readily removed. Indeed the introduction of fully guarded machinery does not altogether meet with the approbation of mill-owners, as so much guarding involves additions to the cost of the plant without increasing the efficiency of the machinery. The liability of employers in case of accident from imperfectly protected machinery, however, renders neglect in this respect an expensive matter in case of injury.

REVIEW OF THE CONTINENTAL PRESS

Maritime Aeronautics.

THE subject of aeronautics continues to occupy the attention of engineers, especially in France as is indicated by the various articles in the technical journals and transactions of societies. The eminently practical nature of such papers shows that the matter is being considered in the same manner as any other mechanical problem, with a view to its working utility as soon as practicable. We notice especially a paper presented before the Société des ingénieurs Civils de France by M. E. Surcouf, upon maritime aeronautics, and also a general review of the recent progress of aeronautics, by M. G. Espitallier in *Le Génie Civil.*

The practical nature of the present investigations is shown by the modifications which have been made in the problem over the efforts of earlier experimenters. Formerly the idea of the early aeronauts was to see how high they could go, and visions of balloons far aloft, sailing from one distant point to another, filled the minds of inventors. Now it is recognized that the real advantage of aerial navigation lies mainly in the avoidance of terrestrial irregularities, and that in most cases it is only desirable to ascend high enough to obtain a clear path. Indeed some sort of communication with the surface is found very desirable, especially in the efforts to secure dirigibility and stability.

Apart from the great question of supporting sufficient motive power to progress against the wind, the two great problems in practical aeronautics are those of securing definite stability, and of controlling the direction of navigation.

One of the greatest obstacles to stability lies in the shifting of the centre of pressure in a balloon which is partially filled with gas. If the bag is not fully inflated the slightest variation of position, especially in the modern cigar-shaped balloon, causes a change in the position of the mass of gas, and the consequent shifting of the centre of pressure. This difficulty has been largely obviated by the use of the so-called internal "ballonet," which, being inflated with air, keeps the outer balloon distended and taut when a portion of the gas has been discharged. This device, due to Dupuy de Lôme, has done much to improve the stability. The experiments of Renard have also shown that the stability may be increased by making the greatest diameter of the balloon one-fourth of its length distant from the forward end.

The greatest aid to stability, however, is the guide rope, first practically employed by the English aeronaut Green. This has been employed to advantage by Santos-Dumont, and was the principal reliance of the ill-fated Andrée and his companions.

Naturally any device of this sort is impeded in its usefulness by the irregularities of the earth's surface, but in a modified form it has been found most serviceable over bodies of water. As M. Surcouf points out, aerial navigation over water, or maritime ballooning as it may be termed, possesses numerous advantages, which he examines at length.

Maritime ballooning was first investigated scientifically by Hervé who, in 1885, studied the effects of moderate floating resistances, and made a number of experiments over the lake of Geneva. In subsequent investigations Hervé has elaborated this idea, until at the present time he has developed what may be termed a system of maritime ballooning of much interest.

Hervé found that a single guide rope, or trailer, while adding materially to the stability, did not fully meet the requirements, and for ballooning over bodies of water, he conceived the idea that the presence of the water might be made a very efficient aid in the management of the balloon. His method consists in the use of two trailers, one, provided with a form of sea-anchor or bucket, trailing out behind the path of the balloon at a low angle, about 22° from the horizontal; the other hanging as nearly vertical as can be practically accomplished. The two trailers thus form a sort of triangular frame with the surface of the water, the balloon being attached to the upper acute angle. The second trailer, instead of carrying a drag anchor, is provided with an articulated float, consisting of a number of blocks of wood in the form of a sort of chain which will float upon the surface of the water, or which may be partially or wholly lifted into the air.

This combination provides a means of correcting for several varying conditions otherwise most difficult to control. The drag rope and bucket maintains the car of the balloon in a stable position, and effectually prevents the dangerous oscillations otherwise caused by every puff of wind. The second, or equilibrium rope adds to the steadying effect, and also provides the long sought compensation for variations in weight.

The great variables in ballooning are snow, hoar frost, and rain. On a large balloon, such as the "Mediterranean" a heavy rain may increase the weight more than 200 kilogrammes, while a rapid evaporation may produce an equal negative effect. Similar effects are produced by snow and frost, and these have always been difficult to provide against. The equilibrium float furnishes a means of varying the ballast, since the very considerable weight of the float may all be thrown upon the balloon simply by lifting it from the surface of the water, while the contrary effect may be produced to any degree by permitting a portion or the whole of it to rest upon the water. By drawing the equilibrium float from the water, the balloon may be caused to descend so that a boat may be lowered or a vessel boarded, after which the float may be lowered and the balloon permitted to ascend.

The use of the triangular system of guide ropes adds to the stability to such a degree that serious attempts may be made to utilise the action of the wind as a propulsive force, their influence being similar to the keel or centre-board of a yacht. This action is greatly assisted by the substitution of a special form of drag to the guide rope, instead of the simple bucket. By employing a drag composed of a number of long plane or curved surfaces attached to two guide ropes, the desired steering capacity is effectively provided, and thus the balloon over the sea is equipped with all the elements for successful sailing.

M. Surcouf discusses the applications of these appliances both to spherical balloons and also to the constructions of M. Santos Dumont, and describes at length the very interesting experiments of M. Hervé, the whole forming a valuable contribution to the increasing literature of modern aeronautics.

Experiments With Electric Boats.

The trials which have hitherto been made of electrically propelled launches and boats have generally not been in such a shape as to render them comparable with tests of other vessels, and hence the trials discussed in a recent article by Professor Oswald Flamm, and published in *Schiffbau*, demand notice and comment.

It was intended to make extended trials of an electric boat of 16 metres length in order to obtain data as to speed and powering, and before proceeding with the construction two models, one-tenth of the size of the completed boat were prepared, and given thorough trials in the testing tank of the North German Lloyds at Bremerhaven to determine their resistance and behaviour at various speeds. Professor Flamm gives the results of these tank trials at some length, analysing the resistances so far as their separation into wave-making and frictional resistance is concerned and showing the effect of the modifications in the lines of the model. Some very interesting photographs show the influence of speed and form upon the waves made by the models when under trial in the testing tank.

The results of the trials was the adoption of a model slightly differing from either as the form of the boat actually constructed and hence the result of the actual tests are not as strictly comparable with the model experiments as would have been the case had the lines of either model been followed absolutely.

The completed boat was 16 metres long, 2.50 metres in width, and 0.80 metre depth amidships, with a displacement of 17.20 cubic metres.

The weight of the motor, accumulator, switches, and conductors made 11,049 kilogrammes, or for 60 h. p., about 185 kilogrammes per motor horse power. This is so greatly in excess of that required for steam or internal-combustion motors as to call instant attention to the field for improvement in the reduction of weight.

The trials of the boat, in which the speed was determined by the corrected readings of several mechanical logs, are given both in tabular form, and as curves, and may be compared to advantage with the records of the tank trials, although, as before noted, the modifications in the model render precise comparison impracticable.

At a speed of 10 knots the power required was 59.30 h. p., at 7.70 knots, 18.10 h. p., and at 4.90 knots, 5.30 h. p. At the speed of 10 knots the radius of action was 30 sea miles, while at 4.90 knots this was extended to 220 sea miles.

Further trials are to be made, but with the data and results already given by Professor Flamm much valuable information as to capacity and cost of electrically propelled boats is given.

The Strength of Spherical Lids.

Some time age we noticed the exhaustive experiments carried on by Professor Bach at Stuttgart, upon the deflection and resistance of flat lids on cylinders subjected to internal pressure. He has now extended these experiments to include hemispherical concave lids, and in view of the extensive use of similar constructions in actual work, his researches possess much practical value.

From a detailed account in the *Zeitschrift des Vereines Deutscher Ingenieure* we make a brief abstract of the account of the experiments, referring the interested reader to the original for fuller details.

As in the case of flat lids, the important information desired in practical service relates rather to the deflection, or gradual yielding, than to the ultimate resistance to rupture, and hence the apparatus was arranged to furnish quantitative measurements of the yielding at various portions of the surface under different pressures. The head under test was riveted into a short and heavy cylinder, closed at the bottom, and arranged so that it could be completely filled with water, and subjected to internal hydraulic pressure. Over the top of the cylinder was placed a rigid frame work pierced with holes through which a number of gauge rods passed, resting freely on the surface of the lid under test. The tops of these rods were all brought to a level before the pressure was applied, and subsequent micrometer measurements showed very precisely the changes occurring at various places on the head.

The experiments were made with heads of copper and also of low steel, 700 mm. in diameter, the tests being made with hydraulic pressures up to 70 atmospheres, or about 1,000 pounds per square inch. The results are plotted in the form of curves, and also reduced to tables, and in general they show that there is very little yielding over the entire surface, until at some limited area there is a sudden reversal of curvature, after which the head becomes entirely reversed as the pressure is increased..

The especial designs under test were intended for the double bottoms of brewery kettles, in which steam is admitted in the space between the two bottoms to heat the liquid. For this purpose it is necessary that the joint should be properly designed, so that the action of the pressure upon the material in actual service shall not be different from that obtaining when under test. Details of suitable joints are given by Professor Bach, and the whole subject is treated in an eminently practical manner.

In thus conducting laboratory tests so as to provide accurate quantitative results upon constructions used in actual practice Professor Bach has set an admirable example for work in mechanical laboratories elsewhere, and a study of his methods will be found valuable to instructors and practicing engineers alike.

Travelling Sidewalks.

Those who observed the very satisfactory operation of the overhead travelling sidewalk at the Paris Exposition of 1900 have doubtless wondered that some permanent installation of such a convenient system of transport has not been made since that time. Naturally such a system does not equal in speed the fast-running electric street railway cars, but the carrying capacity of the travelling sidewalk is immense, and the time saved by the fact that no waiting is required largely makes up for the slower running speed. Especially does the continuous movement render the system applicable to the relief of the congestion at certain centres of traffic, where the main demand is for the transport of great numbers of people, during rush hours of the day, through comparatively short but contracted thoroughfares.

Several years ago an interesting historical paper upon the subject was read before the Société des Ingénieurs Civils de France by M. Armengaud, Jeune, discussing the earlier devices, and describing in detail the travelling sidewalk of the exposition, and now we have a paper before the same society, by M. D. A. Casalonga, emphasising the advantages of the traveling platform, and submitting a plan for such a structure running from the Place de la Concorde to the Place de la Bastille, following the lines of the Grands Boulevards and running in a subway beneath the streets.

The installation of the travelling platform at the exposition of 1900 was overhead, and was 3.4 kilometres in length (2.11 miles), while the plan of M. Casalonga contemplates the distance from the Place de la Concorde to the Bastille and return, making a loop at each end, with a total length of about 10 kilometres, (6.21 miles), the platform running entirely in a subway.

In its general construction the platform suggested by M. Casalonga does not differ materially from that of MM. Blot, Guyenet and de Mocomblé at the exposition, except that he proposes to use three moving platforms in addition to the stationary one, thus obtaining speeds of 4, 8, and 12 kilometres per hour, while he states that with four platforms a maximum speed of 22 kilometres may be conveniently attained, or about 13½ miles. Instead of arranging the platform as a circuit of a given area, moving continually in one direction, the proposed scheme involves a double platform, forming really one continuous structure, running under the so-called Grands Boulevards in both directions, there being loops at the Place de la Concorde and at the Bastille, as already mentioned. By providing cross-overs at the various stations it would be possible for a passenger to travel in either direction for any desired distance and then leave the platform for the returning side. The plan involves a double tunnel of rectangular section, as near the surface as possible, in order to avoid unnecessary stair climbing, and the details appear to be very well worked out.

Whether this ambitious scheme is carried out or not, it calls renewed attention to the capacity and capabilities of the travelling sidewalk as a means of conveyance. Even without resorting to such an extensive application, there are numerous locations in which it might be installed to great advantage. Its chief value appears in the continuous manner in which it acts. Crowds are mainly caused by the intermittent nature of other methods of transport, and in the hurried morning and evening hours the closest practicable headway of trains or trams leaves intervals for crowds to form and become difficult to handle. The continuous travelling platform takes the stream of people as they arrive, thus preventing most effectually any accumulation, and this is the main secret of its applicability. Among the locations where such a system might be readily and conveniently applied are the platforms of railway stations, long piers at steamship landings, and especially the crowded sidewalks of certain bridges. Thus the travelling platform has been suggested as a means of relieving the congestion of the Brooklyn Bridge, New York, for which it appears to be eminently adapted, and indeed there is every reason why the installation of such sidewalks should be contemplated in the construction of all such large and important bridges, even if they are not necessary at first, since the subsequent work might be readily done at a later date if provision were made in the original design.

The travelling platform appears to be the logical evolution of efforts to provide for continually increasing traffic. When the separate train or tram service is first installed the trips are few and far between; as the numbers of passengers increase, the headway is reduced and the cars follow each other closer and closer; so that the introduction of the moving platform is really the merging of separate trains into one great train, covering the entire roadway, and rendered capable of ascent or descent without interruption of motion.

It was Pascal who first defined a river as a travelling highway, and possibly the flow of the river may be repeated in the mechanical stream of the travelling roadway as the solution of a problem in transport which has become perplexingly difficult in many places.

High Pressure Centrifugal Pumps.

The application of centrifugal force for the impelling of gases and liquids has resulted in the production of some very ingenious devices, of which the most important are fans and pumps. As ordinarily constructed, however, such apparatus is limited, especially as regards the pressures against which it can be operated. Fans are therefore usually employed for moving large volumes of air at comparatively low pressures, generally below 24 inches of water, while centrifugal pumps rarely are required to force water against more than 50 feet head.

In a recent paper published in *Le Génie Civil,* M. Rateau, well known for his experience in this class of machinery, discusses the conditions which will enable such machines to act against much higher pressures than hitherto, and as the matter is one of more than ordinary interest, some abstract of his results is here given.

There are two methods of enabling a fan or centrifugal pump to operate against a high pressure, either by increasing its rotative speed, or by arranging several fans in series so as to obtain their cumulative effect. M. Rateau discusses both methods, and describes his experimental tests. For fan blowers the increase in rotative speed is found satisfactory, especially as it has become possible to utilize in this manner the high rotative speed of the steam turbine as a direct-connected motor.

For this purpose M. Rateau constructed a direct-connected set consisting of a steam turbine on the principle of the Pelton wheel and a 10 inch fan, and conducted a careful series of experiments to determine the effect of operation at different high speeds. The experiments, for the full data and results of which the reader must be referred to the original paper, showed that the pressure as indicated on the water gauge varied nearly as the square of the speed. Thus at 10,500 revolutions a water pressure of 4.56 feet was sustained, while at 20,200 revolutions the pressure reached 18 feet. Such pressures enable the centrifugal fan to be used for blast furnaces and for Bessemer converters, applications which have hitherto been found practicable only for blowing engines of far greater cost and bulk.

Especially important is this fact, since it removes for such work the chief disability of the steam turbine, its high rotative speed. Gearing is always objectionable, especially when operated at high speeds, but gearing has been found necessary for the reduction of the speeds of the steam turbine, to enable it to be used even for driving electric generators. For high-speed fans, however, the direct combination of steam turbine and fan appears to be altogether satisfactory, and it should come into extensive use.

In pumping water such high rotative speeds can not always be used, but by the employment of electric motors centrifugal pumps have been operated successfully at speeds of more than 2,200 revolutions, for a wheel of 8.2 inches in diameter, against heads of about 100 feet of water. By combining such pumps in series, the wheels all being upon one axis, and each feeding the water to the next, the water can be forced against much higher heads. Thus with five wheels 10.6 inches in diameter (270 mm.) running at about 1,200 revolutions, water was forced against a head of 200 to 250 feet, with a pump efficiency of nearly 70 per cent.; while with seven such wheels a head of about 325 feet was overcome, with about the same efficiency.

In order to experiment with still higher speeds, M. Rateau constructed a pump of only about three inches in diameter (80 mm.), and operated it, by means of a steam turbine, at speeds from 9,000 to 18,000 revolutions per minute. At 9,000 revolutions this little pump overcame a head of about 230 feet (70 metres), and at 18,000 revolutions the pressure head was equal to nearly 1,000 feet (300 metres), so that the rate of the square of the velocity was practically maintained.

M. Rateau discusses his apparatus and results in detail, giving curves showing the pressure, volumes and efficiencies during the tests, and the whole forms an admirable example of scientific laboratory work, as might be expected from an expert of his standing.

These interesting results appear to open up a little-worked line of engineering practice, for although fans and centrifugal pumps have been in use for a long time, and have been most thoroughly investigated within certain limits, it now appears that those limits may be greatly extended to much advantage. The extreme simplicity of the centrifugal pump, and its ready connection with the equally simple steam turbine, at once places in the hands of the engineer a combination offering many and important applications. The centrifugal pump is no longer limited to the handling of large volumes of water alone, but may be used for deep mine lifts, for municipal water supply, for fire extinction, and even for boiler feeding.

The Trolley Omnibus.

The application of electric traction to common road vehicles has been impeded by the difficulties in connection with the use of storage batteries, especially as to the weight to be carried. One solution of the question has been found in the use of overhead trolley wires to convey the current from a generating station to the vehicles, and from an account in a recent issue of *La Revue Technique* we abstract some account of successful experiments with the trolley omnibus in France.

The Lombard-Gérin system was shown at the Vincennes annex at the exposition of 1900, and has been in practical service at several places since, notably between Fontainebleau and Samois. The idea is to avoid the necessity of constructing any special track, and hence the feature to be secured was the maintenance of communication between the omnibus and the trolley wires, and at the same time permit entire freedom of the road to the vehicle.

Since there can be no rail for the return current, two trolley wires are necessary, and the first attempts were made with a trailing trolley, running upon the wires, and provided with sufficient length of cord and conductors to permit the omnibus to turn to any part of the road. This was found impracticable in service, as might have been expected, the trolley frequently becoming caught and entangled, interrupting travel and rendering accidents imminent.

In order to avoid these difficulties the Lombard-Gérin system provides the trolley with a small motor of its own, which causes it to travel upon the wires in advance of the vehicle, there being always sufficient slack in the connecting wires to leave the omnibus free space for manœuvring. The details by which this arrangement is carried out are ingenious. The omnibus is provided with its own continuous-current motor, taking its current from the trolley wires overhead in the same manner as an ordinary electric tram. Besides its function as a direct-current motor, this is also a rotary transformer, producing a three-phase current, which operates a small three-phase motor in the trolley. By this ingenious arrangement the trolley motor is made to vary its speed just as the speed of the vehicle is varied, and hence the trolley always keeps in advance of the omnibus, advancing and stopping in accordance with the motion of the main motor. The total weight of this automobile trolley is about 20 kilogrammes, and it is readily carried upon the conducting wires.

The line between Fontainebleau and Samois has been in operation long enough to enable some data as to expense of exploitation to be determined. The length of the route is 5 kilometres and the time required per trip is 20 minutes. With a fare of 40 centimes the ratio of receipts to expenses was 58 per cent., and for short distances, where the traffic is not sufficient to warrant the expense of the construction of an electric tramway line, the system may find satisfactory application.

While it is not to be expected that any omnibus system can exist in competition with electric tramway traction there is an intermediate stage in which it may find useful application. This is the case in the replacement of animal traction for roads where the electric railway will ultimately be introduced, but where the immediate demand is insufficient. Also for connecting small resorts and country towns with railway stations, or for the hauling from manufactories to shipping points. In such locations the highway trolley system will doubtless find useful applications, and in many cases build up an important traffic.

REVIEW OF THE AMERICAN PRESS

Reciprocity and Manufacturing.

The development of export trade in American manufactures and especially in American machinery, together with the significant emphasis laid upon reciprocity by President McKinley in his last speech, has impelled the *American Machinist* to investigate the present opinions of leading manufacturers upon the question of foreign trade relations. From a number of replies received in response to a circular letter, some most interesting and valuable deductions may be drawn.

In the first place, out of 58 replies, there were 45 which endorsed the famous passage from Mr. McKinley's speech, while no disapproving responses were received. A great majority of the replies showed that the American machine manufacturers realize that they need no tariff on their productions, and would prefer to see the existing tariff reduced or abolished, believing it to interfere with foreign trade. As one manufacturer significantly expressed it: the only protection needed is that already furnished by the patent laws.

When it is considered that these replies represented establishments having more than $35,000,000 capital, and employing more than 22,000 workmen, it will be seen that the protection sentiment is hardly as strong as it formerly was in American industrial circles.

The fact appears to be that American manufacturers have accepted the view of the late President Garfield in considering protection merely as means toward ultimate free trade, and finding themselves in a position in which they have no possible apprehensions of serious competition from European manufacturers, desire to further trade with all the world to the utmost possible extent.

Whatever may have been the theoretical views of the writers of the letters which the *American Machinist* has so effectively gathered and made public, there is no doubt that the views now expressed are those showing their own immediate business relations. It is the effect which they feel will be produced upon their own trade which impels them to write as they have done, and the opinions are all the more weighty on that account. They realize that a nation cannot always sell and never buy, and they know that their own export trade largely depends upon the opportunity of their customers to sell to them.

The publication of these letters shows that the protection sentiment in manufacturers can no longer be appealed to by politicians upon the old argument that it is necessary to prevent the product of European cheap labor from entering into competition.

As a matter of fact the whole question of modern manufacturing no longer depends upon the employment of cheap labor in the sense of hiring workmen at low wages. Modern methods involve the attainment of economy by the employment of far fewer men, of high attainments, receiving high wages, and directing the vastly increased output of improved machinery. Such methods have nothing to fear from foreign competition, and need no protective tariffs, as the manufacturers have already found out. The wise politician will not be long in discovering the changed relations brought about by the transformation in modern engineering methods, and if he cannot adapt himself to the changed conditions it is not the manufacturers who will have cause for regret.

Foundry Economy.

It is only within quite recent years that the foundry has received its fair proportion of attention as a department of shop administration and economy, although there are few departments which bear as important a relation to the efficiency of an establishment as a whole. The American Foundrymen's Association, however, has done excellent work in raising the standard of the department of mechanical engineering to which it relates, and many of the papers of its members contain valuable matter.

In a recent contribution to the *Journal of the American Foundrymen's Association,* Dr. Richard Moldenke discusses the various methods by which better economy may be attained in the foundry, so that a fair profit may be made, even in the face of the continually falling price of castings. Briefly, as he well says, the solution of the question will be found in the introduction of a good cost system in the office and the use of scientific methods, where needed, in the works. The paper devotes itself to the discussion of the latter portion of the problem.

Scientific methods may usually be more readily introduced in the large foundry than in the smaller establishment, and the small founder must adopt his own methods, the results of his own observations to obtain the best results.

"The most important consideration is naturally the daily product. This must be kept up to standard, and at the same time be as low in cost as possible. Here is where the cost accounts come in. One must know the cost per pound of the good castings sold for every department in the establishment. Thus if the cost of core-making runs say 0.25 cents per pound in one month, and it creeps up gradually to 0.35 cents in the course of the next three, it is time to see if the knife cannot be applied effectively, or failing this, to re-arrange or place new machinery to get the work out to better advantage. On the whole it will pay to do the latter anyway, for until the monthly figures are not brought down to a point where there will be only a fluctuation of a few points, the department cannot be said to be in proper working order. Be it understood that this refers to a fairly uniform run of work. The principle involved, however, is a truly scientific one and should be applied in every manufacturing establishment.

The molding machine question will be found the most important one so far as the foundry pay-roll is concerned. A well-managed pattern shop and pattern storage system are also money savers. If the founder is personally systematic in his work, he will not tolerate slip-shod habits in his employees; if he is not inclined that way, it were better for him to get an associate who is systematic. Then should come the establishment of systems of working marked by extreme simplicity and carried through with an iron hand, the head of the establishment setting the example."

Dr. Moldenke gives some excellent advice about the maintenance of his stock of material in a state from which he can produce the quality of castings demanded by his trade at will. The maintenance of separate and carefully recorded piles for the various brands of pig iron is urged, as well as an intelligent classification of the scrap, both domestic and foreign. This will enable the foundryman to compare his charges with his product, and by cutting out the suspected brands in case of trouble, he may establish his own mixtures with reasonable satisfaction. His words on the subject of the employment of a chemist are suggestive in this connection.

"What is needed to make this work on mixture-making successful? Simply a knowledge of what is in your pig iron and what is in your own scrap. Even this can be narrowed down to the silicon in both items for the daily run of work. I will go even further and say that two or three determinations of silicon a week, together with stocks of irons, well sampled and analysed as they are bought, and an occasional sulphur determination of your coke, is all that the jobbing or stove founder requires. I know cases where this work amounts to less than six dollars a week, or not even the wages of a laborer. I feel quite certain that many a young chemist would be glad to locate in a foundry if he can get that much from three or four foundries to begin with."

So far as operation is concerned, the main thing is to maintain control of your own establishment. It will not do to permit the cupola tender to assume that he knows it all, and that no one may share his knowledge, lest he becomes no longer indispensable. Systematic mixtures, careful weighing of charges, and ordinary intelligence, watched over by foreman and owner, will give reliable results and render the foundryman independent of any individual employee.

"With the purchase of pig iron under

chemical specifications, a good method of making mixtures which can be depended upon to produce the results desired, and the proper disposition of the charges in the cupola, the good that science can do the founder is accomplished in the main. There are of course many points which a well managed laboratory can place on an economical footing, especially when we turn to furnace irons, and special line of castings. For the owner of a foundry which turns out say ten tons of castings every other day, it would, however, be unwise to establish this department as an adjunct to his works. He does better by sending his work out and learns all he can to apply the reports he gets properly.

"Let it be understood that a good mixture mismanaged will give poor castings, but a poor one cannot under any circumstances turn out good work. The sole object of all this scientific manipulation is to start you off right, and then you must follow it up with due vigilance through every department of your work."

The Action of Curved Jetties.

We have already referred in these columns to the principle of the curved reaction break-water of Professor Haupt, and discusses its effects in the incomplete structure at Aransas Pass, Texas. We now have a paper by Professor Haupt, in the *Journal of the Franklin Institute,* discussing the relative action of straight and curved jetties, and showing very clearly the manner in which the latter form acts.

As has already been noticed in connection with the methods of river regulation advocated by Timonoff in Russia, and by Girardon in France, it is becoming understood that the best plan is to control a stream in the course which it has marked out for itself, rather than to attempt to compel it to follow an arbitrary straight course. This point is well brought out by Professor Haupt.

"No stream pursues a straight course if it can possibly avoid it, but swings gracefuly from side to side, cutting first on the right then on the left, but always on the concave bank, and depositing on the elbows and crossings or points of inversion. Neither do the filaments of the stream pursue parallel paths. The maximum velocity is found near the mid-area of the section, but if these particular particles were to continue uninterruptedly along this course of maximum velocity they would run away from the rest of the water and leave a void. This tendency is checked by a constant interchange of position of the particles which restores the equilibrium by swirls and eddies, cross, and even back currents, in certain sections. It not infrequently happens that water runs up hill, as in the case of a flood when the crest of the wave gives a reverse slope up stream. Such are few of the phenomena of flowing bodies, which are well recognized and understood by navigators or others who are familiar with streams flowing between banks; and precisely the same conditions characterize streams in the ocean or other large bodies of water."

These principles have been known and understood for a long time, both by engineers and navigators. Extracts from the writings of such well-known authorities as Wheeler, Scott-Russel, Fontain, and others show that straight reaches are considered unadvisable in the planning of river improvements, and every river pilot knows that the deep channel is to be found close under the concave side of a bend, and that the sharper the bend, the deeper the channel.

At the same time these principles are so frequently violated in actual practice that there is reason for emphasizing them and showing the true extent of their application. It will not always do to apply mathematical principles arbitrarily to physical problems, and while a straight line is the shortest distance between two points it does not follow that it is the best for to apply to a navigable channel. As Professor Haupt says:

"The concave bank practically controls and directs the stream—it is the point of attack for the currents and the point where scour is most rapid. The convex bank is the reciprocal of that where there is virtually no current and where deposit takes place. The continuous change of direction caused by the resistance or reaction of the concave bank, and the consequent differences of velocity of the fluid-particles before and after impart, cause a lateral bottom movement which carries the silt across and on to the convex bank, thus maintaining a deep channel under the concave bend; the depth increasing with the sharpness of the turn.

"By maintaining these oscillations by the erection of artificial banks or reaction-jetties across ocean bars the channel may be quickly and cheaply created by natural processes; but great care must be taken in adjusting their curvature and location to the requirements of the particular site, for if placed on the wrong side of the channel with respect to the littoral drift at inlets, they will result in failure.

"Thus a single structure may be made to produce its counterpart, or convex training-bank, which will be automatically adjusted to the regimen of the currents, whether tidal or fluvial, at less than half the cost of the parallel straight jetties, and give a far better and more permanent result, requiring a much smaller expenditure for maintenance."

Machinery at the Wachusett Dam.

It was at the construction of the Chicago drainage canal that the greatest demonstration in recent times was made as to the economy due to the use of machinery for excavating and handling material, and in a somewhat different manner we have a similar demonstration in the use of machinery in the construction of the great Wachusett dam at Clinton, Mass. From an account of the works in a recent issue of the *Engineering Record* we abstract a portion relating to the mechanical appliances there in use.

The most important features in this equipment are two rope cableways, extending across the valley on the line of the dam, and used for handling the excavation, removing the spoil, and delivering the materials for the masonry. The cableways are of 1,155 feet span, and of 9 tons capacity, and in connection with the railway they have no difficulty in handling all the material.

The power for these and for all the machinery is furnished from a central power station, equipped with water-tube boilers, powerful air compressors, and a complete system of compressed-air mains, delivering power to all parts of the plant. The compressors have a capacity of 3,310 cubic feet of compressed air at a pressure of 80 to 90 pounds. The air is distributed among 16 drills, 26 hoisting engines, and 10 pumps, reheaters being placed at intervals in order to obtain the increase in economy, and avoid refrigeration. It is a matter of interest to note that the hoisting engines are of the usual type intended for their own independent generation of steam. The compressed air is delivered into the boilers, these acting as reservoirs, and the operation is the same as if steam were used, except that the fire and water are absent. In addition to the actual quarrying and handling machinery a number of other mechanical appliances are employed. The sand is screened and handled by machinery and the mortar is machine mixed, all the power being obtained from the compressed-air plant, and wherever power can be employed it is used to supersede manual labor.

In addition to the actual work upon the dam itself, there was much preparatory work required, including the construction of a temporary dam and flumes for the diversion and control of the water during the construction. Details of this work are given, with interesting illustrations showing the plans and progress of the work up to the present. An idea of the magnitude of the undertaking will be gained from the figures of the contract. Thus there are 267,300 cubic yards of earth and 100,000 cubic yards of rock excavation to be done, and more than 275,000 cubic yards of masonry to be built.

The increased use of handling and conveying machinery in work of this kind is a most significant feature in the development of modern engineering methods. Formerly it was assumed that digging and hauling earth was the natural employment of laborers and horses, machinery being employed only where manual labor was impracticable or too expensive. Now it is found that manual labor is in nearly every case far more costly than the use of power appliances, and contractors equipped with modern machinery are nearly always able to make lower bids and greater profits than those who adhere to the old methods. The most effective kind of human labor is found in the application of intelligence to direct mechanical appliances, and nowhere is this more clearly shown than in such undertakings as that above described.

Modern Cooling Towers.

VERY early in the history of the steam engine it was found desirable to obtain the advantages of the condensation of steam and the benefit of a vacuum in locations where a sufficient supply of water for unlimited use was not available, and various methods were devised to enable the same body of water to be used repeatedly. As the amount of water required for the condensation of steam varies from twenty to thirty times the weight of the steam to be condensed, it is evident that this becomes an important question when, as is often the case, the cost of supplying this volume continuously is prohibitory.

The earlier methods consisted in the use of cooling ponds, so arranged as to expose a large surface and shallow depth to the action of the atmosphere, so that by radiation, and by the evaporation of a portion, the heat was abstracted. Such cooling ponds are sometimes provided with spraying devices, by which the hot water is showered into the air and allowed to fall into the pond in fine drops, and various devices for insuring a thorough exposure of the water to the cooling action of the air have been used. These methods, however, are only applicable in locations where ample space is available, and for use in large cities they are altogether impracticable.

The more modern method of cooling the water of condensation is by the use of the so-called cooling tower, in which the water of circulation is allowed to flow downward over some form of baffling surface against an upward current of air, the entire apparatus being contained in a vertical tower erected in convenient proximity to the engine room, in the yard, or even on the roof, in case of necessity.

The conditions of efficiency of such towers are investigated and discussed in an article by Mr. J. R. Bibbins, in a recent issue of *Engineering News*, from which we make an abstract.

The essential points of design may be divided into the three portions of cooling surface, draft, and water distribution. Since the abstraction of the heat from the water is the aim of the device, the cooling surface forms a most important feature in the design. This has passed through a course of evolution, including inclined board surfaces, brush-wood boughs, wire nettings, slats, short sections of pipe, etc., and at the present time a variety of these constructions are in use. In the experimental tower used by Mr. Bibbins in his investigations, the surface consisted of a number of mats made of slats of rough lath, these mats being so placed that the successive tiers intersected each other at right angles. Cooling surfaces of metal are to be recommended, since they permit a certain portion of the heat to escape by conductivity.

The draft through a cooling tower may be either natural or forced, the main object being to remove the saturated air and replace it with drier air as rapidly as the saturation takes place. Where natural draft can be used it is the cheaper, but in many instances where space is of importance it is preferable to use a fan, this enabling a smaller tower to do the work.

So far as the water distribution is concerned, the principal thing to avoid is the direct falling of the water for any distance, it being most desirable to have it thoroughly broken up and brought into intimate contact with the cooling air currents.

The tests made by Mr. Bibbins show some interesting facts, for details of which the original article must be consulted. The main conclusions were as follows:

Conduction plays a minor part in the process of temperature reduction; evaporation being the main agent. Maximum evaporation is obtained by effecting as thorough and uniform a water distribution over the entire surface as possible, it being most desirable to avoid falling water, while at the same time retarding the flow of the descending sheets. A liberal settling basin should be provided, and when natural draft is used there should be extensive air chambers at top and bottom, to provide good air distribution. Liberal stand-pipe capacity should be provided for reciprocating pumps.

Since the cooling is mainly due to the evaporation, it is evident that the loss of water from this cause must be taken into consideration. Experience shows that it may require the entire condensation from the engine to supply this loss, which is what might theoretically be expected.

While the cooling tower undoubtedly is a useful device in certain localities, it seems as if the evaporative condenser, with proper design might in most instances be made to give as good results.

Instead of handling a volume of water about twenty-five times as great as the feed water, it should be possible to produce the evaporation of little more than the amount discharged by the engine, and thus absorb all the heat released by condensation. Evaporative condensers have given good results in a number of instances, and if this form was given the benefit of thorough investigation and experimental research it might be found the preferable type.

A Modernized Cruiser.

An interesting example of the changes and improvements which may be made in a modern cruiser after a comparatively short period of service is seen in the account of the repairs and alterations made to the U. S. S. Olympia, by Naval Constructor W. P. Roberts, in a recent issue of *Marine Engineering*.

The Olympia, it will be remembered, was built at San Francisco in 1895, and was found to be most effective in the performance of her duties as flag-ship at the battle of Manila in 1898. She has now been entirely re-equipped, with the exception of engines, boilers and armament, and it is interesting to observe how many improvements were found to have been developed in the comparatively short period of her career.

At the commencement of the repairs, which were made at the Boston Navy Yard, the vessel was stripped of all furniture, and of all sheathing against the bulkheads and inner surface of the hull, and the steel plates were thoroughly scaled and repainted within and without. Instead of using wooden sheathing, the officers' quarters were sheathed with asbestos, mounted on wire netting, this being fireproof and non-splintering, and affording an even temperature in various climates.

The ammunition hoists have been reconstructed and arranged to be operated by electric motors, and electric power has also been applied to the operation of the turrets, each turret being provided with a 20 kw. motor. These have been found much more effective than the former steam motors, and it is believed that this change greatly increases the effectiveness of the weapons in the turrets.

The value of rapid and effective coaling having been demonstrated in actual service, the Olympia has been fitted with machinery to increase her coaling facilities. Overhead trolleys have been fitted in the wing passages on each side the length of the upper bunkers, so that coal can be rapidly carried to and from any of the bunkers. Four spécial coal trolleys have been installed above the superstructure deck, arranged for coaling over all, this being a great improvement over the old method of coaling through hinged chutes in the sides of the vessel. The coal is now swung aboard in sacks and lowered through hatches directly upon trucks and delivered to the scuttles over the bunkers. The side chutes are retained, and can be used simultaneously with the trolleys, thus enabling coaling to be performed very rapidly.

The whole system of ventilation of the ship has been overhauled, there being nine electrically driven blowers employed, these avoiding the necessity of piercing bulkheads with large ventilating openings, required when fewer large fans are used.

The experience in active service as to the danger from fire has led to the provision of a very complete system of fire mains, a new feeder main being run under the protective deck, connected with powerful fire pumps in the engine rooms. The fire pipes are enameled inside, which is expected to add materially to their life.

As indicating the increase in the applications of electric power, it may be noted that the electrical output of the generators has been raised from 64 to 176 kilowatts. There are now four generators of 32 kw. and two of 24 kw., all being beneath the protective deck, the current being used for operating the turrets, fans, and electric hoists, as well as for the electric lighting of the ship and for the search lights.

As the vessel now exists she is an example of modern interior fitting and general equipment. The steam plant has been overhauled and put in order, and the distilling plant materially enlarged. It is interesting to note that the improvements are those which have been suggested by the experience in actual warfare.

THE ENGINEERING INDEX

"THE ENGINEERING INDEX IS THE KEYSTONE OF APPLIED SCIENCE"

The following pages form an index to the contents of nearly two hundred of the leading engineering journals of the world, in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index item gives the following essential information about every article.

(1) The full title, (2) The name of its author,
(3) A descriptive abstract, (4) Its length in words,
(5) When published, (6) Where published.

We supply the article itself, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. Thus this Index makes it possible within a few minutes' time each month to inform one's self of every important article published anywhere in the world upon the subjects claiming one's special interest.

The original of any article referred to in the Index, together with all illustrations, can be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

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Cambridge-Boston.

The Cambridge Bridge. Illustration, with description of one of the finest structures of its kind in the United States, now being built across the Charles River, Boston. 1200 w. R R Gaz—Feb. 28, 1902. No. 46574.

Cantilever.

The Highland Park Bridge, Pittsburg. Illustrated description of a cantilever highway bridge with unusual pedestal details, chord members and lateral systems. 3000 w. Eng Rec—March 22, 1902. No. 47035.

Concrete Arch.

A New Type of Concrete-Steel Arch Culvert or Bridge. Daniel B. Luten. Illustrated description of a method of reinforcing with a single series of steel rods and steel ties. 1400 w. Ry & Engng Rev—March 15, 1902. No. 47026.

Concrete-Steel Bridge Across Kenduskeag Stream, at Bangor, Maine. Illustrated description of a recently built bridge on the Ransome system. 700 w. Eng News—March 20, 1902. No. 47101.

Concrete-Steel Bridges for Interurban Railways. Daniel B. Luten. An illustrated article giving designs of this class of bridges and commending the material. 1400 w. St Ry Rev—March 15, 1902. No. 47016 C.

Rhodes Creek Concrete Arch, Illinois Central. Illustrates and describes an interesting elliptical concrete arch bridge, and the method of substituting the old steel structure without interrupting traffic. 3000 w. Ry Age, Special number—March 21, 1902. No. 47132 D.

Westvale Concrete Bridge. J. R. Worcester. Illustration with description of an elliptical arch bridge built wholly of concrete. It has a clear span of 66 ft. and a roadway of 35 ft. The construction is given in detail. 1600 w. Munic Engng—March, 1902. No. 46524 C.

Culverts.

The Design of Culverts and Other Masonry Arches (Note sur les Conditions d'Etablissement et de Stabilité des Ponts, Ponceaux et Aqueducs en Maconnerie, Murs de Soutenement). L. Lanave. An illustrated discussion of the design of masonry arches. particularly with reference to the amount of water flowing through them. 3000 w. Rev Technique—Feb. 10, 1902. Serial. 1st part. No. 47160 D.

Deformation.

Experiments on the Deformation of Bridges (Conférence sur l'Expérimentation des Ponts). M. Rabut. A well illustrated account of apparatus and experiments to determine the deflection and vibration of bridges under various loads. Diagrams. 12000 w. Ann d Ponts et Chaussées—3 Trimestre, 1901. No. 46917 E+F.

Erection.

Bridge Erection on the West Virginia Short Line R. R. An illustrated article describing the construction of a line 60 miles in length, which contains 54 steel bridges and three tunnels, one of the latter being 3300 ft. long. 2000 w. Ry & Engng Rev—March 15, 1902. No. 47025.

Ferry Bridge.

Aerial Transfer Ferry Bridge Over the Ship Canal at Duluth. Illustrates and describes a structure having novel and interesting features, designed to meet unusual conditions. 700 w. R R Gaz—March 14, 1902. No. 46829.

The New Ferry Bridge Across the Ship Canal at Duluth, Minn. W. B. Patton. Two-page plate of details, with illustrations and description. 3700 w. Eng News—March 20, 1902. No. 47104.

Inclined Bridges.

Influence of the Forces due to the Inclination and the Action of Brakes on the Principal Members of a Railway Bridge with a Heavy Grade (Influence des Efforts dus à l'Inclinaisan et à l'Action des Freins sur les Poutres Principales d' un Pont de Chemin de Fer à Forte Rampe). M. Rey. A mathematical discussion of the design of bridges inclined from the horizontal, particularly one on the Chamounix line. Illustrations. 2000 w. Rev Gen d Chemins de Fer—Feb., 1902. No. 47173 H.

Lift Bridges.

Lift Bridges over the Elbe-Trave Canal, Germany (Ponts Levants du Canal de l'Elbe à la Trave). An illustrated description of vertical lift bridges worked by hydraulic pressure and electric motors and by hand windlass. 1 plate. 1200 w. Génie Civil—Feb. 15, 1902. No. 46998 D.

Luxembourg Arch.

Some Reflections on the Luxemburg Bridge. Editorial discussion of the design and the use of stone as a structural material for bridges. Ill. 1700 w. Eng News—March 6, 1902. No. 46700.

The Erection of the Luxemburg Stone Arch. Illustrated detailed description of the viaduct between the railway station and the city, which is the longest stone arch yet built, having a 277½-foot span. 1200 w. Eng Rec—March 1, 1902. No. 46611.

The Luxemburg 277-ft. Stone Arch Viaduct. A general description, with two-page plate, of the longest stone arch in the world, now being constructed over the deep valley of the Petrusse, to connect the city with its railway station. 2000 w. Eng News—Feb. 27, 1902. No. 46569.

Pittsburg, Pa.

The Monongahela Bridge for the Wabash Railroad at Pittsburg. States the requirements to be met and gives an illustrated description of a remarkable bridge of the cantilever type, intended for the heaviest double-track modern service. 700 w. R R Gaz—March 14, 1902. No. 46832.

Plate Girders.

Formulæ for the Weights and Economic Depths of Plate Girders. Alfred Fyson. Gives formulæ designed to include every condition of span, depth, load and unit strain which can obtain in practice, and explains the method adopted in arriving at the separate expressions which give the weights. 2800 w. Engng—March 14, 1902. Serial. 1st part. No. 47080 A.

Plate-Girder Webs. T. Graham Gribble. Also editorial. Calls attention to the need for a revision of current theories as to the resistance of plate-girder webs. Examines the properties and the way in which the theory of construction deals with them. Ill. 6500 w. Engng—Feb. 21, 1902. No. 46596 A.

Redheugh Bridge.

The New Redheugh Bridge at Newcastle-on-Tyne. Illustrations of a reconstruction with several new features, with brief description. 1100 w. Sci Am—Feb. 22, 1902. No. 46501.

Renewal.

Renewal of the Florence Bridge, Louisville and Nashville and Southern Railways. Describes a novel method of renewing a bridge of 12 spans of about 120 ft. each. Ill. 400 w. Ry & Engng Rev—March 15, 1902. No. 47028.

Roath Dock Bridge.

Roath Bridge, Great Western Railway. Illustrated detailed description of this structure, which is on the very severe angle of skew of 22 deg. Its skew and square spans measure respectively 228 ft. and 76 ft. 3 in. 3000 w. Engr, Lond—Feb. 28, 1902. No. 46732 A.

Stiffening.

The Stiffening Trusses of Long-Span Railway Suspension Bridges. Editorial discussion of the relation between stiffness and cost in such bridges. 1400 w. Eng Rec—March 22 1902. No. 47033.

Suspension Bridges.

The Stiffening System of Long-Span Suspension Bridges for Railway Trains. Joseph Mayer. A comparison of the merits of various types, based on designs furnished for a bridge across the Hudson at New York. The bridge under discussion has twelve tracks. 17900 w. Pro Am Soc of Civ Engrs—Feb., 1902. No. 46533 E.

Swing Bridge.

A Counterbalance Swing Bridge on the Chicago, Milwaukee & St. Paul. Illustrated description of a new bridge over the Ogden canal, at Cherry street, in Chicago, of the pin-connected truss type. Electricity will be used for operating the bridge. 500 w. Ry Age—March 7, 1902. No. 46759.

A Non-Continuous Swing Bridge. Explains the ordinary construction of swing bridges, and improvements made at different times to overcome difficulties, simplify the operating machinery, and improve them, giving a detailed description of a design recently patented by Charles Worthington, so improved as seemingly to overcome all objections. Ill. 2500 w. Eng News—Feb. 27, 1902. No. 46563.

Viaur.

The Construction of the Viaur Viaduct (Notes sur la Construction du Viaduc der Viaur). M. Théry. A long article giving the calculations for this great steel arch in southern France, descriptions of which by the same author have already been indexed. Tables. Diagrams. 1 plate. 18000 w. Ann d Ponts et Chaussées. 3 Trimestre, 1901. No. 46919 E+F.

Y-Bridge.

The Zanesville Concrete-Steel Y-Bridge. Illustrated detailed description of this bridge and its construction. 1800 w. Eng Rec—March 1, 1902. No. 46609.

CANALS, RIVERS AND HARBORS.

Dams.

A New Automatic Movable Dam. Illustrated description of automatic wickets on top of a masonry dam which close during low water and open during floods 1500 w. Eng Rec—March 8, 1902. No. 46738.

A Severe Test of a Dam. Illustration with brief description of the flood at the Elmhurst dam of the Scranton Gas and Water Co. 600 w. Eng News—March 20, 1902. No. 47107.

Some Thoughts Suggested by the Recent Failures of Dams in the South. Robert L. Johnson. In the writer's opinion the failures were due to too light a section. 1700 w. Eng News—March 20, 1902. No. 47106.

The Melones M. Co. Dam, Stanislaus River, Cal. Plans of the site and plan and elevation of the dam, with views of the construction at several stages, and of the flume leading from the dam to the mill, with descriptive notes. 900 w. Min & Sci Pr—March 8, 1902. No. 46806.

Danube.

The Regulation of the Austrian Danube (Ausbildung der Fahrrinne in der Oesterreichischen Donau). Arthur Herbst. An illustrated account of the work of deepening the channels and improving the navigation on the Danube. 3 plates. 1000 w. Oesterr Wochenschr f d Oeffent Baudienst —Feb. 8, 1902. No. 46932 B.

Docks.

Avonmouth Docks. Plan of this new dock which is to be constructed. It provides for the reclamation of a large tract of tidal flats. 700 w. Engr, Lond—March 7, 1902. No. 46863 A.

Extensive Ore Dock Improvements. On the wonderful developments in hoisting and conveying machinery, and the changes still in progress; the automatic unloaders. Also considers the more substantial form of dock construction. Ill. 4000 w. Marine Rev—March 6, 1902. No. 46757.

Canal Haulage.

Mechanical Traction on the Nivernais Canal. Brief description, with illustrations of mechanical haulage by means of an universal chain. 400 w. Engng—March 7, 1902. No. 46857 A.

China.

Transportation in China (Verkehrwege Chinas). Dr. Franz Ritter v. Le Monnier. A paper giving a comprehensive review of the navigable rivers, canals, and railways, both existing and projected in China. Serial. 3 parts. 1300 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 7, 21 and 28, 1902. No. 46938 each B.

Hydro-Electric Plants.

See Electrical Engineering, Generating Stations.

Inclined Planes.

Canal Lifts on the Austrian Waterways (Die Anlage von Schiffshebewerken im Zuge der Oesterreichischen Wasserstrassen). Emil Krumholz. Illustrated plans for transporting vessels from one level to another and over an intervening ridge. 3 plates. 9000 w. Oesterr Wochenschr f d Oeffent Baudienst—Feb. 22, 1902. No. 46935 B.

The Construction of Inclined Planes for Transporting Vessels (Zur Construction von Geneigten Ebenen für Schiffstransport). Franz Prasil. An illustrated description of an inclined plane system for shifting canal boats from one level to another. 1 plate. 1800 w. Oesterr Wochenschr f d Oeffent Baudienst—March 1, 1902. No. 46936 B.

Isthmian Canal.

The Reports of the Isthmian Canal Commission. John Geo. Leigh. A critical analysis of the respective routes, based upon the reports of the Isthmian Canal Commission, and showing the superiority of the Panama route. 4000 w. Engineering Magazine—April, 1902. No. 47180 B.

Jetty Repair.

The Launching of Concrete and Masonry Blocks in Repairing Jetties (Note sur le Lancement des Blocs Artificials Employés pour l'Entretien des Jetés). M. Chevalier. An illustrated description of a method of launching large and heavy blocks into place. 700 w. Rev Technique—March 10, 1902. No. 47165 D.

Konigsberg.

The Königsberg Canal (Der Königsberger Seekanal). F. Jerosch. An illustrated description of a ship channel made through the shallow waters of the "Frische Haff" from Königsberg to the Baltic Sea. 2000 w. Deutsche Bauzeitung—Feb. 1, 1902. No. 46900 B.

Lighthouses.

The Visibility of Twin Lighthouses (Vision des Feux Associés). M. de Joby. A comprehensive discussion of the visibility of lighthouses, particularly those grouped in pairs. 8000 w. Ann d Ponts et Chaussées—3 Trimestre, 1901. No. 46916 E+F.

River Flow.

The Laws of River Flow. C. H. Tutton. Gives a theory advanced by D. T. Smith, of the Louisville (Ky.) University, with views of other writers. 2600 w. Jour Assn of Engng Socs—Jan., 1902. No. 46707 C.

The Natural Normal Sections of Streams (Die Natürlichen Normalprofile der Fliessenden Gewässer). Richard Siedek. A paper discussing the ideal condition of water flow in rivers, and the regulation of streams in harmony with natural laws. Diagrams. 1 plate. 6500 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 21, 1902. No. 46942 B.

River Gauging.

River Gauging With Rod Floats. Geo. W. Brown. Gives in detail a method of stream gauging by use of rod floats, with an outline of the reductions. 2500 w. Wis Engr—Feb., 1902. No. 46528 D.

River Improvements.

Reasons for the Failure of River Regulation Works. Discussion by Major D. C. Kingman, U. S. A., of the reasons why river improvements by regulation have often been unsatisfactory. 1700 w. Eng Rec—March 22, 1902. No. 47038.

Seaport.

Dalmy, the Russian Commercial Seaport in North China. A full account of this commercial seaport, established by the Russian government, its location, harbor, piers, etc., with maps and illustrations. 3500 w. U S Cons Repts, No. 1291—March 17, 1902. No. 46871 D.

Weir.

The Floating Shutter Weir (Das Schwimmklappenwehr, ein Neues Bewegliches Stauwerk). Emil Grohmann. An illustrated paper giving a description of a weir in which the shutters are moved by pumping water in and out of the lower part which is hollow. 1 plate. 9000 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 7, 1902. No. 46939 B.

Whampou River.

Improvement of the Whampou River by the Removal of the Wu Sung Bar (Amelioration de la Navigabilité de la Rivière Whampou par la Supression de la Barre de Woosung. J. J. Chollot. Project for the improvement of the river connecting Shanghai with the Yangtse-Kiang, with extract from engineers' report and Chinese treaty. Map. 7000 w. Mem d l Soc d Ing Civils de France—Jan., 1902. No. 47169 G.

Zuider Zee.

The Draining of the Zuider Zee. Prof. J. H. Gore. Describes the proposed work and the methods of carrying it out, giving related information. 2500 w. Pop Sci M—April, 1902. No. 47087 C.

CONSTRUCTION.

Building Construction.

Construction of the Remsen Building, New York. Illustrated description of the method of building a 16-story steel-cage office building and of special derricks used in the work. 2800 w. Eng Rec—March 22, 1902. No. 47041.

Structural Details of the Waterside Power Station, New York. Illustrated description of the steel work, including columns and coal pockets, roof-trusses, and smoke-stack platforms in a 197x272 ft. power station rising 155 ft. above the ground. 6700 w. Eng Rec—March 15, 1902. No. 46882.

The Chamber of Commerce Building, New York. Illustrated detailed description of the building and its arrangement. 1800 w. Eng Rec—March 1, 1902. No. 46612.

The Hanover National Bank Building, New York. Illustrated description of the steel-work in a 111x98 ft. office building rising 330 ft. above the sidewalk. 2000 w. Eng Rec—March 8, 1902. No. 46741.

Concrete Factory.

A Jersey City Concrete Factory Building. Illustrated description of large concrete steel cantilever floor supports and of the method of handling the concrete. 1500 w. Eng Rec—March 22, 1902. No. 47036.

Fire-Proofing.

Notes on Fire-Proof Construction Under the System Monier. E. Lee Heidenreich. An illustrated article describing important uses made of this construction in the United States. 1200 w. Ry & Engng Rev—March 15, 1902. No. 47022.

Rational Methods of Fireproofing. William Copeland Furber. Some suggestions, especially to manufacturers of fire clay materials. Ill. 1500 w. Br Build—Feb., 1902. No. 46635 D.

Foundations.

The Construction of Foundations for Buildings. Gerald E. Flanagan. Some points in the construction of foundations for heavy loads. 1200 w. Am Mach—March 27, 1902. No. 47144.

Grain Elevator.

Fireproof Grain Elevator Construction. James MacDonald. Describes the ordinary construction, where wood was the material most generally used, and gives an illustrated description of a system consisting of a combination of tile and reinforced steel members. Discussion. 8500 w. Jour W Soc of Engrs—Feb., 1902. No. 46704 D.

Piles.

The Supporting Power of Piles. Discussion by E. Sherman Gould of paper by Ernest P. Goodrich. 900 w. Pro Am Soc of Civ Engrs—Feb., 1902. No. 46535 E.

The Supporting Power of Piles. George F. Cotterill. Describes the failure of a timber wharf in Seattle and many experiments on models to determine the strength of the piling in the structures. 3000 w. Eng Rec—March 8, 1902. No. 46744.

Roads.

Cost of Building Macadam Roads at Port Huron, Mich. Frank F. Rogers. Abstract of a paper read at Grand Rapids, before Mich. Engng. Soc. A brief illustrated description of two roads, with summary of cost. 2000 w. Eng News—March 6, 1902. No. 46699.

State Road Construction in New Jersey. Explanation, from official reports, of the remarkable success of State aid for New Jersey highways. 1800 w. Eng Rec—March 22, 1902. No. 47039.

Tunnels.

Progress of the Simplon Tunnel (I Lavori del Traforo del Sempione). A. Ferrucci. An analysis of the work done at the various headings during the last quarter of 1901. 2000 w. Gior d Lav Pub e d Str Ferr—Feb. 26, 1902. No. 47190 D.

The Construction of the Aspen, Wyoming Tunnel on the Union Pacific Railroad. W. P. Hardesty. An explanation of recent improvements on this road for shortening the line and improving the grade, with illustrated description of the interesting features in connection with the tunnel named. 3700 w. Eng News—March 6, 1902. No. 46697.

The Ventilation of the Simplon Tunnel. Illustrated description of the ventilating plant employed in tunneling about 12¼ miles under mountains so high that the natural rock temperature is over 100 degrees F. for half the distance. Gives the temperature and humidity readings in different parts of the tunnel. 2600 w. Eng Rec—March 8, 1902. No. 46740.

MATERIALS.

Austrian Report.

Report of the Building Materials Committee (Bericht des Baumaterialien-Ausschusses). Karl Stöckl. A report of a committee of the Austrian Society of Engineers and Architects, with tables for all kinds of building materials and for floors, roofs, etc., with discussion. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—Special Supplement Feb. 21, March 7, 1902. No. 46943 each B.

Bitumen.

Bitumen in Cuba. T. Wayland Vaughan. Account of occurrences of bitumen in Cuba obtained partly during geological research, and partly from existing literature. Ill. 5800 w. Eng & Min Jour—March 8, 1902. No. 46787.

Cement.

Data and Notes Derived from Tests on Cement and also on Concrete Taken from Regular Batches Used in Actual Works. James S. Costigan. 5600 w. Can Soc of Civ Engrs, Adv. Proof—Feb. 27, 1902. No. 46519 D.

Cement Works.

The Rudelsburg Portland Cement Works. Illustrates and describes an interesting plant erected under unusual difficulties, because of the severe requirements never before imposed on a Portland Cement company. 2200 w. Eng Rec—March 1, 1902. No. 46610.

Fire Protection.

Portland Cement Concrete as a Protection from Fire. Charles L. Norton. An illustrated account of tests made to find the temperature of steel framework during a very severe fire test. 1000 w. Ins Engng—Feb., 1902. No. 46518 C.

Paving Brick.

Specifications for Paving Brick for Use at Wheeling, W. Va. Reprint of specifications relating to quality, dimensions, test, inspection, etc. 800 w. Eng News—Feb. 27, 1902. No. 46566.

Reinforced Concrete.

Tests of Reinforced Concrete Beams (Epreuves sur des Poutres en Ciment Armé). An illustrated account of tests of Monier beams made by the Wittenburg Company of Amsterdam. 800 w. Génie Civil—March 8, 1902. No. 47156 D.

Theory of the Strength of Beams of Reinforced Concrete. W. Kendrick Hatt. Abstract of a paper presented to the Indiana Engng. Soc. A computation of the strength of such beams. Mathematical. 3000 w. Eng News—Feb. 27, 1902. No. 46564.

See Civil Engineering, Bridges.

Timber Preservation.

The Hasselmann Process for Timber Preservation (Die Timber Preservation des Imprägnierverfahrens Hasselmann auf Schwellen und Nutzholz). From *Tiefbau.* A description of a process in which the preserving substances, generally metallic salts, are chemically united with the wood, which is also rendered fireproof. 1500 w. Gluckauf—Feb. 1, 1902. No. 46978 B.

MEASUREMENT.

Alaska Frontier.

The Alasko-Canadian Frontier. Thomas Willing Balch. A review of the entire negotiations relating to the purchase of Alaska with a view of determining the boundary. Maps. 8500 w. Jour Fr Inst—March, 1902. No. 46794 D.

Stadia Work.

A Few Notes on the Use of the Planetable for Rapid Stadia Work. John W. Hays. Notes from experience, describing the use of this instrument and the methods. 2200 w. Eng News—March 13, 1902. No. 46801.

MUNICIPAL.

Fire Apparatus.

A Pneumatic Fire Escape and Tower. William S. Crandall. Illustrated description of the pneumatic telescopic aerial truck of the city of Pittsburg. 800 w. Sci Am—March 8, 1902. No. 46691.

Pavements.

Tar Macadam in Pawtucket. Resume of ten years' experience with tar and bituminous macadam on streets having moderately heavy traffic. 900 w. Eng Rec—March 8, 1902. No. 46737.

Refuse Disposal.

The Present State of Refuse Disposal in Different Countries (Etat Actuel de la Question des Ordures Méenageres dans les Divers Pays). Ach. Livache. An illustrated, comprehensive review of the subject, founded largely on W. F. Goodrich's book. 15000 w. Bull Soc d'Encouragement—Feb., 1902. No. 47158 G.

Sewage Purification.

Old and New Methods of Sewage Purification at Pawtucket, R. I. Summary from a paper by George A. Carpenter, of work with the septic tank and with bacteria beds, and the intermittent sand filters. 2500 w. Eng News—Feb. 27, 1902. No. 46567.

Sewers.

Early History of the Separate Sewerage System. States facts concerning early failures of separate sewers of too small diameter. 1000 w. Eng Rec—March 8, 1902. No. 46743.

The Use of Concrete in Sewer Construction. Harry V. Gifford. Read before the Mich Engng. Soc. Describes a sewer built at Coldwater, Mich., giving a full account of the work with illustrations. 3000 w. Munic Engng—March, 1902. No. 46526 C.

Street Sprinkling.

The Sprinkling of Streets in Paris (L'Arrosement de la Voie Publique à Paris). E. Bret. A well illustrated account of street sprinkling and flushing, and the apparatus used. 4000 w. Génie Civil—Feb. 22, 1902. No. 47,151 D.

WATER SUPPLY.

Epidemics.

The Recent Epidemic of Typhoid Fever at Baraboo, Wis., and its Probable Relation to the Water Supply. W. G. Kirchoffer. Describes the location of the city, the source of water supply, plant, etc., and concludes that it is not safe to run a pure water main through polluted water with no other protection than a lead joint. Ill. 1500 w. Eng News—Feb. 27, 1902. No. 46562.

Ground Water.

The Measurement of Ground Water (Versuchsbrunnenanlagen). Hr. Prinz. A paper on the importance of ground water supplies, and methods of determining the amount available, by means of experimental wells, etc. 4500 w. Gesundheits, Ing—Jan. 31, 1902. No. 47196 B.

Meters.

Notes on Water Meters (Note sur les Compteurs d'Eau). M. Couronne. An account of Paris regulations and laboratory for testing meters, and an illustrated review of many types. Serial. 1st part. 4000 w. Rev de Mecanique—Jan., 1902. No. 47167 E+F.

Purification.

Water Purification. P. A. Maignen. A review of the history of filtration, appliances used, results, etc. Ill. 8000 w. Jour W Soc of Engrs—Feb., 1902. No. 46705 D.

Reservoirs.

Construction of the Forbes Hill Reservoir and Stand-Pipe at Quincy, Mass. C. M. Saville. Illustrated description of work carried out to furnish storage and protection to the southern part of the Metropolitan water district, and to provide for sudden and unusual drafts. 6000 w. Eng News—March 13, 1902. No. 46805.

Forbes Hill Reservoir and Water Tower, Quincy, Mass. Alfred D. Flinn. Illustrated description of a steel standpipe enclosed in a masonry tower, and of an open basin with a very thick concrete lining of unusual construction. 2200 w. Eng Rec—March 15, 1902. No. 46880.

St. Louis.

Report of the St. Louis Water Supply by an Expert Commission. Abstracted by Robert E. McMath. 9000 w. Eng News—March 6, 1902. No. 46701.

Water Mains.

Electrolysis Investigations at Erie, Pa. Illustrated description of some unusual results due to electricity leaving the street railway tracks. 1200 w. Eng Rec—March 8, 1902. No. 46739.

Water Sheds.

The Drainage of Swamps for Watershed Improvement. Edward S. Larned. An illustrated article explaining methods used in draining the Sudbury watershed in Massachusetts, giving costs. Also discussion. 5000 w. Jour N E Water Wks Assn—March, 1902. No. 46651 F.

Water Tank.

Stresses in a Conical Bottomed Water Tank. Illustrated analysis of the stresses in a tank like that which collapsed in 1901 at Fairhaven, Mass. 700 w. Eng Rec—March 8, 1902. No. 46745.

Water Works.

The Water-Works System of Middletown, N. Y. Brief history of the works with illustrated description of improvements and additions now under construction. 1000 w. Munic Engng—March, 1902. No. 46525 C.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cable Laying.

Submarine Cable Laying During a Canadian Winter. G. U. G. Holman. Illustrates and describes the laying of a cable between Quebec and Levis, Canada. 2200 w. Elec Wld & Engr—March 22, 1902. No. 47098.

Cable.

The Imperial Cable. An interesting account of the All-British cable now in course of construction, which will connect England with Canada, Fiji and other South Sea Islands, Australia and New Zealand. 4000 w. Engr, Lond—Feb. 21, 1902. No. 46599 A.

Duplex.

Improvements in Hughes Duplex Telegraphy (Verbesserungen in der Hughes Duplex-Telegraphie). J. Jokisch. An illustrated description of a refined differential duplex arrangement. 1500 w. Oesterr Wochenschr f d Oeffent Baudienst—Feb. 15, 1902. No. 46934 B.

Exchanges.

The City Exchange of the Post-Office Telephone Department. Illustrated technical description of the telephone system being erected in London, and of the equipment of the new city exchange. 2500 w. Elect'n, Lond—March 7, 1902. Serial. 1st part. No. 46850 A.

The Equipment of a Modern Telephone Exchange. F. A. S. Wormull. Read before the Newcastle Sec. of the Inst. of Elec. Engrs. Illustrates and describes three systems as representative of the most recently built exchanges in England. 4500 w. Elec Engr, Lond—March 7, 1902. No. 46853 A.

The Janus Branch Exchange System for Business Telephony (Janusnebenstellen-System für Geschäftstelephonie). Hans Zopke. A well illustrated description of a switchboard system for changing connections from an interior network to the public lines and vice versa. 3000 w. Elektrotech Zeitschr—Feb. 20, 1902. No. 46950 B.

Faults.

The Final Localization of "Earths" on Low-Tension Networks. A. P. McDouall. Concernings the means of locating a fault when the solid system of laying mains is used, describing the loop test. 1000 w. Elec Rev, Lond—March 14, 1902. No. 47071 A.

Space Telegraphy.

Marconi's Wireless Telegraph Company. Gives Mr. Marconi's address to the shareholders at a recent meeting in England. 4800 w. Elec Rev, Lond—Feb. 28, 1902. No. 46718 A.

Mr. Marconi's Latest Achievement in Ocean Wireless Telegraphy. Wilfrid Blaydes. A report of the recent trip of the "Philadelphia" with a reproduction of the signal received 2099 miles. 1200 w. Elec Wld & Engr—March 8, 1902. No. 46786.

New Slaby-Arco Wireless Telegraph Installation. From *Elektrotechnische Zeitschrift.* Describes some installations of this system. 900 w. Elect'n, Lond—Feb. 21, 1902. No. 46584 A.

On the Elevation of the Electrically-Conducting Strata of the Earth's Atmosphere. A. E. Kennelly. Interesting reasoning explanatory to the propagation of the waves in wireless telegraphy. 500 w. Elec Wld & Engr—March 15, 1902. No. 47008.

Slaby-Arco Wireless Telegraph Apparatus. A. Frederick Collins. Illustrated description of this system and the apparatus used. 1800 w. Elec Wld & Engr—March 1, 1902. No. 46619.

Space Telegraphy (Rundschau). An editorial on Marconi's recent work, on the practicability of transoceanic operation, and on the necessity to the improvement of details in short and medium distance work. 800 w. Elektrotech Zeitschr—March 13, 1902. No. 46958 B.

The Guarini Repeating Wireless Telegraph System. A. Frederick Collins. Illustrated description of the system of M. Emile Guarini, and his repeating device. 2000 w. Sci Am—March 8, 1902. No. 46693.

The Paternity of Wireless Telegraphy. Discusses the claims of Dr. E. Branly, of France, and shows that many have contributed to the discovery and perfection of wireless telegraphy. Ill. 2500 w. Elec Engr, Lond—Feb. 21, 1902. No. 46583 A.

The Scientific Foundations of Spark Telegraphy (Die Wissenschaftlichen Grundlagen der Funkentelegraphie). Prof. A. Slaby. An illustrated review of the theory and fundamental experiments of wireless telegraphy. 3000 w. Elektrotech Zeitschr—Feb. 27, 1902. No. 46951 B.

Wireless Telegraphy and Submarine Cables. Emile Guarini. Discusses various sides of the question relating to the practical use of wireless telegraphy across the oceans, making comparisons with the cable. 3800 w. Elec Rev, Lond—Feb. 28, 1902. No. 46719 A.

Telegraphy.

The Burry Ticker and Page Printing Telegraph. Frank C. Perkins. Illustrated description. 1300 w. Elec, N Y—March 19, 1902. No. 46878.

Telephony.

Features of Modern Telephone Work. Address of J. J. Carty to the N. Y. Elec. Soc. at the new Cortlandt St. Exchange of the N. Y. Telephone Co. 2800 w. Elec Wld & Engr—Feb. 22, 1902. No. 46515.

The Faller System of Automatic Telephony. Illustrated description. 1700 w. Elec Rev, N Y—March 22, 1902. No. 47097.

DISTRIBUTION.

Accumulator Switch.

An Automatic Storage Battery Switch (Ueber einen Neuen Selbstthätigen Zellenschalter). Paul Thieme. An illustrated description of a switching apparatus for automatically cutting in and out cells of arc accumulator battery, and a general review of such switches. 2000 w. Elektrotech Zeitschr—Feb. 27, 1902. No. 46952 B.

Booster.

The Diminishing of Earth Currents on Alternating-Current Railways with Track Return Circuit (Verminderung der Erdströme bei mit Wechselstrom betriebenen Ueberlandbahnen mit Schienenrückleitung). Emil Ziehl. An illustrated account of experiments confirming Gisbert Kapp's method of using boosters at points along the railway. 2000 w. Elektrotech Zeitschr—Feb. 20, 1902. No. 46948 B.

Conduits.

A New Electric Conduit System (Ueber ein Neues Installationssystem). A. Peschel. Paper before the Elektrotechnischer Verein, giving illustrated description of a conduit system consisting of split steel tubes which can be cut in any suitable length and whose ends fit tightly into connecting pieces. 4000 w. Elektrotech Zetischr—March 6, 1902. No. 46957 B.

Economical Section.

The Economical Section of Conductors (Die Berechnung der Leitungen auf Wirthshaftlichkeit der Anlage). Prof. J. Teichmüller. A discussion of various formulæ for the most economical size of conductor for a given power transmission plant, with an attempt to harmonize them. Diagrams. 5500 w. Elektrotech Zeitschr —March 6, 1902. No. 46955 B.

Karlsruhe.

See Electrical Engineering, Generating Stations.

ELECTRO-CHEMISTRY.

Alkali.

Electrolytic Production of Alkali. An illustrated description of the Middlewich Works and the processes, with an account of the investigations of Dr. Sproesser, concerning the suitability of various carbons as anodes for the electrolysis of sodium chloride. 2800 w. Engng—March 14, 1902. No. 47086 A.

Alkali Works.

The Electrolytic Alkali Company's Works. Illustrated description of the works at Middlewich, where the Hargreaves-Bird process is used. 2700 w. Elec Engr, Lond—March 14, 1902. No. 47070 A.

ELECTRO-PHYSICS.

Earth Currents.

Experiment Investigation of Electric Earth Currents (Untersuchungsergebnisse über den Natürlichen Elektrischen Erdstrom). E. Jahr. A record of experiments in the vicinity of Berlin, showing the influence of the relative positions of the earth plates, etc. 2400 w. Elektrotech Zeitschr—March 6, 1902. No. 46956 B.

Electric Waves.

The General Problem of Wave Propagation Over Non-Uniform Conductors. M. I. Pupin. Showing that the mathematical solution of the problem of wave propagation over non-uniform conductors of the series type is the most general solution because every other case can be deduced from it. 2400 w. Elec Wld & Engr —March 1, 1902. No. 46621.

Electrodynamics.

Electrodynamics of Moving Bodies (Electrodynamique des Corps en Mouvement). E. Carvallo. The application of electrodynamic equations, founded on a generalization of Kirchoff's two laws, to moving bodies. 700 w. Comptes Rendus —Jan. 20, 1902. No. 47179 D.

Electrons.

Radio-Activity and the Electron Theory. Sir William Crookes. Read before the Royal Soc. An illustrated account of experimental investigations. 2700 w. Nature—Feb. 27, 1902. No. 46710 A.

Interrupter.

A Carbon Electrolytic Interrupter. A. H. Taylor. Describes a cheap, simple, self-adjusting instrument suited for continuous service. Ill. 1500 w. Elec, N Y—March 5, 1902. No. 46643.

A Modified Wehnelt Interrupter. Prof. A. L. Foley and R. E. Nyswander. Illustrates and describes an interrupter used for more than two years in the Indiana University Physics Laboratory with better results and less trouble than any others of the electrolytic type. 1000 w. Elec Wld & Engr—March 1, 1902. No. 46618.

Magnetic Declination.

Results of Magnetic Observations at Bochum, Westphalia, in 1901 (Ergebuisse der Magnetischen Beobachtungen in Bochum im Jahre 1901). Hr. Lenz. Curves and tables of the magnetic declination for every hour of the year. Glückauf—Special Supplement, Feb. 1, 1902. No. 46-976 B.

Magnetic Expansion.

The Magnetic Expansion of Iron and Steel. Philip E. Shaw, and S. E. Laws. Thorough investigation of Swedish iron, mild steel and hard steel. Ill. 3000 w. Elect'n, Lond—Feb. 21, 1902. Serial. 1st part. No. 46587 A.

Magnetic Properties.

The Conductivity and Magnetic Properties of Alloys of Iron. Abstract of a paper by Prof. W. F. Barrett and W. Brown, read at meeting of the Inst. of Elec. Engrs, England. Discusses electric conductivity, magnetic properties, non-magnetic alloys of iron, alloys of iron more magnetic than the purest commercial iron, etc. 3200 w. Elect'n, Lond—Feb. 21, 1902. No. 46585 A.

Magnetism.

The Electrical and Magnetic Properties of Iron Alloys. Editorial on the researches of Prof. Barrett, with Messrs. Brown and Hadfield. 1200 w. Engng—March 14, 1902. No. 47085 A.

Radiography.

Some Properties of the Rays from Radio-Active Bodies (Sur quelques Propriétés du Rayonnement des Corps Radioactifs). Henri Becquerel. Notes on experiments with uranium, radium, etc. 900 w. Comptes Rendus—Jan. 27, 1902. No. 47191 D.

The Experimental Classification of Different Kinds of X Rays by Means of the Radiochromometer (Definition Expèrimentale des Diverses Sortes de Rayons X, par le Radiochromomètre). L. Benoist. A description of an instrument which classifies the degree of penetration of different kinds of X rays, and applications. 500 w. Comptes Rendus—Jan. 27, 1902. No. 47192 D.

Thermo-Electricity.

The Thermo-Electric Properties of Steel and Nickel-Steel (Sur la Thermo-Electricité des Aciers et des Ferro-Nickels). G. Belloc. A record of experiments with alloys with various percentages of nickel to determine the temperature of the neutral point and the electromotive force. 400 w. Comptes Rendus—Jan. 13, 1902. No. 47177 D.

Vacuum Tubes.

Distribution of Current at the Surface of Cathodes in Vacuum Tubes. A. Wehnelt. Translated from *Ann. der Physik*. Considers the distribution of current in cathodes not completely covered with glow light, at the surface of completely covered plane cathodes, at the surface of curved cathodes, and the influence of the material and the surface condition upon the distribution between two parallel cathodes. Ill. 4500 w. Elect'n, Lond—March 14, 1902. No. 47074 A.

GENERATING STATIONS.

Armature Winding.

The Theory of the Equipotential Connections of the Armatures of Direct Current Machines (Theorie der Aequipotential-Verbindungen der Anker von Gleichstrommaschinen). Prof. E. Arnold. A mathematical discussion of the connection of equipotential points of the armature winding. Diagrams. Serial. Part I. 3000 w. Elektrotech Zeitschr—March 13, 1902. No. 46960 B.

Bankside.

The City of London Electric Lighting Company's Works. Illustrated article describing the extension and changes from alternating to continuous current at the Bankside Works. 3000 w. Elec Engr, Lond—Feb. 28, 1902. No. 46716 A.

The Direct-Current Plant at Bankside. Illustrated description of the plant and engine-room with which the continuous-current supply has been given. 2300 w. Elec Times—Feb. 27, 1902. No. 46711 A.

Dynamos.

Designing of Continuous Current Dynamos. Aubrey Clayton. Discusses the subject of commutation. 1800 w. Elec Rev, Lond—Feb. 21, 1902. No. 46582 A.

Large Generators for Bolton Corporation. Illustrated account of the tests of two 1100 kilowatt machines at the works of the English Electric Manufacturing Company. 2200 w. Tram & Ry Wld—Feb. 13, 1902. No. 46589 B.

Hydro-Electric Plants.

Development of a Great Water Power System at Hartford, Conn. Alton D. Adams. A detailed report of the operation of the Hartford Electric Light Company during the last ten years. The plant is a combined steam and water plant. Ill. 3300 w. Elec Wld & Engr—March 8, 1902. No. 46784.

Hydro-Electric Plants in the Alps (Les Installations Hydro-Electriques dans la Region des Alpes). M. de la Brosse. A well illustrated comprehensive report on a number of plants in the French Alps and about Geneva. 17000 w. Ann d Ponts et Chaussées—3 Trimestre, 1901. No. 46915 E+F.

The Dam and Power Station of the Hudson River Water Power Co. Illustrated description of a large masonry dam and power house at Spier Falls, for developing 20,000 H-P. 1400 w. Eng Rec—March 8, 1902. No. 46736.

Karlsruhe.

New Electric Stations (Neuere Elektrizitätswerke). Felix Winawer. An illustrated description of the electric station at Karlsruhe, Baden, and the distribution plant. 2000 w. Elektrizität—Jan. 18, 1902. No. 47198 C.

Los Angeles.

The System of the Los Angeles Electric Company. Illustrates and describes the new power house of the Los Angeles Elec. Co. and its equipment. 1500 w. Jour of Elec—Feb., 1902. No. 46879.

Power Plant.

A Modern District Central Station. Illustrated detailed description of the plant of the Westchester Lighting Company, at

New Rochelle, N. Y. 2200 w. Am Elect'n —March, 1902. No. 46677.

Design for a Power Station in Providence. Illustrated detailed description of a plant in process of construction. 1800 w. St. Ry Jour—March 1, 1902. No. 46772 D.

New Power Plant of the National Cash Register Co., Dayton, Ohio. Fred W. Ballard. Illustrated detailed description of a new plant under construction. 5000 w. Engr, U S A—March 1, 1902. No. 46670.

Notes on the Care of the Power House. Arthur B. Weeks. An illustrated article on repairs to station circuit-breakers. 1600 w. St Ry Rev—March 15, 1902. No. 47-020 C.

Sheiks Island Power Plant. F. H. Leonard, Jr. Detailed description. 1800 w. Elec Rev, N. Y—March 1, 1902. No. 46560.

The Hydraulic Equipment of the Colgate Power House. An illustrated detailed description of the Risdon wheels and governors, by Thomas J. Barbour, with reference also to other features. 5000 w. Jour of Elec—Jan., 1902. No. 46615.

The Power Station of the Manhattan Railway, New York. An illustrated detailed description of the electric power station for the elevated system in New York. 5300 w. Ir Age—March 13, 1902. No. 46874.

The Stations of the Independent Electric Light and Power Co., San Francisco, Cal. Illustrated description of a large electric central station in which oil is used exclusively for the generation of heat in the boiler furnace. 1500 w. Power—March, 1902. No. 46687.

Regulation.

Armature Interference and Brush Position. H. M. Hobart. Showing the influence of armature windings, and brush position upon regulation, and giving a table of useful observations to be taken on a commutating dynamo to determine the most favorable fixed brush position for a given machine. 1800 w. Elec Rev, Lond —Feb. 28, 1902. Serial. 1st part. No. 46717 A.

Sub-Station Equipment.

Influence of Sub-Station Equipment on the Cost of Electricity Supply. Andrew Stewart. Part of a paper read before the Newcastle Sec. of the Inst. of Elec Engrs. Discusses types of sub-stations and their equipment and present methods of distribution, giving results of investigations. 4800 w. Elect'n, Lond—Feb. 21, 1902. No. 46586 A.

Switchgears.

The Construction of High Tension Central Station Switchgears, with a Comparison of British and Foreign Methods. Henry W. Clothier. Read before the Manchester Soc. of the Inst. of Elec. Engrs. Brief outline of switchgear practice for alternating currents, and illustrates the main features of the apparatus produced in Germany as compared with English productions. Ill. 2400 w. Elec Times—Feb. 20, 1902. Serial. 1st part. No. 46577A.

Transformers.

Types of Transformers. John H. Ryan, Jr. An illustrated article explaining the systems of transmission of high-voltage currents and the transformers in use. 3500 w. Engr, U S A—March 15, 1902. No. 47005.

University Plant.

Power Plant and Heating System of the Ohio State University, Columbus. W. C. McCracken. Illustrated description of the system for heating, lighting and power distribution for a number of buildings. 2000 w. Engr, U S A—March 15, 1902. No. 47004.

The Power, Lighting and Heating Plant of the University of Chicago. Illustrated description of an installation of tubular boilers of 1,350 h. p., with an elaborate auxiliary equipment and a unique system of tunnels for the heating and electric lines. 5100 w. Eng Rec—March 15, 1902. No. 46881.

HEATING AND WELDING.

Electric Furnaces.

Electric Furnaces. Bertram Blount. Abstract of a paper read before the Manchester Sec. of the Inst. of Elec Engrs. An illustrated article describing the types and reviewing the history and development. 5500 w. Mech Engr, Lond—March 15, 1902. No. 47063 A.

Electrical Resistance Furnaces. Extract from an article by Otto Vogel, appearing in a German paper. Discusses the resistance furnace. 1300 w. Elec Rev, Lond—March 14, 1902. No. 47072 A.

LIGHTING.

Arc Lamps.

The Heany Enclosed Arc Lamp. E. Trier. Illustrated description with a statement of the points of excellence claimed. 1400 w. Elec Wld & Engr—March 8, 1902. No. 46785.

The Theory of the Regina Enclosed Arc Lamp (Zur Theorie der Regina-Dauerbrand-Bogenlampe). Dr. B. Donath. An illustrated account of photometric and photographic investigations, with explanation of the high actinic power of this lamp. 800 w. Elektrotech Zeitschr—March 13, 1902. No. 46961 B.

Canal Lighting.

Power Transmission Plant for Lighting the Cornwall Canal, Canada. An illustrated article describing an installation of American apparatus. 2000 w. Elec Wld & Engr—March 1, 1902. No. 46622.

Enclosed Arc.

Note on the Spectrum of the Enclosed

Arc. William Lincoln Smith. Comparisons showing the remarkable differences in light distribution between the light of the sky and that from the enclosed arc, and the Nernst lamp. 700 w. Elec Wld & Engr—Feb. 22, 1902. No. 46513.

Illumination.

Methods of Illumination. Louis Bell. Discusses the important qualities for a perfect illuminant, general illumination, &c., considering the practical rather than the technical side. 9300 w. Trans Am Inst of Elec Engrs—Feb., 1902. No. 46-654 D.

Military.

See Mechanical Engineering, Automobiles.

Nernst Lamp.

Nernst Lamp, 1902 Model (Nernstlampe Model 1902). Illustrated description of details of the latest Nernst lamps manufactured by the Allgemeine Elektrizitäts-Gesellschaft, of Berlin. 600 w. Elektrizität—Jan. 18, 1902. No. 47197 C.

Osmium Lamp.

The Osmium Incandescent Lamp (Die Osmium-Glühlampe von Freiherr Auer v. Welsbach). From a paper by Robert Gabriel before the Elektrotechnischer Verein, Vienna, giving an account of the manufacture of electric lamps with osmium filaments, made by Dr. Auer von Welsbach, and experiments showing high efficiency. 1200 w. Elektro-Techniker—Jan. 15, 1902. No. 47199 B.

MEASUREMENT.

Phase Difference.

An Exact Method for Measuring Very Large Phase Differences (Eine Methode zur Exakten Messung Sehr Grosser Phasenverschiebungen). Dr. Max Breslauer. From the *Zeitschrift für Elektrotechnik* An illustrated description of a modification of the "three-voltmeter" method, in which only a differential galvanometer is used, with very exact results. 2500 w. Elektrotech Zeitschr—March 13, 1902. No. 46-962 B.

Testing.

Testing by Resistance Measurements. Considers the tests made in central stations and the methods used. Ill. 2200 w. Cent Station—March, 1902. No. 46751.

Testing Materials.

The Testing of Materials (Prüfung von Materialien). Dr. Paul Holitscher. An account of methods and results of testing all kinds of materials used at the electrical works of W. Lahmeyer & Co. Diagrams and tables. Serial. 2 parts. 8000 w. Elektrotech Zeitschr—Feb. 20, 27, 1902. No. 46949 each B.

Wattmeters.

Rating of Wattmeters for Three-Phase Systems. Charles Brandeis. On means of determining correct ratings. 800 w. Elec Wld & Engr—March 15, 1902. No. 47009.

Test Coils for Alternating-Current Wattmeters. R. Beattie. A suggestion of a simple addition to a wattmeter which would make it in a certain sense self-testing. Explanatory. 1200 w. Elect'n, Lond—March 14 1902. No. 47073 A.

POWER APPLICATIONS.

Electric Motors.

A Device for Synchronizing Motors. William Duane. Illustrated description of a device for synchronizing two electric motors under stated conditions. 1300 w. Elec Rev, N. Y—March 15, 1902. No. 46897.

Early Forms of Electric Motors. Illustrated descriptions of the motors designed by Page, Davenport and Hjorth, about the middle of the nineteenth century. 800 w. Sci Am Sup—March 22, 1902. No. 47117.

Mine Hoisting.

A New System of Electric Hoisting for Mine Shafts (Ueber ein Neues System Elektrischer, Schacht-Fördermaschinen). Hans Bansen. A description of a system in which the hoisting motor is in circuit with a dynamo driven by an auxiliary motor, by which means the speed is regulated. 800 w. Glückauf—Feb. 22, 1902. No. 46-979 B.

Mining.

Electricity in Mining. George H. Gibson. On electrical machinery used in mining, with report of a number of recent installations. Ill. 2700 w. Eng & Min Jour—March 1, 1902. No. 46641.

Power Plant.

Electric Power in a Shale Oil Works. Brief description of an installation of exceptional interest about to be put down at the works of the Oakland Oil Company, in Scotland. 1200 w. Elec Rev, Lond—March 7, 1902. No. 46854 A.

TRANSMISSION.

High Tension.

High-Tension Electric Power Transmission. Geo. H. Gibson. A discussion of the extent to which high-tension transmission enters as a factor in the utilization of natural forces, with illustrations from important installations. 3500 w. Engineering Magazine—April, 1902. No. 47186 B.

Lightning-Arresters.

Horn Lightning-Arresters with Iron Framing. Eugen Klein. Illustrated description of lightning safety devices for electrical apparatus. 900 w. Elect'n, Lond—March 7 1902. No. 46851 A.

Long Distance.

The Longest Power-Transmission in the World. Thomas Commerford Martin. An illustrated article giving much interesting information in regard to the allied Bay Counties Power and Standard Electric companies of California. 3600 w. Rev of Revs—March, 1902. No. 46516 C.

Mexico.

The Transmission System of the Compania Explotadora De San Ildefonso of the City of Mexico. Stephen Q. Hayes. An illustrated description of a remarkable system where a number of generating stations supply power to a single sub-station. 3000 w. Elec Wld & Engr—March 15, 1902. No. 47006.

MISCELLANY.

Electric Shock.

Electric Shock and Legislation Thereon. C. E. Webber. Concerning the scientific aspect, liability to exposure, and legislation. 5800 w. Inst of Elec Engrs—Feb. 27, 1902. No. 46676 D.

Electric Shocks at Five Hundred Volts. Alexander Pelham Trotter. Records a few experiments and discusses the conditions under which shocks at 500 volts are devoid of danger. 4000 w. Inst of Elec Engrs—Feb. 27, 1902. No. 46675 D.

Electric Shocks. F. B. Aspinall. Discusses points on which information is desired, in the hope of learning better methods of giving aid in case of accident. 5000 w. Inst of Elec Engrs—Feb. 27, 1902. No. 46674 D.

Liverpool.

The Rapid Progress of Electricity in Liverpool. Abstracted from a report submitted by A. B. Holmes. Gives much information relating to supply and cost. 2000 w. Elec Engr, Lond—Feb. 28, 1902. No. 46715 A.

Russian Congress.

The Second Congress of Russian Electrical Engineers at Moscow (Der II. Kongress Russischer Elektrotechniker in Moskau). C. v. Vetterlein. A general review of the congress, held in January, 1902, and of the papers read there. 2000 w. Elektrotech Zeitschr—Feb. 27, 1902. No. 46-953 B.

Theory.

The Scientific Foundations of Electrical Engineering (Die Wissenschaftlichen Grundlagen der Elektrotechnik). Prof. Max Reithoffer. An illustrated lecture on the fundamentals of electricity and magnetism. 4500 w. Zeitschr d Oesterr Ing u Arch Ver—Special supplement, Feb. 14, 1902. No. 46941 B.

GAS WORKS ENGINEERING

Acetylene.

Acetylene for Railway Lighting in France. Information concerning the mixture of acetylene and cannel coal gas used in lighting the coaches of the Paris-Lyons-Mediterranean Ry. 1000 w. Engr, Lond—March 14, 1902. No. 47075 A.

Some Disastrous Acetylene Gas Explosions. An account of two explosions, wrecking the houses in which they occurred, and causing loss of life. Ill. 500 w. Sci Am—March 22, 1902. No. 47113.

Address.

Mr. Charles Hunt's Presidential Address before the Midland Association of Gas Managers. Interesting discussion of matters relating to the gas industry. 10000 w. Gas Wld—March 1, 1902. No. 46713 A.

Bench Firing.

Coal for Bench Firing. R. C. Cornish. Read before the Wisconsin Gas Assn. An account of methods used at Racine, Wis. 1000 w. Pro Age—March 15, 1902. No. 46822.

Carburetted Air.

Carburetting Air for Lighting Purposes. Reviews what has been done by the French Aërogen Gas Company, in the direction of the practical application of carburetted air for the purpose of illumination. Ill. 2100 w. Jour Gas Lgt—March 18, 1902. No. 47149 A.

Chimneys.

The Control of Chimney Draught. E. H. Hudson. Read before the Manchester Dist. Inst of Gas Engrs. Discussion of the design of chimneys in connection with retort-house work, and the difficulties due to draught. Ill. 4500 w. Jour Gas Lgt—March 4, 1902. No. 46841 A.

Coal Gas.

Coal Gas Treatment. A. B. Slater, Jr. Read before the New England Assn. of Gas Engrs. Discusses results of various methods, with special reference to the deposition of naphthaline. 2300 w. Pro Age—March 15, 1902. No. 46821.

New Comparisons in Favor of Coal Gas. T. E. Pye. Concerning the relative hygienic values of coal gas and electricity respectively as illuminating and heating agents. 2000 w. Jour Gas Lgt—March 11, 1902. No. 47065 A.

Coal Shed.

A Model Coal Shed. Thomas H. Hintze. Read before the New England Assn. of Gas Engrs. An illustrated description of a new structure of the Lowell (Mass.) Gas Light Company. 3300 w. Am Gas Lgt Jour—March 17, 1902. No. 46896.

Coke.

The Disposal of Coke. W. Whatmough. Read before the Manchester Dist. Inst. of Gas Engrs. Discusses the trade situation due to decrease in prices obtained for coke, and the remedy. General discussion follows. 4500 w. Jour Gas Lgt—March 4, 1902. No. 46842 A.

Distribution.

Distributing Artificial Gas at High Pressure in a Suburban Locality. George F. Goodnow. Read before the New England Assn. of Gas Engrs. Also discussion. Describes the methods used by the North Shore Gas Company of Illinois. Ill. 6000 w. Am Gas Lgt Jour—March 3, 1902. No. 46623.

Explosive Limits.

Explosive Limits of Combustible Gases. Dr. P. Eitner. Abstract translation of a series of five articles in recent numbers of the *Journal für Gasbeleuchtung*. A review of researches and results. 3000 w. Jour Gas Lgt—March 11, 1902. Serial. 1st part. No. 47068 A.

Gasholders.

Standard Specifications for Supplying the Structural Ironwork of Gasholders. Drawn up in 1901, conjointly by the German Assn. of Gas and Water Engrs. and the Union of German Mfrs. of Gasholders. 2500 w. Jour Gas Lgt—March 11, 1902. No. 47069 A.

High-Pressure.

High-Pressure Gas Lighting. Joseph Nasmith. Extracts from a paper read before the Manchester Assn. of Engrs. Discusses the recent improvements in the gas industry, especially incandescent lighting, and high pressure, or intensified gas lighting. Also general discussion. 6200 w. Jour Gas Lgt—Feb. 25, 1902. No. 46663 A.

Incandescent Lighting.

The Variability of the Incandescent Gas Light (Die Launen des Gasglühlichts). A discussion of the variability of the light, and the possibility of properly regulating the burner. 1000 w. Gesundheits Ing—Jan. 31, 1902. No. 47195 B.

Mantles.

The Theory of the Incandescent Mantle. A. H. White, H. Russel, A. F. Traver. Read at meeting of Mich. Gas Assn. Discusses the cause of luminosity of the mantle, quoting from other investigations, and giving results of experiments of temperature measurements, and a statement of the writers' views. 3800 w. Pro Age—March 15, 1902. No. 46820.

Orleans Tramway Plant.

See Street and Electric Railways.

Petroleum.

Mineral Oil as an Illuminant. Vivian B. Lewes. Abstract of the first of a course of three lectures delivered at the Petroleum Inst., London. The present lecture deals with the use of oil in lamps. 1700 w. Gas Wld—March 15, 1902. Serial. 1st part. No. 47062 A.

Pipes.

A Twin Pipe. R. J. Melbourne. Illustrated description of a pipe of oval shape, divided into two parts, each part having the same capacity as a single pipe. Discusses the advantages and economy secured. 1800 w. Jour Gas Lgt—March 4, 1902. No. 46838 A.

Producer Gas.

The Use of Producer Gas in Engineering. Extracts from paper by F. J. Rowan, read at meeting of the Inst. of Engrs. in Scotland. Considers producers with water bottoms, the furnaces which are specially useful to engineering and shipbuilding, the use of producer gas in gas-engines, &c. 3500 w. Jour Gas Lgt—Feb. 25, 1902. No. 46664 A.

Retorts.

Inclined Retorts and Their Working. H. P. Maybury. Read before the Midland Assn. of Gas Mgrs. Also discussion. A paper favoring the use of inclined retorts, discussed by those who had had no experience with them. 9400 w. Jour Gas Lgt—March 4, 1902. No. 46840 A.

Retort-House Working in Berlin. Edward Drory. Tabulated results of actual workings with explanatory remarks, showing the advantage of inclined retorts. 1600 w. Jour Gas Lgt—Feb. 25, 1902. No. 46661 A.

The Early History of Inclined Retorts. A summary of the history, which does not date back more than twenty years. 2000 w. Jour Gas Lgt—Feb. 18, 1902. Serial. 1st part. No. 46536 A.

Ventilation.

A Scheme of Ventilation with Gas-Warmed Air. Suggests that forced ventilation be accompanied by an arrangement for warming the inflowing air by means of pipes or plates heated by gas. 1800 w. Jour Gas Lgt—Feb. 25, 1902. No. 46659 A.

Water Gas.

Some Details in the Operation of a Water Gas Plant. Charles F. Leonard. Notes points that have appealed to the writer in a comparatively brief experience in gas-works using the Lowe process. Also discussion. 9500 w. Am Gas Lgt Jour—March 24, 1902. No. 47120.

The Building of a Water Gas Plant. C. W. Tippy. Read at meeting of the Mich. Gas Assn. Illustrates and describes a plant recently built in Detroit. 4000 w. Am Gas Lgt Jour—March 10, 1902. No. 46758.

INDUSTRIAL ECONOMY

Business Preparation.

The Commercial Side of Engineering. Charles Kirchhoff. A lecture to students showing the need of commercial training as well as mechanical, to carry to a successful issue the undertakings of engineering works. 4500 w. Sib Jour of Engng—Feb., 1902. No. 46653 C.

Chemical Industries.

Engineering in the Chemical Industries. R. H. Thurston. On the value of a knowledge of chemistry in connection with mechanical engineering. 7200 w. Sib Jour of Engng—Feb., 1902. No. 46652 C.

Coal Supremacy.

Our Coal Supremacy and Its Significance. Edwin Moxey. Discusses the relation of fuel supply to progress as a nation. 3200 w. Sci Am Sup—March 15, 1902. No. 46813.

Commerce.

Russia and America in the Near East. Alexander Hume Ford. Discusses railroad building for commercial purposes, and other measures for securing trade. 4000 w. Ir Age—March 20, 1902. No. 46898.

Education.

Technical Education vs. Shop Education. Egbert P. Watson. Arguments favoring the latter. 2300 w. Ir Age—March 20, 1902. No. 46899.

The Place of the Mechanical Laboratory in the Education of the Engineer. Prof. J. Boulvin. A discussion of the great value of an intelligently conducted mechanical laboratory in the technical school. 4500 w. Engineering Magazine—April, 1902. No. 47184 B.

Factory Office.

The Factory Office Considered as a Productive Department. Kenneth Falconer. The first of a series of papers dealing with the factory office, and its functions in connection with modern works management methods. 2000 w. Engineering Magazine—April, 1902. No. 47185 B.

Government Aid.

Government Aid to Mining. A number of discussions communicated in advance of the meetings of the Canadian Mining Institute. 13700 w. Can Min Rev—Feb. 28, 1902. No. 46626 B.

India.

The Industrial Development of India. Nilkanth B. Wagle. Discusses plans proposed for future work in developing the industrial resources. Followed by general discussion. 17700 w. Jour Soc of Arts—March 14, 1902. No. 47059 A.

Industrial Methods.

British vs. American Methods of Construction. Extract from an article by D. N. Dunlop, in the *Nottingham Guardian*, relating primarily to the Westinghouse Electric Works at Manchester, but involving questions which affect the entire industrial situation of Great Britain. 1000 w. U S. Cons Repts. No. 1289—March 14, 1902. No. 46746 D.

Labor.

Attitude of Courts Toward Labor Interference. Articles by James A. Miller and Arthur E. Ireland. The first article encourages resort to the courts; the second discusses present laws affecting strikes, and related matters. 4200 w. Mod Mach—March, 1902. No. 46665.

The Eight-Hour Bill. Testimony of A. C. Dinkey and Judge L. E. Payson before the House Committee on Labor, opposing the passage of the bill. 4500 w. Ir Age—March 6, 1902. No. 46605.

Theory of Compensation of Labor. A discussion of the proper way to introduce piecework systems in railroad shops. 1600 w. Am Engr & R R Jour—March, 1902. Serial. 1st part. No. 46542 C.

Pensioning.

The Pension System and Profit Sharing. J. B. Johnston. Discusses the growing sentiment in favor of pensions to the invalided or superannuated workmen; also the subject of profit sharing, which the writer does not think an unqualified success. 1600 w. Am Mfr—Feb. 27, 1902. No. 46538.

Premium Plan.

The Premium Plan of Paying for Labor. F. A. Halsey. An explanation of this system and a discussion of its advantages and disadvantages. 7000 w. Sib Jour of Engng—March, 1902. No. 47055 C.

Trade Unions.

The Possibilities of a New Trade Unionism. Percy Longmuir. Discussing modern industrial conditions in connection with labour relations, showing that interested co-operation is the true motive for association. 3000 w. Engineering Magazine—April, 1902. No. 47187 B.

Works Management.

Money-Making Management for Workshop and Factory. C. U. Carpenter. Mr. Carpenter's third paper discusses and classifies the various productive departments, prior to examining their functions in detail. 2000 w. Engineering Magazine—April, 1902. No. 47181 B.

MARINE AND NAVAL ENGINEERING

Battleships.

H. M. S. Queen. Plan and description of this new British ship, its armor and equipment. 2000 w. Engr, Lond—March 7, 1902. No. 46865 A.

Our New Battleships. Editorial on the new British battleships Queen, Prince of Wales, and King Edward VII. 1700 w. Engng—March 7, 1902. No. 46858 A.

Repairs to the Battleship "Oregon" at the Puget Sound Navy Yard. Illustrates and describes the method of making of extensive repairs to the keel and bottom of this heavy vessel, which was damaged by striking an uncharted rock in Chinese waters. 2000 w. Eng News—March 13, 1902. No. 46800.

The New English Battleship Type "King Edward VII." From *Illustrirte Zeitung.* Illustrated description of a new type of warship, and its equipment. 800 w. Sci Am Sup—March 15, 1902. No. 46814.

The Russian Battleship "Pobieda." Compares this vessel with some other ships of her displacement, giving the principal details of the vessel, and remarks on the class to which she really belongs. Ill. 1800 w. Engr, Lond—Feb. 28, 1902. No. 46733 A.

Boilers.

See Mechanical Engineering, Steam Engineering.

British Navy.

Engineer Officers for the Fleet. Rollo Appleyard. Discusses the question of obtaining sufficient number of men qualified for the engineering duties. 2500 w. Elec Rev, Lond—Feb. 21, 1902. No. 46581 A.

Cruisers.

His Imperial German Majesty's Cruiser "Vineta." Richard Inch. Describes the main engines, auxiliary machinery, boilers, &c. Ill. 3800 w. Jour Am Soc of Naval Engrs—Feb., 1902. No. 47053 H.

The Armored Cruiser "Good Hope." Interesting illustrated description of this vessel which has just satisfactorily completed her official contract steam trials. 3800 w. Engng—Feb. 28, 1902. No. 46728A.

Destroyer.

Contract Trial of the Torpedo-Boat Destroyer "Decatur." H. Webster. Illustrated detailed description of the vessel and its equipment, with report of trial. 2000 w. Jour Am Soc of Naval Engrs—Feb., 1902. No. 47048 H.

Docking.

Docking of Ships. Theodore Lucas. Describes graving docks, floating docks, and marine railways, considering the advantages of each, and discussing blocking and all the arrangements in docking. 2200 w. Naut Gaz—March 13, 1902. No. 46819.

Dry Dock.

Test of the New Floating Dry-Dock at Algiers, La. Frederick Moore. A brief account of this dock and its test by the battleship "Illinois." 600 w. Sci Am—March 8, 1902. No. 46692.

Economy.

The Growth of Economy in Marine Engineering. W. M. McFarland. Mr. McFarland's second paper deals with the introduction of higher steam pressures and the development of the compound engine. 3500 w. Engineering Magazine—April, 1902. No. 47183 B.

"Hohenzollern."

Below Decks on the "Hohenzollern." An illustrated article especially describing the mechanical equipment. 1200 w. Sta Engr—March, 1902. No. 47012.

Hull Protection.

The Protection of the Hulls of Iron Ships (Comment on Peut Proteger les Coques des Navires en Fer). From the *Chemiker Zeitung.* A brief review of sheathing and protective paints, particularly the Rahtjen composition. 900 w. Rev Technique—March 10, 1902. No. 47164 D.

Hulls.

Deformation and Resistance of the Hulls of Vessels with Transverse Forces (Déformation et Resistance des Coques de Navire à la Flexion Transversale). H. Chaigneau. A mathematical discussion of the transverse stresses and strains of hulls under various circumstances. Serial. 1st part. 4000 w. Rev Technique—Feb. 25, 1902. No. 47163 D.

Liners.

The New Liners of the French General Transatlantic Company. Two-page plate, illustrations, and description of the two new liners, "Lorraine" and "Savovie." for service between France and New York. 800 w. Engng—March 14, 1902. No. 47-081 A.

Mail Steamers.

The "Kronprinz Wilhelm." Illustrated description of this high-speed Atlantic liner. 1000 w. Sci Am Sup—March 15, 1902. No. 46812.

Marine Engines.

Results of Investigations on Recent Engines of the German Navy. Chief Naval Constructor Köhn von Jaski, in *Schiffbau.* Translation. Investigations into the degree of uniformity of the stresses on the shafts in the new vessels, with other facts necessary to judge of the efficiency of the engines. 3800 w. Jour Am Soc of Naval Engrs—Feb., 1902. No. 47046 H.

The Balance of a Four-Cylinder, Triple Expansion Marine Engine. Harvey D. Williams. An investigation of the possible causes of vibration in a marine engine of a type quite generally used. Ill. 2800 w. Jour Am Soc of Naval Engrs—Feb., 1902. No. 47050 H.

Marine Machinery.

Notes on Details of Construction and Arrangement of Marine Machinery. Emil Theiss. Calls attention to details of construction often slighted. Results of observations and experience on the battleships Alabama and Kearsarge. 6500 w. Jour Am Soc of Naval Engrs—Feb., 1902. No. 47045 H.

Motor-Boats.

An International Motor-Boat Exhibition at Berlin. An account of an exposition to be opened June first, near Berlin, which contemplates a display of the best that has been achieved in all countries in respect to the construction, care and use of boats, launches, yachts, and craft propelled by gas. gasoline, electrical or steam motors. 800 w. U S Cons Repts, No. 1290—March 15, 1902. No. 46870 D.

Naval Development.

Naval Development During the Next Decade. George W. Melville. Discusses reasons why the United States should have her navy increased, and improvements needed. 3300 w. Sci Am Sup—Feb. 22, 1902. No. 46502.

Seaworthiness.

"Seaworthiness." B. Goldsmith. Discusses the importance to passengers, and also to underwriters, of the seaworthiness of vessels, especially for long voyages. 10500 w. Aust Min Stand—Jan. 23 & 30, Feb. 6, 1902. 3 parts. No. 46868 each B.

Shipbuilding.

Notable Shipbuilding Abroad. Mainly a review of this industry in the United States, with notes also on Germany and Holland. 1400 w. Engr, Lond—Feb. 21, 1902. No. 46601 A.

The Eastern Shipbuilding Company. Gives an account of the organization of this company. and an illustrated description of its plant, and the equipment. 3000 w. Marine Engng—March, 1902. No. 47001 C.

Signals.

Sound Signals. E. Price-Edwards. A review of experiments made with fog-signals and a discussion of the many difficulties met. 12600 w. Jour Soc d Arts—March 7, 1902. No. 46843 A.

Stability.

Variations in Initial Stability (Variazioni della Stabilita Iniziale). R. Levati. Discussing the changes in stability in the case of the filling of one or more compartments. 2000 w. 2 plates. Rivista Marittima—Feb., 1902. No. 47189 G.

Steam Cutters.

Standard Steam-Cutter Machinery for the U. S. Navy. A. M. P. Maschmeyer. Describes the fixed types, gives particulars of a trial, with indicator diagrams, with tables of dimensions of engines, boilers, &c., and their weights. 1100 w. Jour Am Soc of Naval Engrs—Feb., 1902. No. 47-047 H.

Steamships.

Handsome New Coasting Steamship. Illustration, with description of the "Spokane" for the merchant marine of the Pacific coast. 1500 w. Naut Gaz—March 13, 1902. No. 46818.

Lake Built Ocean Tramp Steamers. Charles C. West. Illustrates and describes the design and construction of the "Minnetonka" and "Minnewaska" which are to be cut in two and towed to Montreal and there re-united. 2000 w. Marine Engng—March, 1902. No. 47002 C.

New Combination Ferry and Excursion Steamer. Illustration and description of a boat under construction for service on the Detroit River. 2800 w. Naut Gaz—Feb. 27, 1902. No. 46616.

Stern Frame.

See Mechanical Engineering, Machine Works.

Trials.

Progressive Trials of U. S. Battleships. Report concerning the progressive trials of the "Alabama," "Massachusetts," and "Kearsarge," held on the Barren Island course, in Chesapeake Bay. 4800 w. Jour Am Soc of Naval Engrs—Feb., 1902. No. 47052 H.

Yachts.

High-Speed Twin-Screw Yacht "Vixen." Illustrated description of a private yacht built for service of the owner principally between Tarrytown and New York. 800 w. Sci Am—March 1, 1902. No. 46550.

Steering Gear of the Yacht "Meteor." Brief illustrated description of the novel steering gear designed especially for the Emperor's new yacht. 500 w. Eng News—Feb. 27, 1902. No. 46568.

The Building Season of 1901-2. W. P. Stephens. The progress of designing and the work of the yards are discussed. Plans of vessels are given. 4500 w. Rudder—March, 1902. No. 46755 D.

The Emperor's Yacht "Meteor III." Illustration, with interesting information concerning this, and other yachts owned by the Emperor. 1200 w. Sci Am—March 1, 1902. No. 46548.

MECHANICAL ENGINEERING

AUTOMOBILES.

Acceleration.

Acceleration of Automobiles. L. M. Aspinwall. Considers means of determining the power necessary to accelerate a vehicle of a given weight. 1300 w. Horseless Age—March 12, 1902. No. 46892.

Brakes.

New Brakes for Automobiles. From *La Locomotion.* Illustrates and describes new braking apparatus exhibited at the recent Paris Automobile Show. 700 w. Sci Am Sup—March 1, 1902. No. 46558.

Charging Batteries.

Single-Phase Permutator with Revolving Brushes. P. Letheule. Illustrates and describes an apparatus designed for the purpose of charging automobile storage batteries from a single-phase distributing system. 500 w. Elec Wld & Engr—March 15, 1902. No. 47007.

Cycle Design.

Design for an Electric Motor Cycle. J. C. Brocksmith. Illustrated detailed description of a design for use particularly in cities. The present article describes the frame. 2300 w. Am Elect'n—March, 1902. Serial. 1st part. No. 46678.

Electric Vehicles.

Recuperative Braking on Electric Vehicles. W. A. Th. Mueller, in *Centralblatt fuer Accumulation Elementen und Accumobilenkunde.* A discussion of means of getting the greatest possible mileage out of a given battery, compound winding, general principles, &c. 1500 w. Horseless Age—March 26, 1902. Serial. 1st part. No. 47143.

English Daimler.

Le Chat Noir. Illustrates and describes what is considered the finest machine yet made by this company. 700 w. Autocar—March 1, 1902. No. 46709 A.

Exhibition.

Crystal Palace Show. An illustrated article giving particulars of the leading features, exhibits, and novelties. 5800 w. Auto Jour—March 15, 1902. No. 47126 A.

Exhibits.

Exhibits at the Coliseum. Brief illustrated descriptions of automobiles and accessories at the automobile show in Chicago, March 1 to 8. 5400 w. Auto Topics—March 1, 1902. No. 46632 C.

Feed Regulation.

The Automatic Feed Regulation of Steam Vehicle Boilers. J. Edward Baldwin. Reviews the existing situation, showing what is desirable and undesirable in the construction and operation of these devices. 1000 w. Horseless Age—March 5, 1902. No. 46667.

Gasoline Motors.

The Starting of Gasoline Motors. Albert L. Clough. Notes improvements which have increased the popularity of gasoline vehicles, and offers some suggestions for self-starters. 1100 w. Horseless Age—March 19, 1902. No. 47013.

Gasoline Vehicles.

A Novel Air-Cooled Gasoline Motor. An illustrated description of the Balzar revolving cylinder air-cooled gasoline motor. 1200 w. Sci Am—March 1, 1902. No. 46547.

Gasoline Automobiles—1902 Models. Illustrations with brief descriptions of several of the recent designs. 2200 w. Sci Am—March 1, 1902. No. 46549.

Suggestion for a Gasoline Tank Fitting. Robert G. Pilkington. Calls attention to points needing to be improved. 1000 w. Horseless Age—March 5, 1902. No. 46668.

The Duryea Gasoline Carriage. Illustrated detailed description of the Duryea three-wheeled phaeton. 1300 w. Sci Am—March 1, 1902. No. 46553.

The Packard Gasoline Touring Car. Illustrated detailed description. 2000 w. Sci Am—March 1, 1902. No. 46552.

Ignition.

Evolution in Jump Spark Plug Construction. Hugh D. Meier. Considers the requirements, principle and detail construction, material, &c. Ill. 1300 w. Horseless Age—March 12, 1902. No. 46893.

Ignition Devices for Gas and Petrol Motors. S. R. Bottone, in the *English Mechanic.* Brief notes on the more important devices in use for this purpose, with remarks on their fitness or unfitness for certain requirements. 1400 w. Sci Am Sup—March 22, 1902. No. 47118.

Ignition Faults. Reginald Wales. Discusses the four vital features: the batteries; the transmission wires; the induction coils; and the sparking points. 1500 w. Auto Topics—March 22, 1902. No. 47044.

Industrial Vehicles.

Industrial Motor Cars in France. An illustrated article explaining the development of the motor car industry in France, and giving much information in regard to places where successful service of heavy vehicles has been established, considering the types used, motive power, &c. 3800 w. Engr, Lond—Feb. 28, 1902. No. 46730 A.

We supply copies of these articles. See page 319.

Light Carriages.

The Eight Horse Power Clement Carriage. From *La Locomotion*. Illustrated description of an 8 horse power double cylindered light carriage. 4000 w. Horseless Age—March 19, 1902. No. 47014.

Military.

Electric Lighting and Automobiles in Military Operations (Elektrische Beleuchtung und Maschinenfahrzeuge im Landkriege). Maj. Gen. F. Otto. An article showing the great advantages of electric lighting and steam vehicles for traction and power purposes in warfare. 2000 w. Zeitschr d Ver Deutscher Ing—March 8, 1902. No. 46927 D.

Motor Cycles.

Some Motor Cycles at the Crystal Palace. A. J. Wilson. Illustrations and brief descriptions of interesting exhibits. 3000 w. Autocar—Feb. 22, 1902. No. 46-579 A.

Motor Vehicles.

A Successful and Interesting Automobile. Alexander F. Sinclair. An illustrated description of a vehicle made in Birmingham, England. 2300 w. Auto Mag—March, 1902. No. 46517 C.

Non-Freezing Liquids.

Non-Freezing Liquids for Cylinder Jackets. E. E. Keller. An account of experiments with calcium chloride solutions. 1700 w. Autocar—March 8, 1902. No. 46845 A.

Serpollet System.

The Serpollet System. A brief description of the main features of these steam cars. Ill. 1200 w. Autocar—March 8, 1902. No. 46844 A.

Steam Carriages.

The Lane Steam Carriage. An illustrated description of a very successful carriage, especially noting its novel features. 1200 w. Sci Am—March 1, 1902. No. 46545.

The Overman Steam Automobile. Illustrated detailed description. 1000 w. Sci Am—March 1, 1902. No. 46546.

The White Steam Carriage. Illustrated detailed description of the 1902 model. 1800 w. Sci Am—March 1, 1902. No. 46544.

Steering.

Steering Gears for Automobiles. Hermann Lemp. Shows the importance of a properly designed steering gear, its requirements, &c., with discussion of the lever and the wheel, and of the hydraulic steering check. 2000 w. Horseless Age—Feb. 25, 1902. No. 46507.

Trolley Automobile.

Traction by Trolley Automobile (Traction par Trolley Automoteur). Jean Loubat. An illustrated account of omnibus lines in which the vehicle runs on ordinary roads and is operated by an electric motor which gets its current from double trolley wires overhead, on which a small automotor trolley travels. 2800 w. Rev Technique—Feb. 25, 1902. No. 47162 D.

Traction by Overhead Motor Trolley. From *La Revue Technique*. Illustrated description of the leading features of the Lombard-Gérin system, in which the electric energy is supplied to the vehicle from two aërial wires. 1500 w. Engr, Lond—March 14, 1902. No. 47079 A.

HYDRAULICS.

Centrifugal Pumps.

High Pressure Centrifugal Pumps Driven by Electric Motors or Steam Turbines (Pompes Centrifuges à Haute Pression avec Moteurs Electriques et Turbines à Vapeur). A. Rateau. Illustrated description, with results of tests. 3000 w. Génie Civil—Feb. 15, 1902. No. 46997 D.

High-Speed Centrifugal Fans and Pumps. Summary of a paper by M. A. Rateau, published recently in the *Bulletin de la Société de l'Industrie Minérale*. Describes fans and pumps driven by steam turbines and electromotors for high pressures. 1800 w. Engr, Lond—March 7, 1902. Serial 1st part. No. 46862 A.

Pumping Plant of the Skinner Dry Dock, Baltimore, Md. Illustrated description of the centrifugal pumping plant with a capacity of 150,000 gallons per minute. 2300 w. Eng Rec—March 22, 1902. No. 47037.

See also Mechanical Engineering, Miscellany.

Keokuk, Iowa.

A Proposed Dam and Water Power on the Mississippi River at Keokuk, Iowa. Lyman E. Cooley. A general account of the proposed work with a statement of the conditions, and general discussion. 5000 w. Jour W Soc of Engrs—Feb., 1902. No. 46702 D.

Meters.

See Civil Engineering, Water Supply.

Mine Pumps.

See Mining and Metallurgy, Mining.

Pumping Plant.

A Gas Engine Driven Direct Pressure Pumping Plant, with Some Experiments on Pump Valve Area. D. W. Mead. An illustrated outline of a plant installed at Winchester, Indiana, with account of experiments made. 6000 w. Jour W Soc of Engrs—Feb., 1902. No. 46703 D.

Pumps.

The Riedler "Express" Pump. Illustrated description of high-speed pumps.

1600 w. Engng—March 7, 1902. No. 46856 A.

Varieties and Principles of Pumps. T. W. Shelton. Briefly describes many varities, explaining their advantages. 1400 w. Engr, U S A—March 1, 1902. No. 46672.

Turbines.

The 5500 Horse Power Turbines of the Niagara Falls Power Co. and their Hydraulic Governors (Die 5500 P. S. Turbinen der Niagara Falls Power Cie. und deren Hydraulische Regulatoren). A well illustrated description of this machinery, built by Escher Wyss & Co., of Zurich, for the 1900 extension of the power plant above the Falls. 1800 w. Schweiz Bauzeitung—Feb. 15, 1902. No. 46995 B.

MACHINE WORKS AND FOUNDRIES.

Armor.

Armor Plate Tools. Arthur Masters. Illustrates and describes the method of fitting armor and backing to warships. 1100 w. Mach, N. Y—March, 1902. No. 46774.

Boiler Making.

Modern Practice in Boiler-Making Shops. Egbert P. Watson. A comparison of the crude early methods with the efficient equipment of the modern boiler shop, richly illustrated from European and American practice. 3500 w. Engineering Magazine—April, 1902. No. 47182 B.

Boiler Plates.

Diagram for the Thickness of Boiler Plates. James A. Brown. Diagram, with explanatory notes. 500 w. Am Mach—Feb. 27, 1902. No. 46512.

Boring Mill.

Boring Mill (Tours Verticaux). G. Nardin. A well illustrated description of machine tools constructed by the Ducommun works at Mulhouse, Alsace. 1200 w. Génie Civil—Feb. 22, 1902. No. 47150 D.

Castings.

A Set of Tools for Machining a Cam. Joseph V. Woodworth. Illustrates and describes a set of tools for machining a repetition casting of unusual shape, which was used as a cam on an automatic machine for making fruit baskets. 700 w. Am Mach—March 20, 1902. No. 47100.

Methods of Continuous Casting and Rolling for Light Sections. Theodore J. Vollkommer. An illustrated article reviewing what has been done in the work of continuously casting and rolling steel, discussing the possibilities. 5600 w. Ir Trd Rev—March 20, 1902. No. 47095.

Two Fixtures for Finishing Cast Iron Segments. D. E. MacCarthy. Illustrated description. 400 w. Am Mach—March 6, 1902. No. 46686.

Dies.

A Quadruplicate, Automatic-Slide Die for Piercing Conical Shells. William Doran. Illustrates and describes a die designed for the economic production of a pierced brass shell which formed the draft regulator of a new burner of the "Bunsen" type. 1900 w. Am Mach—March 6, 1902. No. 46685.

Drill Press.

Multiple Drill Press (Der Serienbohrapparat). Wm. C. Wachholtz. An illustrated description of a multiple drill chuck which can be applied to any drill press, and used to drill holes in pipe flanges, cylinder heads, etc. 600 w. Technologist—Jan., 1902. No. 46913.

Economy.

Foundry Economy. Dr. Richard Moldenke. How the foundryman is to economize by the application of scientific methods is discussed, and other suggestions given. 2800 w. Jour Am Found Assn—April, 1902. No. 46521.

Factory Office.

See Industrial Economy.

Feed Gear.

A Self-Acting Feed Gear for Horizontal Boring Bars. C. Patterson. Shows a self-acting feed gear as applied to the 2-inch boring bars on a special multiple spindle horizontal boring machine. Ill. 600 w. Am Mach—March 13, 1902. No. 46888.

Hardening.

Combined Oil and Water Hardening of Taps, Milling Cutters, etc. John L. Bacon. Describes a method that seems not only to save time, but to give more satisfactory results than the ordinary method used. 1400 w. Am Mach—March 6, 1902. No. 46683.

Hardening Extra Long Stay-Bolt Taps. E. R. Markham. Directions for this work. 1600 w. Mach. N. Y—March, 1902. No. 46775.

Heating in Red Hot Lead for Hardening. E. R. Markham. Notes from experience on heating steel in the lead crucible. 900 w. Am Mach—March 6, 1902. No. 46681.

Heavy Work.

Hydraulic Device for Adjusting Heavy Work on Machine Tools. Illustration and description of a device applicable to large work to be machined where work is stationary and the cutting tools movable, the work having to be adjusted to the correct position for the cutting. 600 w. Am Mach—March 27, 1902. No. 47145.

Machine Tools.

Bevelling Machine. Illustrates and describes a machine for use by shipbuilders. 1400 w. Engr, Lond—March 14, 1902. No. 47077 A.

Pipes.

On Pipes and Pipe Threads. Engravings and remarks on the trouble caused by not following the standard proportions, suggesting that the name of the maker be stamped on the pipe with the quality of the material, and the pressure to which the pipe has been tested. 1800 w. Locomotive—Jan., 1902. No. 46604.

Premium Plan.

See Industrial Economy.

Pulleys.

A Cone Pullev Pattern. John M. Richardson. Illustrates and describes a method that requires no core except a stock core through the hub. 800 w. Am Mach—March 6, 1902. No. 46682.

Radiators.

European Radiators. Charles F. Hauss. Illustrated descriptions of types. 800 w. Met Work—March 15, 1902. No. 46816.

Screw Machine.

The Schmutz Automatic Screw Machine. Illustrates and describes a screw machine having no turret, and the tools are simple pieces of bar steel ground to shape at the ends, easily sharpened, and adjusted by a turn of a spanner. 1200 w. Engng—March 14, 1902. No. 47083 A.

Seamless Pipes.

The Manufacture of Large Boiler Flues and Heavy Seamless Pipes (Ueber Herstellung Grosser Kesselschüsse und Schwerer Nahtloser Rohre). Hr. Ehrhardt. An illustrated paper before the Verein Deutscher Eisenhüttenleute giving a description of methods of rolling hollow cylinders into pipes; with discussion. 2500 w. Stahl u Eisen—March 1, 1902. No. 46966 D.

Shrinkage.

Shrinkage and Pressure Joints. William Ledyard Cathcart. An illustrated discussion of practice in the various applications of this work. 10600 w. Sch of Mines Qr—Jan., 1902. No. 46798 D.

Shops.

New Shops of the Grant Tool Company. Illustrated description of new works at Franklin, Pa. 2000 w. Mach, N. Y—March, 1902. No. 46773.

Skimming Gates.

Some Skimming Gates. A. E. Fay. Illustrates some forms that have been used or suggested for the purpose of obtaining cleaner metal for the mold, with brief descriptions. 1500 w. Foundry—March, 1902. No. 46523.

Stern Frame.

Building a Stern Frame. Richard L. Tappenden. Illustrates and describes the building of an ordinary L-shaped frame. 800 w. Ir Age—March 27, 1902. No. 47121.

Tube Expander.

The Plastic Pressure Tube Expander. Illustrated description of a new device manufactured in England, and its operation. 1000 w. Am Mach—Feb. 27, 1902. No. 46511.

Watchmaking.

An Escape-Wheel Cutting Engine. A H. Cleaves. Illustrated description of a cutting machine and its operation. 1300 w. Am Mach—March 6, 1902. No. 46684.

Works Management.

See Industrial Economy.

MATERIALS OF CONSTRUCTION.

Budapest Congress.

New Researches in the Constitution of Materials (Ueber Neuere Arbeiten im Gebiete der Prüfung der Materialien der Technik). Prof. Fried. Kick. An illustrated review of some of the papers presented before the Budapest Congress of the International Association for the Testing of Materials, bearing particularly on solutions, metallography, etc. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—March 7, 1902. No. 46945 B.

The Congress of the International Association for the Testing of Materials at Budapest in 1901 (Der Internationale Kongress für die Materialprüfungen der Technik zu Budapest, 1901). A general review of the congress and its proceedings. 2000 w. Schweiz Bauzeitung—Jan. 25, 1902. No. 46993 B.

Electrical Apparatus.

See Electrical Engineering. Miscellany.

Metallography.

Notes on Metallography (Note di Metallografia). A. Ruggieri. A discussion of the use of the microscope in metallographical investigation of materials used in naval construction. 5000 w. Rivista Marittima—Feb., 1902. No. 47188 G.

Oil.

The Way in Which the Qualities of Oil Are Determined. Dr. Julius Ohly. The determining the specific gravities, and conclusions drawn from observations. 1100 w. Mines & Min—March, 1902. No. 46-777 C.

Recording Machine.

An Automatic Recording Machine. E. C. Oliver. Illustrates and describes a machine which records on a continuous strip of paper the momentary changes of conditions in making tests of steam, gas, or other engines or machines. 1800 w. Am Mach—Feb. 27, 1902. No. 46509.

Spherical Plates.

The Resistance of Spherical Plates to External Pressure (Die Widerstandsfähigkeit Kugelförmiger Wandungen gegenüber

Aeusserem Ueberdruck). C. Bach. A well illustrated experimental determination of the resistance of curved heads of boilers, etc., to pressures on the convex side. Serial. 1st part. 2000 w. Zeitschr d Ver Deutscher Ing—March 8, 1902. No. 46926 D.

POWER AND TRANSMISSION.

Aerial Tramways.

The Arlington Tramway. H. E. T. Haultain. An illustrated description of the tramway at Arlington mine, Erie, B. C. 1100 w. B. C. Min Rec—March, 1902. No. 46749 B.

Belting.

Belt Speeds and Journal Pressures. Letter from Forrest R. Jones on the common assumption that high speed belts result in increased pressure and friction at the journal bearings. 800 w. Eng Rec—March 15, 1902. No. 46885.

Horse-Power of Belting and Pulleys. E. C. DeWolfe. Diagram with explanation of its use. 2200 w. Power—March, 1902. No. 46688.

The Safe Management of Belts. An illustrated article giving hints based on a pamphlet issued by the "Association des Industriels de France contre les Accidents du Travail." 2500 w. Quarry—March 1, 1902. No. 46847 A.

Belt Shifters.

New Belt Shifters (Nouveaux Monte-Courroies Fixes pour Transmissions). Henry Mamy. A well illustrated description of apparatus for placing belts on pulleys in motion, without danger to workmen. 700 w. Génie Civil—Feb. 15, 1902. No. 46999 D.

Compressed Air.

Moisture in Compressed Air. D. W. Hering. Discusses the statements made concerning air compressed hydraulically, and explains the process. 2000 w. Compressed Air—March, 1902. No. 46815.

The Volumetric Efficiency of Air Compressors and Tests of Shütz Compressors at the "Centrum" and Fröhliche Morgensonne Mines, Westphalia (Ueber den Volumetrischen Wirkungsgrad der Kompressoren und Versuchsergebnisse von Shütz 'schen Kompressoren auf den Zechen "Centrum" und Fröhliche Morgensanne). R. Goetze. An illustrated description of experiments and results. 1500 w. Glückauf—Jan. 18, 1902. No. 46972 B.

Underground Compressed Air Mine Plant. Robert Peele. Considers the application of compressed air to rock drills, pumps, hoisting engines, and coal cutters. 5000 w. Mines & Min—March, 1902. No. 46779 C.

Elevators.

Elevator Safety Appliances. William Baxter, Jr. An illustrated review of the various appliances employed. 1600 w. Am Mach—March 13, 1902. Serial. 1st Part. No. 46887.

Mechanical Handling.

Mechanical Sorting of Small Packages at the Austerlitz Railway Station in Paris (Triage Mécanique des Petits Colis de Messageries (au depart) dans la Gare de Paris-Austerlitz). M. Pons. A well illustrated account of the mechanical handling, transporting of packages and parcels at this Paris station of the Orleans Railway. Serial. 2 parts. 4 plates. 12000 w. Rev Gén d Chemins de Fer—Feb., March, 1902. No. 47172 H.

Power Loss.

Power Loss by Friction and Transmission. Henry Souther. Read before the Canadian Mfr. Assn. Discusses this subject, giving Prof. Benjamin's rules to save friction losses in manufacturing establishments. 1600 w. Sta Engr—March, 1902. No. 47011.

Spiral Gears.

A Diagram for Laying Out Spiral Gears. J. N. Le Conte. Gives diagram and explanation of its use. 1200 w. Am Mach—Feb. 27, 1902. No. 46510.

Tractive Power.

Traction on Wagon Roads. Ira O. Baker. An account of experiments on the tractive power required to draw wagons on different roads and pavements, with general discussion of the subject. Ill. 2500 w. Eng News—March 8, 1902. No. 46696.

SPECIAL MOTORS.

Gas Engines.

Experimental Gas Engine Construction. Don McNaughton. On points of importance in the construction. 1800 w. Horseless Age—March 26, 1902. No. 47142.

Temperatures of the Cylinder Wall of a 400-Horse Power Double-Acting Gas-Engine. E Körting. Summarized translation from the *Zeitschrift des Vereines Deutscher Ingenieure*. An account of measurements of the temperature at different points, with a view to the prevention of injurious expansion. 1200 w. Jour Gas Lgt—March 11, 1902. No. 47067 A.

The Heat in Gas-Engine Cylinder-Walls. Illustrated review of some German experiments on a 400-h. p. two-cycle engine, to determine the temperature stresses in motors of this size. 1200 w. Eng Rec—March 15, 1902. No. 46883.

Gasoline Motors.

See Mechanical Engng, Automobiles.

Mine Locomotives.

See Electric and Street Railways.

Orleans Tramway Plant.

See Electric and Street Railways.

Boiler Erection.

Practical Points in the Erection of the Thornycroft Boiler. Description with diagrams. 1800 w. Marine Engng—March 1902. No. 47003 C.

Boiler Plant.

Hampton Boiler Plant. Illustrated description of a new boiler plant of the D. L. & W. Coal Mining Department at Scranton, Pa. 3000 w. Mines & Min—March, 1902. No. 46776 C.

Boilers.

Plans for Economical Boiler Feeding. W. H. Wakeman. Considers various plans for forcing water into boilers. 1600 w. Elec, N Y—March 12, 1902. No. 46750.

The Dürr Water-tube Boiler. S. J. Thompson. Abstract of a paper read before the So. Staffordshire Iron and Steel Inst. Illustrates and describes the construction of this land type of the Dürr boiler, its cleaning and the circulation. 1900 w. Ir & Coal Trds Rev—Feb. 21, 1902. No. 46502 A.

The Second Report of the Boiler Committee. A critical review of this report. 5500 w. Engr, Lond—March 7, 1902. No. 46860 A.

The Morrin Patent "Climax" Steam Boiler. Illustrated description of a water-tube boiler which has advantages of interest. Report of an extensive test, made by Bryan Donkin, is also given. 2500 w. Engng—March 14, 1902. No. 47082 A.

The Water Tube Boiler Question in the German Navy. Köhn von Jaski Translated from *Marine Rundschau*. A lengthy discussion of the reasons for the introduction of water-tube boilers, their disadvantages, choice of type, the fitting of German warships, economy of the various systems, efficiency, cost, etc. 15700 w. Jour Am. Soc of Nav Engrs—Feb., 1902. No. 47049 H.

Water-Tube Boilers. Report on trials of H. M. S. "Hyacinth," H. M. S. "Minerva," and R. M. S. "Saxonia," by the committee appointed by the Admiralty to inquire into the question of water-tube boilers for the British navy. 9500 w. Engng—Feb. 28, 1902. Serial. 1st part. No. 46726 A.

Cooling Towers.

Notes on the Construction and Operation of Cooling Towers. J. R. Bibbins. Description and tests of an experimental tower, for cooling circulating water in a steam power plant, recently put into service by the Edison Illuminating Co., of Detroit, with opinions on questions of design. 3000 w. Eng News—March 20, 1902. No. 47102.

Economy.

See Marine and Naval Engineering.

Engines.

The Engines of the New York Edison Power Station. Briefly describes this plant, located between 38th and 39th Sts, First Ave. and the East River, and particularly describes the remarkable features of the engines, giving illustrations. 900 w. Sci Am—March 22, 1902. No. 47114.

Fuel Economy.

Feed Water Heaters. D. B. Dixon. Considers it the most essential appliance in a steam power plant, discussing its advantages. 1400 w. Am Mfr—Feb. 27, 1902. No. 46537.

Heating Plant.

Central Steam Heating Plant on Randall's Island, New York City. Illustrated description of the system installed for 16 asylum buildings: the condensation water in buildings too low to return to the boiler house by gravity is handled by a vacuum system. 1000 w. Eng Rec—March 22, 1902. No. 47043.

Indicators.

Calculations From Indicator Diagrams. Charles L. Hubbard. Definition of work, foot pound, work diagrams, calculation of power, mean ordinate, planimeters, etc. 4000 w. Steam Engng—March, 1902. No. 47094.

Correcting for Variations in Indicator Springs. A. Koob. Gives methods for computing spring measurements. 2300 w. Power—March, 1902. No. 46689.

Reading Indicator Diagrams. Illustrates characteristics of the diagrams from various engines, explaining the meaning of the twists and turns. 2000 w. Steam Engng—March 1902. No. 47091.

Reducing Gears for the Steam Engine Indicator. W. H. Wakeman. An illustrated explanation of various devices for reducing crosshead motion to convenient proportions for use on the indicator drum, without destroying the peculiarities of the crosshead motion. 2400 w. Steam Engng—March, 1902. No. 47093.

Steam Engine Indicators. C. W. Obert. Illustrates and describes modern indicators, explaining the principle of Watt's, McNaught's, and Richards' instruments, and describing other forms. 2300 w. Steam Engng—March, 1902. No. 47090.

The Analysis of Indicator Diagrams. W. H. Wakeman. Gives diagrams and explains what they indicate. 1200 w. Engr, U S A—March 1, 1902. No. 46671.

The Preparation for Indicating. George L. Fowler. An illustrated article reviewing the work of preparation; the drilling and tapping the cylinders, piping, measuring clearance, attachment of indicator, etc. 2200 w. Steam Engng—March, 1902. No. 47092.

Watt's and McNaught's Steam Engine Indicators. Gives an account, in Watt's own words, of his first indicator, showing what he intended to effect by its means. Also notes improvements made by Watt and by McNaught. Ill. 2500 w. Engr, Lond—March 7, 1902. No. 46864 A.

Marine Engines.

See Marine and Naval Engineering.

Oil Fuel.

Oil Burning. H. B. Gregg. Discusses the essential equipment for the successful burning of crude oil in locomotives, giving tests. Ill. 3300 w. Wis Engr—Feb., 1902. No. 46530 D.

Radiators.

Tests of Radiators With Superheated Steam. R. C. Carpenter. Read at meeting of the Am. Soc. of Heat and Ven. Engrs. A report of tests which seem to indicate that superheated steam is a poor medium to employ for heating purposes. 1200 w. Dom Engng—March 15, 1902. No. 46889 C.

Sisson High Speed.

Sisson High Speed Compound Steam Engine (Machine à Vapeur Compound, à Grande Vitesse Système Sisson). A well illustrated description of a vertical engine, built by Wm. Sisson, of Gloucester, Eng., and exhibited at Glasgow, 1901. 1 plate. 800 w. Génie Civil—March 1, 1902. No. 47154 D.

Steam Engine Practice.

Modern Steam Engine Practice Abroad. Frank C. Perkins. Considers methods and general design in modern central stations in England, France, Belgium, Germany and Austria. Ill. 1700 w. Am Mfr—March 6, 1902. No. 46752.

Steam Laundry.

A Modern Steam Laundry. Illustrated description of a large laundry in Germany, and its mechanical appliances. 1000 w. Sci Am Sup—March 1, 1902. No. 46559.

Superheating.

Superheated Steam, from 1827 to the Present Day (La Vapeur Surchauffée, de 1827 à Nos Jours). G. Loffet. An illustrated general review of the subject, in theory and practice. Serial. 1st part. 2000 w. Rev Technique—Feb. 10, 1902. No. 47161 D.

Valve Gear.

History of the Walschaerts Valve Gear (Historie de la Distribution Walschaerts). Prof. J. Boulvin. A biographical sketch of Egide Walschaerts, of Belgium, and an illustrated history of his valve gear, which was mistakably attributed to Heusinger von Waldegg. 2000 w. Rev de Mecanique —Feb., 1902. No. 47168 E+F.

Valves.

Piston Valves. Illustrates and describes various types. 2200 w. Loc Engng—March, 1902. No. 46649 C.

Waste Heat.

Recent Experience and Tests with Waste Heat Engines. John H. Barr. An explanation of the operation of the binary vapor engines with a statement of certain properties of the working fluids employed. 1500 w. Sib Jour of Engng—March, 1902. No. 47058 C.

Water-Hammer.

On Explosions of Steam Pipes Due to Water-Hammer. C. E. Stromeyer. An illustrated explanation of how these explosions are brought about, with a mathematical discussion of the problem. 3800 w. Engng—Feb. 28, 1902. No. 46729 A.

MISCELLANY.

Aeronautics.

Aerial Navigation Problems. Carl E. Meyers. A reply to the article of Rear Admiral Melville published in the Dec. *North American Review.* 3500 w. Sci Am Sup—Feb. 22, 1902. No. 46503.

Maratime Aeronautics (L'Aéronautique Maritime). E. Surcouf. An illustrated, long, comprehensive review of aerial navigation above the sea, with recent progress and apparatus. 1 plate. 1800 w. Mem d l Soc d Ing Civils de France—Jan., 1902. No. 47171 G.

The Progress of Aeronautics (Les Progrès de l'Aéronautique). G. Espitallier. A well illustrated, comprehensive review with account of the recent experiments of Santos Dumont and other aeronauts. Serial. 3 parts. 13000 w. Génie Civil—March 1, 8 and 15, 1902. No. 47153 each D.

The Use of Balloons in War. Eric H. Stuart Bruce. Reviews the work that has been accomplished by military balloons, discussing goldbeaters' skin balloons and their advantages, and the use of balloons in the South African campaign. Also discussion. 6900 w. Jour Soc of Arts—Feb. 21, 1902. No. 48578 A.

The Villard Flying Machine. Illustrated description of the machine devised by M. Henri Villard. 900 w. Sci Am—March 8, 1902. No. 46695.

Alcohol.

Lighting and Heating with Alcohol at the Competition in Paris, 1001 (L'Eclairage et le Chauffage par l'Alcool au Concours de 1901). M. Lindet. A well illustrated eomprehensive paper on lighting and heating with alcohol. 8000 w. Bull Soc d'Encouragement—Feb., 1902. No. 47157 G.

The Manufacture and Technical Uses of Alcohol in Germany. An account of a special exposition being held in Berlin, with illustrated description of interesting exhibits of domestic and industrial uses of alcohol, including spirit engines and motors, flatirons heated, lamps, etc. 2200 w. U. S. Cons Repts, No. 1288—March 13, 1902. No. 46734 D.

Centrifugal Fans.

Application of the Principle of the Conservation of Energy to the Operation of Centrifugal Ventilators (Application du Principe de la Conservation de l'Energie au Fonctionnement des Ventilateurs Centrifuges). A. H. Courtois. A long, illustrated, mathematical discussion of the theory of centrifugal pumps and fans. The first part is devoted to pumps. Serial. 1st part. Tables. 16000 w. Rev de Mecanique—Jan., 1902. No. 47166 E+F.

Heating.

Central Heating Plants in the United States. Concerning the recent growth of commercial central heating stations. 1500 w. Eng News—March 20, 1902. No. 47105.

The Heating and Ventilation of the Edward Wyman School, St. Louis, Mo. Alvin D. Reed. Read before the Am. Soc. of Heat. & Ven. Engrs. Illustrated detailed description. 1400 w. Met Work—March 29, 1902. No. 47146.

Ventilation and Heating in the United States Mint, Philadelphia. Illustrated description of the apparatus for circulating the air through the building by means of both supply and exhaust fans. The warming is by direct steam radiation. 3000 w. Eng Rec—March 1, 1902. No. 46613.

Hot Water.

Hot Water Heating. P. Trowern. Read before the Canadian Assn. of Stationary Engrs. Briefly reviews the history of heating appliances, especially heating with hot water. 1400 w. Dom Engng—March 15, 1902. Serial. 1st part. No. 46890 C.

Mechanical Plant.

Mechanical Installation in the Modern Office Building. Continued discussion of paper on this subject by Charles G. Darrach. 9600 w. Pro Am Soc of Civ Engrs—Feb., 1902. No. 46534 E.

Machinery.

Weak Points in Machinery. Albert Stritmatter. Mentions certain evils that have thrown machines out of use, and discusses the remedy. Advises the manufacturer to keep track of as many machines as possible and endeavor to learn whether or not they are satisfactory, and if not, why not. 1200 w. Am Mfr—Feb. 27, 1902. No. 46539.

Metric System.

The English versus the Metric System. Charles T. Porter. An argument against the adoption of the metric system. 1000 w. Elec Rev, N Y—March 8, 1902. No. 46762.

Ordnance.

The Evolution of Fire-Arms and Ordnance and Their Relation to Advancing Civilization. General Joseph Wheeler. Historical review, with related matter of interest. 10600 w. Jour Fr Inst—March, 1902. No. 46795 D.

Pyrometer.

See Mining and Metallurgy, Miscellany.

Ventilation.

See also Mining and Metallurgy, Mining.

Weaving.

Recent Inventions in Weaving Machinery. Prof. Roberts Beaumont. Discusses many recent improvements made in looms. Also discussion. 8000 w. Jour Soc of Arts—Feb. 28, 1902. No. '6712 A.

MINING AND METALLURGY

COAL AND COKE.

Africa.

The Wankie Coalfield, Rhodesia. Description, with map, and report of progress and cost of working quality of coal, etc. 3000 w. Col Guard—Feb 21, 1902. No. 46594 A.

Ash Fusibility.

A Study of the Fusibility of the Ashes of Combustibles (Etude sur la Fusibilité des Cendres des Combustibles). MM. H. Le Chatelier and Chantepie. An illustrated account of experiments to determine the temperature of fusion of ashes of coal and other combustibles, with results. 2000 w. Bull Soc d'Encouragement—Feb., 1902. No. 47159 G.

Bituminous Coal.

Efficiency of Bituminous Coal. Harlan J. German. Discusses some of the losses which are incident to the combustion of bituminous fuels. 2200 w. Ry Mas Mech—March, 1902. No. 46637.

Bohemia.

The Coal Mining Industry of Northwestern Bohemia (Darstellung der Verhältnisse des Nordwestböhmischen Kohlenbergbaues). A general review of the Bohemian brown coal industry, as set forth in a speech by Frederick Zechner before the Austrian House of Deputies. 7000 w. Oesterr Zeitschr f Berg u Hüttenwesen—March 1, 1902. No. 46991 B.

British Columbia.

British Columbia Coal Fields. William

M. Brewer. Describes the various coal fields and collieries on Vancouver Island and the main land. 4800 w. Eng & Min Jour—March 22, 1902. No. 47099.

Calorific Value.

The Heating and Evaporative Power of Coal (Heizwert und Verdampfungsfähigkeit der Kohle). A. Dosch. From Dingler's Polytech Journal. This part gives the theoretical calorific power with different percentages of carbon, hydrogen, etc. Serial. Part I. Tables. 2000 w. Ill. Zeitschr f Klein u Strassenbahnen—March 1, 1902. No. 46910 C.

Coal Cutting.

Coal Cutting by Machinery in British Collieries. Sydney F. Walker. Illustrated description of machines used. 3000 w. Eng & Min Jour—March 8, 1902. Serial. 1st part. No. 46789.

Coal Supremacy.

See Industrial Economy.

Compressed Fuel.

Kuhn's Coal-Stamping Machinery. Illustrated description of a coal-compressing machine used in coking with explanation of its operation and statement of its advantages. 3800 w. Ir & Coal Trds Rev—Feb. 28, 1902. No. 46720 A.

The Charging of Coke Ovens with Compressed Fuel. Illustrates and describes appliances invented by John H. Darby for compressing fuel before coking, thus improving the quality and making it possible to obtain satisfactory results from some lean fuels. 1200 w. Col Guard—Feb. 28, 1902. No. 46724 A.

Faults.

A Lesson on Faults. Prof. Arthur Lakes. An illustrated sketch of the Aspen mining region, Colorado, in which the effects of faulting in the past, and still going on, are shown. 3000 w. Mines & Min—March, 1902. No. 46778 C.

Mid-Somerset.

The Mid-Somerset Coalfield Problem. Gives map and description of the peculiar geological formation found here, discussing the methods for extracting the coal. 3500 w. Col Guard—March 14 1902. No. 47124 A.

New Mexico.

The Coal, Graphite, and Oil Field of Raton, N. Mex. Prof. Arthur Lakes. Illustrates and describes the location and geological characteristics, the coal mines, and prospects for graphite and oil. 3000 w. Mines & Min—March, 1902. No. 46-781 C.

Peat.

A New Process for Preparing Peat for Briquetting and Other Purposes (Ein Neues Verfahren zur Aufbereitung von Torf für Briquettirungs und Andere Zwecke). Gustav Kroupa. An illustrated description of methods and machines for pressing and briquetting peat. Serial. 2 parts. 1 plate. 4000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Feb. 1, 8, 1902. No. 46984 each B.

New Method of Preparing Peat for Briquette Making, etc. G. Kroupa. From *Oesterreichische Zeitschrift für Berg und Huttenwesen.* Illustrated description. 900 w. Col Guard—March 7, 1902. No. 45866 A.

The Calorific Power of Peat (Ueber den Heizwerth des Torfs). Anderson and Dillner. An experimental investigation of peat in Sweden, abstracted from *Jernkontorets Annaler.* 2000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Feb. 22, 1902. No. 46990 B.

COPPER.

Copper Supply.

Sources of Copper Supply. A discussion of the situation and the effects made to regulate the prices, and review of the sources of supply. 1400 w. Engr, Lond—Feb. 21, 1902. No. 46602 A.

Low-Grade Ores.

Electrolytic Recovery of Copper from Low-Grade Ores. N. S. Keith. States the conditions and considerations applied in the planning and erecting of works for the electrolytic method of recovering copper from the ores of a mine near New York city. The article is limited to the consideration of the variety of wet method in which electrolysis is used to effect the final deposition of the copper. 3400 w. Elec Rev, N Y—March 22, 1902. No. 47096.

Production.

American Copper Production. Editorial discussing the copper districts of the United States and the production for 1901, with some of the causes affecting it. 1700 w. Engng—March 7, 1902. No. 46859A.

Reduction Works.

Anaconda Copper Mining Company's New Reduction Works. An illustrated description of recently completed works, which are probably the largest, most complete and up-to-date of any of their kind. 4000 w. Eng & Min Jour—March 1, 1902. No. 46642.

Refining.

Electrolytic Refining of Copper. Illustrated description of the largest copper-refining works in the world, located at Raritan, N. J. 1700 w. Sci Am—March 15, 1902. No. 46811.

South America.

South American Copper. Editorial discussing the production in the various countries, especially Chili and Peru. 2000 w. Engng—Feb. 21, 1902. No. 46598 A.

Sweden.

The Nautanen Mineral Field (Das Erzfeld Nautanen). Björn Kjellberg. From *Teknisk Tidschrift.* An account of a copper region, in which gold occurs, near Gellivare, Sweden, with description of the ores. 700 w. Glückauf—March 1, 1902. No. 46982 B.

GOLD AND SILVER.

British Columbia.

Boundarv District of British Columbia. E. Jacobs. Reports concerning the ore, shipments from various mines, their working, and other information. Ill. 3800 w. Eng & Min Jour—March 1, 1902. No. 46639.

Concentration.

Screen vs. Hydraulic Sizing. S. I. Hallett. On the use of vibrating screens and their advantage over hydraulic apparatus. 2000 w. Min & Sci Pr—March 1, 1902. No. 46679.

Dredging.

A Few Notes Upon Gold Dredging. F. Satchell Clarke. Gives some account of gold dredging in British Columbia, the types of dredges used, their operation, etc. 4000 w. Can Min Rev—Feb. 28, 1902. No. 46625 B.

Low Grade Ore.

A Method of Mining Low Grade Ores in the Boundary Creek District. Frederic Keffer. Describes the methods of mining at the Mother Lode mine in Deadwood Camp, and the reasons for their adoption. The ores contain copper, gold and silver in varying degree. Ill. 1600 w. Can Min Rev—Feb. 28, 1902. No. 46624 B.

Mexico.

The Guanajuato Mining District in Mexico. Henry Russell Wray. An illustrated article briefly reviewing the history, formation and general conditions of this district. 800 w. Min Rept—March 6, 1902. No. 46753.

Nome.

The Story of the Nome Gold Fields. Otto Halla. Reviews the history of this field since its discovery in Julv. 1898. 1900 w. Min & Sci Pr—March 1, 1902. No. 46680.

Ore Treatment.

Some Unsolved Questions of Ore Treatment. O. H. Howarth. Considers some of the mechanical and other imperfections in milling processes. 4400 w. Mines & Min—March, 1902. No. 46780 C.

Southern States.

Gold in North Carolina. Frederic Moore. Reviews the history of gold mining in this state, giving illustrations of the workings. 1200 w. Sci Am Sup—March 22, 1902. No. 47116.

Utah.

Stateline Mining District, Iron County, Utah. Grant H. Smith. Brief account of the mines. The ores carry gold and silver, associated with a small percentage of iron, and of manganese. 1400 w. Min & Sci Pr—Feb. 22, 1902. No. 46505.

Washington.

The Mount Baker Mining District, Washington. George Otis Smith. An illustrated description of this gold mining region. 1500 w. Eng & Min Jour—March 15, 1902. No. 46824.

IRON AND STEEL.

Basic Ingots.

The Non-Homogeneity of Soft Basic Open-Hearth Ingots (Ueber Inhomogenität der Weichen Basischen Martinblöcke) Adolf Riemer. An account of experiences with small ingots with analyses of different charges and different parts of the same ingot, and explanations of the nonhomogeneity. 2200 w. Stahl u Eisen—March 1, 1902. No. 46968 D.

Blast Furnaces.

On Electric Lifts for Blast Furnace Bell-tops. F. Janssen. Illustrates and describes a blast-furnace bell-top lift which has been in operation about one year, stating the advantages from the employment of electricity. 2500 w. Ir & Coal Trds Rev—March 14, 1902. No. 47088 A.

The Operation of Blast Furnaces (Interessante Erscheinungen beim Hochofengauge und ihre Erklärung). Bernhard Osann. A paper before the Verein Deutscher Eisenhüttenleute discussing various interesting phenomena in blast furnace practice and their explanation. 6000 w. Stahl u Eisen—March 1, 1902. No. 46-967 D.

Charging Machine.

Wellman Electric Charging Machine for Open Hearth Furnaces (Chargeuse Electrique, Système Wellmann pour Fours Siemens-Martin). An illustrated description of these machines for charging steel furnaces mechanically. 1500 w. Génie Civil—Feb. 15, 1902. No. 46996 D.

Constitution.

The Chemical Equilibrium of Ferro-Carbon Systems (Sur l'Equilibre Chiminique des Systèmes Fer Carbon). Georges Charpy et Louis Grenet. Discussion and experiments on the chemistry and constitution of combustions of iron and carbon. 500 w. Comptes Rendus—Jan. 13, 1902. No. 47176 D.

Crucible Steel.

The Improvements of the Crucible Steel

Company of America. Detailed description, with plans of new plants being built by this company. 2300 w. Ir Age—March 20, 1902. No. 47000.

Germany.

German Imports and Exports of Iron Ore, Iron, Iron Manufactures, Machines and Vehicles for 1900 and 1901 (Des Deutschen Zollgebietes Einfuhr begw. Ausfuhr von Eisenerz, Eisen, Eisenwaren, Maschinen und Fahrzenengen in den Jahren 1901 und 1900). Complete statistical tables. 3 plates. Stahl u Eisen—March 1, 1902. No. 46971 D.

Lahn Valley.

The Probable Duration of Iron Mining in the Lahn and Dill Districts, Germany (Die Muthmassliche Dauer des Fortbestehens des Eisenerzbargbaud der Lahn und Dillreviere). An abstract of a memoir on the canalization of the Lahn, describing the iron geology and iron ores of these districts in Nassau, Germany. 1600 w. Stahl u Eisen—March 1, 1902. No. 46-970 D.

Rheinish-Westphalia.

The Iron Industry in the Rhenish Westphalian Coal Region (Die Eisenhüttenindustrie im Rheinish - Westphälischen-Kohlenrevier). Abstract from the *Allgem. Deutscher Bergmannstag*. A historical and up-to-date review of iron and steel manufacture in this parf of Germany. Serial. 2 parts. 4500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Feb. 8, 15, 1902. No. 46987 B.

Rolling Mill.

A Two-High Roll Train with Electrically Driven Transfer Tables (Die Neue 950 er Duo Reversirstrasse mit Elektrisch Fahrbaren Rollgängen). An illustrated description of a rolling mill at Morgenroth, Silesia, in which the metal is handled between the passes by an electrically driven table which travels parallel to the rolls. 1 plate. 800 w. Stahl u Eisen—Feb. 15, 1902. No. 46964 D.

Hollow Geared Rolls with Internal Coupling (Ueber Hohlkammwalzen mit Innerem Augriff der Spindeln für Walzwerke). R. M. Daelen. An illustrated description of coupling shafts with spherical heads gearing into the hollow ends of rolls. 800 w. Stahl u Eisen—Feb. 15, 1902. No. 46963 D.

New Mill for Re-Rolling Worn Rails. Illustrated description of a new mill at Tremley Point, N. J., where the McKenna process of re-rolling old rails is to be installed. 2000 w. R R Gaz—March 14, 1902. No. 46827.

The Rolling of Sections in Iron and Steel. Adolph S. White. Considers the methods used in the rolling of angles and channels and their relative merits. Ill. 1800 w. Ir Age—March 27, 1902. No. 47122.

See also Mechanical Engineering, Miscellany.

Russia.

The Present State of the Russian Metallurgical Industry (Zur Gegenwätigen Lage der Russischen Montanindustrie). Dr. Neumark. A review of the Russian iron and steel and allied industries, with statistical tables. 3000 w. Stahl u Eisen—March 1, 1902. No. 46969 D.

United States.

Iron and Steel Works of the United States. James M. Swank. Extracts from the preface to the fifteenth edition of the *Directory to the Iron and Steel Works of the United States and Canada*, describing the condition at the close of 1901, as compared with 1898. 1700 w. Eng & Min Jour—March 8, 1902. No. 46788.

MINING.

Accidents.

Important Mining Accidents in 1901 (Bemerkenswerthe Unfälle beim Bergwerksbetriebe im Auslande). A brief record of mine accidents and explosions in all parts of the world. 800 w. Oesterr Zeitschr f Berg u Hüttenwesen—Feb. 15, 1902. No. 46989 B.

Electric Hoisting.

See Electrical Engineering, Power Applications.

Explosions.

Mine Explosions. Austin King. Gives the history and cause of those occurring in the bituminous regions of Pennsylvania since 1883, and the lessons taught by them. 4200 w. Mines & Min—March, 1902. No. 46782 C.

Notes on the Talk-o'-th'-Hill Explosion. An interesting account of the explosion which occurred May 27, 1901, killing four persons and twenty-seven horses and ponies. Also brief notes on other explosions. 2300 w. Col Guard—Feb. 21, 1902. No. 46593 A.

The Nature of Explosions. Review of Prof. Dixon's second lecture at the Midland Institute, Birmingham, Eng. The writer has been working in connection with this subject for twenty-five years. 3000 w. Quarry—March, 1902. No. 46-848 A.

The Universal Colliery Explosion. Prof. W. Galloway. From the official Home Office Report. Describes the method of working, ventilation and general conditions, the explosion, supposed cause, means of preventing, etc. 5800 w. Ir & Coal Trds Rev—Feb. 28, 1902. No. 46-721 A.

Hoisting Engines.

Notes on Mine Hoisting Engines. Robert Peele. Considers the hoisting engine from a mechanical engineering point of view, discussing the type form of ordinary intermittent-running engine. 8500 w. Sch of Mines Qr—Jan., 1902. No. 46797 D.

Mine Pumps.

Mining Machinery (Les Machines de Mines). Henri Deschamps. An illustrated review of mining machinery at the Paris Exposition of 1900. The present part treats of pumping machinery. Serial. 1st part. 5 plates. 18000 w. Rev Univ d Mines—Jan., 1902. No. 46920 H.

Mining Locomotives.

Electric versus Compressed Air Mining Locomotives. Frank C. Perkins. The present article is mostly devoted to the compressed air locomotives and their advantages. Ill. 800 w. Min Rept—Feb. 27, 1902. Serial. 1st part. No. 46615.

Electric and Compressed Air Mining Locomotives. Frank C. Perkins. Considers the details of leading types, comparing their working advantages and disadvantages, etc. 1800 w. Min & Sci Pr—March 8, 1902. No. 46808.

See also Electric and Street Railways.

Mining Methods.

Mining Under an Old Gob. Explains the conditions and the methods used in extracting coal under difficulties. 1500 w. Col Guard—March 14, 1902. No. 47-123 A.

Power in Mines.

The Distribution of Power in Mines. Sydney F. Walker. The first of a series of articles proposing to discuss the whole question of the distribution of power in and about mines, and also the distribution of air for ventilating purposes. 2000 w. Mines & Min—March, 1902. Serial. 1st part. No. 46783 C.

Rock Drill.

The Flottmannsche Rock Drill (Die Flottmannsche Gesteinsbohrmaschine). Hr. Limberg. An illustrated description of a rock drill to be driven by compressed air or steam, with improved valve gear having very little friction. 1 plate. 1500 w. Glückauf—March 8, 1902. No. 46983 B.

Rope Haulage.

The Rope Haulage Plant at Diedenhofen, Lorraine (Die Seilförderungsanlage im Karlstolln bei Diedenhofen). Hr. Heise. An illustrated description of a rope-haulage plant for an iron mine tunnel. 1 plate. 2500 w. Glückauf—Feb. 1, 1902. No. 46977 D.

Shaft Sinking.

Shaft Sinking at the Dubensko Coal Mine in Upper Silesia (Das Schlachtabteufen des Junghannschachtes II auf der Dubenskogrube in Oberschlesien). E. Langer. Abstract of a paper before the International Meeting of Boring Engineers at Karlsbad, giving an account of shaft sinking through watery quicksand. Ill. 900 w. Glückauf—March 1, 1902. No. 46981 B.

Stratameter.

The Gothan "Stratameter" (Der Stratameter von Hermann Gothan in Gross-Lichterfelde). H. Thumann. Paper before the International Meeting of Boring Engineers at Karlsbad, in 1901, describing a compass needle apparatus for determining the dip and strike of strata encountered in bore holes, and the plumbness of th latter. 1600 w. Glückauf—Jan. 18, 1902. No. 46973 B.

Ventilation.

Losses of Pressure in the Ventilation of Mine Workings (Ueber Druckverluste bei der Bewetterung der Abbaubetriebe). Franz Pospisil. General discussion of various methods of working, with observations at a coal mine in Moravia. 1 plate. 2400 w. Oesterr Zeitschr f Berg u Hüttenwesen—Feb. 1, 1902. No. 46985 B.

Winding.

Winding from Great Depths. An illustrated detailed description of the Whiting system is given in the present article. 2000 w. Ir & Coal Trds Rev—Feb. 28, 1902. Serial. 1st part. No. 46722 A.

MISCELLANY.

Alloys.

Upon the Constitution of Binary Alloys. John Alexander Mathews. Continued discussion. 3000 w. Jour Fr Inst—March, 1902. No. 46796 D.

Aluminum Alloys.

Alloys of Aluminum with Iron and with Manganese (Contribution à l'Etude des Alliages Aluminium-Fer at Aluminium-Manganèse). Leon Guillet. A record of chemical experiments. 600 w. Comptes Rendus—Jan. 27, 1902. No. 47193 D.

Austria.

The Austrian Mineral Industry for 1900 (Die Bergwerksproduktion Oesterreichs im Jahre 1900). Statistical tables of the production of metals and minerals. 800 w. Glückauf—Jan. 18, 1902. No. 46-974 B.

Manganese.

The Occurrence of Manganese Associated with Iron at Platten in Bohemia and Johanngeorgenstadt in Saxony (Das Vorkommen von Manganerzen in Gesellschaft von Eisenerzen bei Platten in Böhmen und Johanngeorgenstadt in Sachsen). Josef Lowag. Geological and mineralogical description, with some production figures. Serial. 2 parts. 4000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Feb. 8, 15, 1902. No. 46986 B.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

Should Executive Officers Be Held Criminally Responsible for Accidents? Editorial discussion of Park Avenue tunnel disaster and the indictment of the Grand Jury. 2000 w. Eng News—March 13, 1902. No. 46804.

Capacity.

Limit of Capacity of Single Track. Presents papers by H. C. Thompson and Augustus Mordecai, read in 1883, also responses to a general invitation to discuss this subject, and an editorial. 18700 w. Ry & Engng Rev—March 15, 1902. No. 47030.

Employes.

Vision, Color-Sense and Hearing. Charles H. Williams. Considers methods of examination and required standards. Also discussion. 18000 w. W Ry Club—Feb. 18, 1902. No. 46792 C.

Locomotive Running.

Successful Locomotive Engine Running. Paper by R. S. Goble, read before the Pacific Coast Ry. Club. On the necessity of practical experience. 2000 w. Ry Mas Mech—March, 1902. No. 46638.

Trains Parting.

Control of Trains Parted Between Air-Brake Cars. E. W. Pratt. Believes all cars should be equipped with automatic brakes and enginemen carefully instructed in handling long trains. 1300 w. R R Gaz—March 21, 1902. No. 47109.

MOTIVE POWER AND EQUIPMENT.

Balancing.

The Balancing of Locomotive Engines. Information from leading locomotive superintendents and engine builders of Great Britain as to what is the best practice of to-day. 4600 w. Engr, Lond—Feb. 28, 1902. No. 46731 A.

Brakes.

The Combined Straight Air and Automatic Engine and Tender Brake. F. B. Farmer. From a paper read before the Northwest Ry. Club. States the disadvantages of the automatic brake in switching, and the advantages of the straight air brake, and the reasons why the new arrangement is considered desirable. Ill. 3200 w. Ry Age—March 14, 1902. No. 46895.

Brake Shoes.

Locomotive Brake Shoes. W. H. Stocks. A report of a comparative brake shoe test recently made on the C. R. I. & P. Ry. with discussion. 9300 w. W Ry Club—Feb. 18, 1902. No. 46793 C.

Cars.

Best Methods in Shop Practice in Meeting the Requirements for the Maintenance of All-Steel Cars. Paper by W. S. Morris, with lengthy discussion. Ill. 15600 w. N Y R R Club—Feb. 20, 1902. No. 46873.

80,000-Lb. Capacity Box Car. Illustrated description of a new standard 36-ft. box car for the N. Y. C. & H. R. R. 500 w. Am Engr & R R Jour—March, 1902. No. 46540 C.

Santa Fe Combination Steel and Wood Box Car, 80,000 Pounds' Capacity. Illustrates and describes a car having special features which are novel, and designed with a view to overcoming defects. 1200 w. Ry Age—Feb. 28, 1902. No. 46631.

The New York Central Box Car. Illustrations of the standard box car F 8 are presented, showing how the problem of designing an all-wood box car has been solved. 900 w. Ry Age—Feb. 28, 1902. No. 46630.

Electrical Driving.

The Electric Problem of Railways. James Swinburne. Read before the Manchester Sec. of the Inst. of Elec. Engrs. Considers the different systems in use and of possible application. 6500 w. Mech Engr, Lond—March 1 and 8, 1902. 2 parts. No. 46875 each A.

High Speed.

High Speed and Electric Operation on Standard Railways (Ueber Schuellbahnen und Elektrische Zugförderung auf Hauptbahnen). Hr. Wittfeld. A discussion before the Verein für Eisenbahnkunde, of the comparative merits of steam and electric traction. 7000 w. Glasers Ann—March 1, 1902. No. 46931 D.

See also Electric and Street Railways.

India.

The Design and Construction of Railway Carriages in India. C. F. Bamford. Illustrates and describes the design and construction of the different railway passenger carriages adopted on the Assam-Bengal Railway metre-gauge, and also the general practice adopted by other Indian broad and metre-gauge railways. 1800 w. Engng—Feb. 21, 1902. Serial. 1st part. No. 46595 A.

Journals.

Notes on the Wear of Journals. David Van Alstine. Notes on an investigation made of the consumption of axles, by C. G. W. Ry. 2300 w. R R Gaz—Feb. 21, 1902. No. 46498.

Locomotives.

Compound Express Locomotive of the Adriatic Railway, Italy (Locomotive Compound Express des Chemins de Fer de l'Adriatique). F. Barbier. A well illustrated description of an Italian locomotive with the cab in front and smokestack in rear, three pairs of drivers and four-wheeled bogie truck, exhibited at Paris. 1 plate. 2500 w. Génie Civil—March 8, 1902. No. 47155 D.

Compound Ten-Wheel Passenger Locomotive. Illustrated detailed description of this new locomotive for the Plant System, which is the 20,000th locomotive built by the Baldwin Locomotive Works, and a most interesting engine. It combines the four-cylinder balanced construction with the Vanderbilt boiler and tender. 900 w. Am Engr & R R Jour—March, 1902. No. 46541 C.

Express Engines, Furness Railway. Sectional drawings, with dimensions and description of some powerful express bogie passenger engines. 600 w. Engr, Lond—Feb. 21, 1902. No. 46603 A.

Rogers Cross Compound for the Great Northern. Detailed description with illustration. 800 w. Loc Engng—March, 1902. No. 46645 C.

The Differentiation of the American Locomotive. J. C. Bayles. A comparison of engines built 70 years ago with those of to-day, the types being represented by "Old Ironsides," built in 1832, and the Ten-wheel locomotive recently built for the Plant System. 2200 w. Ir Age—March 6, 1902. No. 46607.

The Locomotive. Ira C. Hubbell. Extracts from a paper read before the Ry. Club of Pittsburg, discussing the question of cylinder-clearance and economy of steam distribution in general. 1200 w. Ry & Engng Rev—March 1, 1902. No. 46644.

The Tractive Power of Locomotives. Edward C. Schmidt. Gives tables and curves showing the results of two methods of determining the draw-bar pull of four locomotives. 600 w. R R Gaz—March 7, 1902. No. 46790.

Springs.

Underhung Springs. J. P. Kelley. On the method of hanging the driving springs and the equalizers of locomotives, and related subjects. Ill. 1300 w. Loc Engng—March, 1902. No. 46648 C.

Train Acceleration.

A Consideration of the Inertia of the Rotating Parts of a Train. Norman Wilson Storer. An investigation of this feature which has been almost neglected. 1500 w. Trans Am Inst of Elec Engrs—Feb., 1902. No. 46656 D.

The Relation of Energy and Motor Capacity to Schedule Speed in the Moving of Trains by Electricity. Cary T. Hutchinson. A general solution of the question involved in the movement of a body from rest to rest, covering all cases that can arise in ordinary practice of train movement. 5700 w. Trans Am Inst of Elec Engrs—Feb., 1902. No. 46655 D.

The Selection of Electric Motors for Railway Service. W. B. Potter. Discussing the paper of Dr. Cary T. Hutchinson, pointing out some variations from the average met with in the practical consideration of motor selection. 2500 w. Trans Am Inst of Elec Engrs—Feb., 1902. No. 46657 D.

PERMANENT WAY AND BUILDINGS.

Buildings.

Buildings. Report of the American Railway Engineering and Maintenance of Way Association, on coaling stations and water tanks. Ill. 11700 w. Ry Age Special No. March 21, 1902. No. 47136 D.

Bumping Posts.

Hydraulic Bumping Posts (Hydraulische Prellböcke). An illustrated description, partly from a paper by Hr. Sarre before the Verein für Eisenbahnkunde, of bumping posts with hydraulic cylinders, in use in German railway stations. 1000 w. Zeitschr f Lokomotivführer—Feb. 28, 1902. No. 46914 B.

Coaling.

Locomotive Coaling Stations. Waldon Fawcett. Illustrates and describes a recent system of coaling which the writer considers almost perfect. A steel coal pocket of the suspended-bin type is mounted above the tracks. The arrangements for filling are described and also for emptying the ashes. 1500 w. Loc Engng—March, 1902. No. 46647 C.

Coaling Stations.

The New Chicago & Alton Coaling Stations. Illustrated descriptions of these stations and their equipment. Arrangements are such that locomotives receive their supply of coal, water, and sand, and discharge the cinders from fire-box and smoke-box simultaneously. 1000 w. R R Gaz—March 14, 1902. No. 46837.

Construction Work.

New Construction Work on the Pennsylvania R. R. Extracts from the annual report giving interesting particulars of recently completed work. 1500 w. Eng News—March 13, 1902. No. 46802.

Crossings.

Time Lock to Prevent Derailments at Interlocked Grade Crossings. Illustrated description of a mechanical time lock. 1000 w. Eng News—March 13, 1902. No. 46803.

Freight House.

New Freight House for the Chicago Great Western, in Chicago. Illustrated description of a new four-story house equipped with modern conveniences for handling the freight of a large city terminal. 700 w. Ry & Engng Rev—March 15, 1902. No. 47029.

Freight Yards.

Freight Yards of the Chicago Transfer and Clearing Co. Illustrated detailed description of work nearly completed, which will give an immense switching yard connected with all railroads entering Chicago. 2100 w. R R Gaz—March 14, 1902. No. 46833.

The New Pennsylvania Yard at Pittsburg. Two-page plate with description of an entirely reconstructed and greatly enlarged yard and approaches. 1400 w. R R Gaz—March 14, 1902. No. 46835.

Improvements.

Bridge and Track Improvements on the Chicago & Alton. Deals with roadway improvements during the past year, giving photographs of the interesting structures. 2200 w. Ry Age, Special No—March 21, 1902. No. 47131 D.

The Improvements in the Pennsylvania Division of the New York Central & Hudson River Railroad. Two-page plate with description. 1400 w. R R Gaz—March 14, 1902. No. 46830.

Work of the Past Year in and Around Chicago. An account of the extensive track elevation, including elevation of yards, and involving many difficulties; the building of freight-houses and suburban passenger stations; interlocking plants; enlarged yards and terminals &c. 2800 w. R R Gaz—March 14, 1902. No. 46826.

Yard and Stations Improvements at St. Paul, Minn. General plan of rearrangement of track system for the St. Paul Union Depot Co. with illustrated description of other improvements. 2000 w. Ry Age, Special No—March 21, 1902. No. 47129 D.

Interlocking.

New Interlocking Plant at the Pittsburg Terminal of the P. R. R. Illustrates the general layout of the tracks and the arrangement of the switch machines and signals. 400 w. Ry & Engng Rev—March 15, 1902. No. 47032.

Proposed Interlocking for a Gauntlet Track Arrangement. W. M. Torrence. Shows an arrangement designed by the writer for use in connection with work of lining the east end of Musconetcong tunnel on the Lehigh Valley R. R. 800 w. Ry & Engng Rev—March 15, 1902. No. 47027.

Masonry.

Masonry. Report of the American Railway Engineering and Maintenance of Way Association, with discussion. 25600 w. Ry Age, Special No—March 21, 1902. No. 47140 D.

New York Central.

New York Central's Current Engineering. Illustrations and description of features which may be considered as samples of the standard engineering of the road in the lines covered. 5800 w. Ry Age. Special No—March 21, 1902. No. 47130 D.

Rail.

Rail. Report of American Railway Engineering and Maintenance of Way Association, with discussion. 10000 w. Ry Age, Special No—March 21, 1902. No. 47137 D.

Railway Curves.

Line and Surface for Railway Curves. Charles C. Wentworth. Discusses the original center line used as the base of measurement, indicating what was wrong, and proposing simpler means for correcting the trouble than those now in use. 2000 w. Pro Am Soc of Civ Engrs—Feb., 1902. No. 46532 E.

Roadway.

Roadway. Report of the American Railway Engineering and Maintenance of Way Association, with discussion at the Chicago convention. 16700 w. Ry Age, Special No—March 21, 1902. No. 47133 D.

Sheds.

Railway Platform Sheds (Freistehende Perronhallen). Karl Haberkalt. An illustrated mathematical discussion of the design and construction of roofs and their supporting columns for station platforms. 1 plate. 6000 w. Oesterr Wochenschr f d Oeffent Baudienst—March 8, 1902. No. 46937 B.

Shops.

New Shops at the Ft. Worth & Denver City Ry. Illustrated detailed description of small shops with provision for extension. 800 w. R R Gaz—March 21, 1902. No. 47110.

The New Shops of the Union Switch and Signal Company. Illustrated detailed description of new shops at Swissvale, Pa. 1100 w. R R Gaz—March 14, 1902. No. 46836.

Herman's Automatic Electric Semaphore. Illustrated description of an instrument designed to work three-position signals. 1200 w. R R Gaz—March 14, 1902. No. 46831.

Rowell-Potter Safety Stop and Block Signals on the C. M. & St. P. Ry. Describes the apparatus in detail giving illustrations, and discusses the subject of signalling generally. 3800 w. Ry & Engng Rev—March 15, 1902. No. 47031.

The Miller Locomotive Cab Signal. Illustrates and describes the essential features of this system, by which stop and go-ahead signals are given in the cab of the locomotive. 2200 w. R R Gaz—Feb. 21, 1902. No. 46499.

Structures.

Iron and Steel Structures. Report of the American Railway Engineering and Maintenance of Way Association, on contracts for bridge work, specifications for rolled steel, live loads, impact and unit strains, with discussion. 16800 w. Ry Age, Special No—March 21, 1902. No. 47138 D.

Terminals.

A Model Terminal Station. Illustrates and describes the mechanical and electrical equipment of the new terminal station of the Pittsburg & Lake Erie, at Pittsburg, Pa. 6000 w. Ry Age, Special No.—March 21, 1902. No. 47127 D.

Inadequate Freight Terminals. George Hannauer, with discussion. Discusses local conditions at St. Louis, which are similar to other large cities, and the remedy. Shows what a freight terminal should be, &c. 7000 w. St. Louis Ry Club—Feb. 14, 1902. No. 46627.

New Chicago Terminal for Lake Shore & Michigan Southern and Chicago, Rock Island & Pacific. Illustration, plans, and descriptive notes. 600 w. R R Gaz—March 14, 1902. No. 46834.

Terminal Improvements of the Plant System, at Port Tampa, Fla. A comprehensive illustrated description of this terminal, including much recent engineering work and giving much information of the business which passes through this point. 3300 w. Ry & Engng Rev—March 15, 1902. No. 47021.

Ties.

Buhrer Steel Ties on the Lake Shore & Michigan Southern Ry. A statement of the efficiency, serviceability and cost of these ties. 1500 w. Ry & Engng Rev—March 15, 1902. No. 47024.

Ties. Report of the American Railway Engineering and Maintenance of Way Association, with discussion at the Chicago convention. 17200 w. Ry Age, Special No—March 21, 1902. No. 47135 D.

Track.

Track. Report of the American Railway Engineering and Maintenance of Way Association, with discussion at the Chicago convention. 16400 w. Ry Age, Special No—March 21, 1902. No. 47134 D.

Tunnel Ventilation.

The Ventilation of the Simplon Tunnel (Die Ventilationsanlagen am Simplontunnel). C. T. Wagner. An illustrated account of the ventilating plant and method of ventilation. 2 plates. 2500 w. Oesterr Wochenschr f d Oeffent Baudienst—Feb. 15, 1902. No. 46933 B.

Union Station.

The Proposed Union Station for Washington, D. C. Map, showing erection of a proposed station for the Pennsylvania and Baltimore & Ohio railroads, with information concerning it. 1100 w. Ry Age, Special No—March 21, 1902. No. 47128 D.

Yards.

On Yards and Terminals. Report of the American Railway Engineering and Maintenance of Way Association, giving plans and discussion. 14000 w. Ry Age, Special No—March 21, 1902. No. 47139 D.

MISCELLANY.

Austria.

Statistics of the Austrian Local Railways for 1899 (Uebersichts-Tabellen, zusammengestellt aus der Statistik des Verbandes der Oesterreichischen Localbahnen für das Jahr 1899). General statistical tables. 3000 w. Mitt d Ver f d Förderung d Local u Strassenbahnwesens—Feb., 1902. No. 46923 D.

Bosnia-Herzegovina.

The State Railways of Bosnia and Herzegovina (Die Bossnisch-Herzegowinischen Staatsbahnen). From the *Zeitschr, d. Vereins Deutscher Eisen-Verwaltungen.* A general statistical report of these railways and their operation in 1900. 1600 w. Ill Zeitschr f Klein u Strassenbahnen—Jan. 16, 1902. No. 46904 C.

Cuba.

Cuban Railroads. From *The Economist.* A review of existing railroads, their financial standing. &c. 1000 w. R R Gaz—Feb. 28, 1902. No. 46576.

Organization.

Railroad Organization. George T. Sampson. General remarks with a description of one of the best organizations in the United States, and as the writer believes, in the world. 13000 w. Jour Assn of Engng Socs—Jan., 1902. No. 46706 C.

Prussia.

Budget for the Prussian State Railways in 1902 (Etat der Eisenbahn-Verwaltung für das Etatsjahr 1902). The official estimates for operation and maintenance, with many tables. Serial. 6000 w. Glasers Ann —Feb. 15, 1902. No. 46930 each D.

Switzerland.

Statistics of the Swiss Railways for 1899 (Statistique des Chemins de Fer Swisses pour l'Année 1899). An analysis of the Government statistics. Tables. 2000 w. Rev Gen d Chemins de Fer—March, 1902. No. 47175 H.

STREET AND ELECTRIC RAILWAYS

Accumulator Locomotive.

Switching Locomotive with Electric Accumulators (Elektrische Rangier-Lokomotiven mit Akkumulatoren). An illustrated description of a 40-H. P. electric locomotive carrying a storage battery of 120 cells. 1000 w. Ill Zeitschr f Klein u Strassenbahnen—Feb. 16, 1902. No. 46908 C.

Alternating Currents.

Four-Motor Equipments and the Possibilities of Alternating Currents for Street Railway Service. Albert H. Armstrong. Extract from an address before the New England Street Ry. Club, on the suburban phase of street railway work. 2800 w. St Ry Jour—March 8, 1902. No. 46747 D.

Berlin.

Interesting Constructions on the Berlin Electric Elevated and Underground Railway (Intercessante Montagen der Elektrischen Hoch- und Untergrundbahn zu Berlin). Hans Dominik. A well illustrated account of various interesting features of the construction work. Two parts. 3000 w. Ill Zeitschr f Klein-u Strassenbahnen—Jan. 1, 16, 1902. No. 46902 each C.

The Berlin Electric Elevated and Underground Railway (Die Elektrische Hoch- und Untergrundbahn in Berlin). Hr. Langbein. A very well illustrated and complete account of all the features of this road, which has lately been opened for traffic. Serial. 3 parts. Map. 24000 w. Zeitschr d Ver Deutscher Ing—Feb. 15, 22, March 1, 1902. No. 46925 each D.

The Berlin Elevated and Underground Electric Railway. Abstract translation of an article by Mr. Gisbert Kapp, which appeared in the *Elektrotechnische Zeitschrift,* giving a description of the undertaking. Ill. 2200 w. Elec Engr, Lond—March 7 & 14, 1902. Serial. 2 parts. No. 46852 each A.

The Berlin Electric Elevated and Underground Railway (Die Elektrische Hoch- und Untergrundbahn in Berlin). Gisbert Kapp. A well illustrated description of the road, the cars and the power station. 3500 w. Elektrotech Zeitschr—Feb. 13, 1902. No. 46333 B.

The Stations of the Berlin Electric Elevated and Underground Railway (Die Bahnöfe der Elektrischen Hoch- und Untergrundbahn zu Berlin). Hans Dominik. A well illustrated description of the stations on the new Berlin electric railway. Two parts. 2500 w. Ill Zeitschr f Klein u Strassenbahnen—Feb. 16, Mar. 1, 1902. No. 46907 each C.

British Isles.

Recent Electric Tramway Practice in the British Isles. P. T. J. Estler. Abstract of a paper read before the University College Engng. Soc., London. The paper is confined to the overhead trolley system and discusses the permanent way, overhead equipment, generating station and rolling-stock. Ill. 7500 w. Tram & Ry Wld—Feb. 13, 1902. No. 46591 B.

Chamonix.

Electric Railway from Fayet to Chamonix and the Swiss Frontier (Chemin de Fer Electrique du Fayet à Chamonix et à la Frontière Suisse). M. Geoffray. A well illustrated description of this third-rail road near Mont Blanc and its hydro-electric plants. 3 plates. 16000 w. Ann d Ponts et Chaussées—3 Trimestre, 1901. No. 46918 E+F.

Conduit System.

The Cost of the London Tramway Conduit System. A report of the proposed conversion of the tramway lines to this system of electric traction, the present position of the undertaking, cost, &c. 1700 w. Engr, Lond—Feb. 21, 1902. No. 46600 A.

Convertible Car.

The Duplex Car for Summer and Winter Use (Der Duplexwagen, ein neuer Sommer- und Winter-Wagen). Hans Dominik. An illustrated description of a new convertible electric car. 700 w. Ill Zeitschr f Klein u Strassenbahnen—March 1, 1902. No. 46909 C.

Electric Locomotive.

Three-Phase 10,000-Volt Railway at Gross-Lichterfelde. Frank C. Perkins. Illustration, with description of a Siemens & Halske three-phase current locomotive, and brief account of the experimental line on which it is used. 8000 w. Sci Am—March 22, 1902. No. 47115.

Electric Tramways.

Recent Electric Tramway Practice. P. T. J. Estler. Abstract of a paper read before the London Univ. Col. Engng. Soc. Deals only with the overhead trolley system, discussing the permanent way in the present article. 3000 w. Mech Engr, Lond—March 15. 1902. Serial. 1st part. No. 47064 A.

English Tramways.

Electric Traction on English Railroads and Tramways. On the present position of electric traction matters in Great Britain. 1800 w. R R Gaz—Feb. 28, 1902. No. 46573.

Equipment.

The Electrical Equipment of the Providence, Warren & Bristol Railroad. Describes the equipment of this section of the New York, New Haven & Hartford Railroad, with the overhead trolley system. Ill. 2400 w. St Ry Jour—March 1, 1902. No. 46766 D.

High Speed.

High Speed Railways (Ueber Eisenbahn-Schnellverkehr). Ludwig Ritter v. Stackert. An illustrated paper giving a general discussion of high-speed railways, including steam, electric, suspended, etc. 7000 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 14, 1902. No. 46940 B.

Operating Notes on High Speed Electric Railways. States the conditions at present existing on interurban electric roads, discussing recent improvements, and needed improvements. 2500 w. St Ry Rev—March 15, 1902. No. 47017 C.

The Berlin-Zossen High-Speed Electric Railway Experiments. Enrico Bignami. Notes recent progress in Europe in regard to electric traction and begins an illustrated description of this experimental line and its working. 3000 w. Elec Rev, N. Y—March 8, 1902. Serial. 1st part. No. 46761.

Hungary.

Statistics of Hungarian Electric Street Railways for 1900 (Betriebsergebnisse der Elektrischen Strassenbahnen in Ungarn für das Jahr 1900). General statistical table. 300 w. Mitt d Ver f d Förderung d Local u Strassenbahnwesens—Feb., 1902. No. 46924 D.

Interurban.

The Grand Rapids, Holland and Lake Michigan Rapid Ry. William D. Ray. From a paper read before the Chicago Elec. Assn. Illustrated detailed description of the line and its equipment. 9000 w. St Ry Rev—March 15, 1902. No. 47015 C.

Italy.

Electrical Operation on the Italian Mediterranean Railway (Elektrischer Betrieb auf den Linen der "Italienischen Mittelmeer-Eisenbahn-Gesellschaft"). A comprehensive illustrated description of standard electric railways running north from Milan and their power station and substations. 2000 w. Mitt d Ver f d Förderung d Local u Strassenbahnwesens—Jan., 1902. No. 46912 D.

Electric Traction on the Railway Lines from Milan to other Northern Towns of Italy (Traction Electrique sur les Lignes de Milan à Gallarate, Varese, Porto Ceresio, Arona et Laveno). Illustrated description of these electric railways of the Italian Mediterranean Company and of the power plants. 1 plate. 4000 w. Rev Gen d Chemins de Fer—Feb., 1902. No. 47174 H.

Journals.

Test of a Ball Bearing Car Journal on the Fitchburg Electric Ry. Illustrates and describes the Chapman double ball bearing, and gives report of comparative test between this and a car fitted with the ordinary journal bearing. 1500 w. Ry & Engng Rev—Feb. 22, 1902. No. 46478.

London.

The Great Northern and City Railway. Illustrated description of this underground road, the tunnel and the special shield designed for the work, and its method of operation. Ill. 5400 w. St Ry Jour—March 1, 1902. No. 46770 D.

The Central London Underground Electric Railway (Die Central London Untergrundbahn mit Elektrischen Betriebe). E. A. Ziffer. A well illustrated paper, giving a comprehensive account of this railway and its operation. 5000 w. Mitt d Ver f d Förderung d Local u Strassenbahnwesens—Jan., 1902. No. 46911 D.

Mine Locomotives.

The Progress of Locomotive Haulage in Mines (Die Fortschritte der Lokomotivförderung). Hr. Baum. A comprehensive illustrated review of locomotives for mine haulage, principally electric and benzine. Serial. 3 parts. 7 plates. 17000 w. Glückauf—Jan. 25, Feb. 8, 15, 1902. No. 46975 each B.

Moving Sidewalk.

A Subterranean Electric Moving Platform for Paris (Nouvelles Applications des Plates-Formes Roulantes Souterraines à Traction Electrique). D. A. Casalonga. An illustrated description of a proposed moving platform under the boulevards of Paris from the Place de la Concorde to the Place de la Bastille. 2000 w. Mem d l Soc d Ing Civils de France—Jan., 1902. No. 47170 G.

Operating Costs.

Operating Costs and Guaranties of Electric Street Railways (Betriebskosten und Betriebskostengarantie bei Elektrischen Strassenbahnen). An analysis of costs so as to enable guaranties of operating costs to be made intelligently. 3000 w. Ill Zeitschr f Klein u Strassenbahnen—Feb. 16, 1902. No. 46906 C.

Orleans.

The Orleans, France, Electric Tramway and its Gas Power Plant (Die Elektrische Tramway in Orleans und deren Kraftgas-Anlage). E. A. Ziffer. An illustrated description of this road and particularly of gas producing plant and gas engines, with a general discussion of the use of power gas. 1 plate. 5000 w. Mitt d Ver f d Förderung d Local u Strassenbahnwesens—Feb., 1902. No. 46922 D.

Railway Motors.

Geared Electric Motors for City and Suburban Railways (Zahnradmotoren für Stadt- und Vorotbahnen). Hr. Siebert. An illustrated discussion of motors for railway work. 1000 w. Elektrotech Zeitschr—March 6, 1902. No. 46954 B.

Roadbed.

Concrete Roadbed Construction for Street Railways. Discusses the best practice for city streets, and gives the details of roadbed construction for street railways in a number of large cities where concrete is used to a greater or less extent. Ill. 3500 w. Eng News—March 6, 1902. No. 46698.

Safety Frame.

Safety Apparatus for Electric Street Cars (Schutzvorrichtung gegen das Ueberfahren durch Elektrische Strassenbahnwagen). Max. v. Leber. An illustrated description of a movable frame which is automatically dropped in front of the wheels and prevents people from being run over. 600 w. Zeitschr d Oesterr Ing u Arch Ver—March 7, 1902. No. 46947 B.

Signals.

Automatic Signals for Street and other Secondary Railways (Sicherungen im Kleinbahn- und Strassenbahn-Betriebe durch Selbstthätige Scheiben-, Licht- und Glockensignale). An illustrated description of electric signal apparatus, visible and audible, which can also be applied to standard railways, and is independent of the motive power. 2000 w. Ill Zeitschr f Klein u Strassenbahnen—Jan. 1, 1902. No. 46903 C.

Steel Wheels.

Steel Street Car Wheels. W. L. Wright. Reviews the difficulties encountered in making a satisfactory steel wheel for street cars, and discusses the requirements of an ideal wheel. 1500 w. St. Ry Jour —March 1, 1902. No. 46769 D.

Stray Currents.

The Injury of Metal Pipes by Electric Railways (Zur Frage der Gefährdung von Metalleitungen durch Elektrische Bahnen). R. Ulbricht. A mathematical discussion of the dangers of electrolysis of underground pipes by stray currents from electric railways. Diagrams. 3000 w. Elektrotechen Zeitschr—March 13, 1902. No. 46959 B.

Surface Contact.

Surface Contact Electric Tramways at Wolverhampton. Illustrated description of a line equipped with the Lorain surface contact system. The construction is described in detail, also the rolling stock. 5000 w. Tram & Ry Wld—Feb. 13, 1902. No. 46588 B.

Suspended Railway.

The Barmen-Elberfeld-Vohwinkel Suspended Railway (Die Schwebebahn Barmen-Elberfeld-Vohwinkel). Hr. Petri. A paper before the Verein für Eisenbahnkunde giving an illustrated account of this railway, and of the advantages of suspended railways in general, with illustrations of one at Loschwitz near Dresden. 3000 w. Glasers Ann—Feb. 15, 1902. No. 46928 D.

Sweeper.

Sprinklers and Sweepers for Electric Tramways (Arroseuses et Balayeuses Electriques). A short illustrated account of a sprinkling trolley car at Lyons and a track-sweeping car at Paris. 700 w. Revue Technique—Jan. 10, 1902. No. 46361D.

Transporter-Trucks.

Conveyance of Standard-Gauge Stock Over Narrow-Gauge or Tramway Lines. Illustrated description of an arrangement for carrying standard-gauge cars on transportation trucks running on the small-gauge line. Trials have been made in France and are reported. 2700 w. Tram & Ry Wld—Feb. 13, 1902. No. 46590 B.

Trolley Automobile.

See Mechanical Engng, Automobiles.

Vibration.

Tube Railways and Vibration. A discussion of the statements in the recent report of investigations made in London. 2800 w. Engr, Lond—March 14, 1902. No. 47076 A.

Vibrations Caused by Underground Railway Trains. Summary of a report on the serious vibrations in buildings along the Central London Railway. 2300 w. Eng Rec—March 8, 1902. No. 46735.

Vibration on the Central London Railway. Extracts from the report of the committee appointed to investigate complaints of vibration in buildings adjacent to the Central London Railway. 2000 w. R R Gaz—Feb. 28, 1902. No. 46572.

Vienna.

Experimental Electrical Operation of the Vienna City Railway (Der Elektrische Probebetrieb auf der Wiener Stadtbahn). An illustrated account of successful experiments which will probably lead to the electrification of the road. 1000 w. Ill Zeitschr f Klein u Strassenbahnen—Feb. 1, 1902. No. 46905 C.

The Vienna City Railway (Die Wiener Stadtbahnen). A well illustrated description of this elevated and underground railway, at present operated by steam locomotive, but on which electrical operation is being experimented with. Serial. 2 parts. 3500 w. Schweiz Bauzeitung—Feb. 1, 8, 1902. No. 46994 each B.

EXPLANATORY NOTE.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
American Telephone Journal. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Armee und Marine. *w.* Berlin.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, Eng.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin Scientifique. *m.* Liege.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Age. *m.* *New York.*
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical Times. *w.* London.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.

Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemist & Metallurgist. *m.* London.
Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *w.* New York.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Indian and Eastern Engineer. *m.* Calcutta.
Ingeneria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Assn. Eng. Societies. *m.* Philadelphia, U.S.A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, Mass.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. w. San Francisco, U.S.A.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. m. Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Wurtt. Ver. f Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Power Quarterly. New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Railroad Digest. *w.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. ed Agr. *b-m.* Catania.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Steam Engineering. *m.* New York.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Telephony. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am.Ins.of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a. S.

THE WORLD IS ITS FIELD.

THE ENGINEERING MAGAZINE

VOL. XXIII JUNE, 1902. No. 3.

LORD KELVIN. HIS WORK AND INFLUENCE.

By Francis Bacon Crocker.

With an Editorial Introduction.

PROFESSOR CROCKER gives in the following pages a sketch, brief but full of character, of the greatest figure in the contemporary world of physical science. It is a page from the note-book of a busy worker in the field of electrical engineering, which Kelvin did so much to clear, define, and develop. And for this reason it is of special interest, for it shows the man as he is seen by his disciples and his co-workers. Professor Crocker was a pioneer and has been a leader in the great industrial and commercial development of electricity—which has so changed economic conditions in the United States during the last thirty years. He is one of the men who "do things"—who accomplish practical results from the application of scientific discoveries. And in this rare combination of genius and talent, Kelvin, as he points out, is one of the world's greatest masters. Professor Crocker does not make any effort to give a personal or a professional biography of Lord Kelvin, nor a summation of his work. Such data are readily available from many sources. His sketch displays something different—a personal impression of the individuality of the great scientific worker, and a brief interpretation of his peculiar powers of mind.—THE EDITORS.

TO write a complete biography of Lord Kelvin, one should possess at least a portion of his many-sided talents,—in fact, it would probably be necessary for a number of specialists to review his work, each from his own point of view. A full record of what he has accomplished in the electrical field alone would fill many volumes. I have had the honor and good fortune to meet this great man on many occasions, and particularly during his recent visit to the United States. A few notes regarding the impressions made by his personality and the lessons taught by his career may be appropriate and interesting at the present time.

In his case we have an excellent example of inherited ability; his father was professor of mathematics in the University of Glasgow, where the son subsequently rendered fifty years of most distinguished service. His brother, James Thomson, was professor of engineering and mechanics in the same seat of learning—a remarkable case of three members of one family occupying professional chairs in the same university and following closely similar lines of work. A striking point in Lord Kelvin's life is the fact that he began his public career with fully developed powers when he graduated from Cambridge as second wrangler and first Smith's prize man, being almost immediately appointed professor of natural philosophy in the University of Glasgow. The jubilee of his brilliant service there was celebrated a few years ago, the attendance including delegates from educational institutions and learned societies from all over the world, who came to testify their admiration for the scientific achievements of a great savant as well as their personal respect and esteem for the man.

The part played by Lord Kelvin in connection with the laying of the Atlantic cable is undoubtedly his strongest claim to high rank in the history of science and engineering. No other feat accomplished by human powers appeals more forcibly to the layman as well as to the specialist. Not only were mathematical knowledge and ability of the highest order required to solve the problems involved in this great undertaking; co-ordinated with these faculties the greatest possible degree of common sense and practical faculties were equally necessary. It is ordinarily supposed that these two phases of mind are opposed to each other, the development of one having a tendency to dwarf or diminish the other. In Lord Kelvin's case the two are combined and each is of the very highest order. It is in this particular respect that he is undoubtedly the greatest man of any time. On the purely scientific side, Helmholtz and other names might be mentioned as his equals; a number of electrical engineers and inventors, notably

Edison, have accomplished more individually in the way of actual mechanical achievement than he has; but no one else has done so much in both directions at the same time, and done it so well, as he. In abstract science, his mathematical investigations in mechanics, heat, electricity, and magnetism, are classical and will always remain fundamental in the progress of human knowledge. The numerous pieces of working apparatus invented by him will certainly remain prominent for a long time to come, if not perpetually. For example, the principles of his reflecting galvanometer, ampere balance, electrometers, siphon recorder, marine compass, and deep-sea sounding apparatus, would seem to be so general that they would always be useful—in fact necessary—even though improvements in construction and operation might be devised in the course of time. And the mere listing of their names suggests the breadth of the range of Lord Kelvin's accomplishments in the domain of applied science.

In the case of men of genius, personal qualities often detract from their intellectual achievements and seriously interfere with their popularity; but in Lord Kelvin's case the reverse is true to a remarkable degree. Anyone who has even heard him speak in public has been at once impressed and charmed by his mental and personal qualities. He combines the intellect of a great philosopher with the straightforwardness and simplicity of a schoolboy. He takes his audience into his confidence, and thinks aloud without the slightest affectation or self-consciousness. He regards the great things that he has accomplished as matters of fact, and accepts the credit and praise that is given to him without the least embarrassment or protest. When he speaks of his own work the language is most modest, and it is characteristic of him to name in the same breath others whom he credits with having contributed as much as or more than he has. There is no artfulness in this manner of referring to his great deeds; it is a natural—in fact, an unconscious—expression of his fairness and broad-mindedness. Another characteristic feature of his modesty is his habit of asking numerous questions of any one he meets, whether it be a learned scientist or a common workman—and his manner of addressing the one is as good-natured, polite, and interested, as when he speaks to the other.

His ideas and methods have always been marked with a high degree of originality. Whatever subject he has taken up, he has viewed from his own standpoint; and he has been free from the prejudices and narrowness that may have surrounded it. Indeed, if one were to criticize his work it would probably be on the ground that originality had been carried too far, and, that some of his conceptions regarding the constitution of matter and of the universe in general were hardly warranted by the accepted facts of science. In other words, he is not confined by the academic methods of reasoning and conservatism in reaching conclusions. As an example of his radical views, I may quote his stated belief that the entire power of Niagara should be appropriated for the useful purposes of mankind, even at the sacrifice of the most beautiful and impressive sight on the face of the globe. He mentally pictures the rocks over which the waters now flow as covered with green grass. To him this is a more beautiful idea than the present grandeur of Niagara. The saving and distribution of four million horse power for the benefit of humanity is more to be desired than the mere scenic phenomenon which delights the eye and impresses the mind. His genius in this case undoubtedly enables him to see farther and more clearly than the ordinary person, and it is probable that the idea which now appears so radical will gradually become more and more general and that the world will be reconciled to it—unæsthetic and utilitarian as it may appear at the present time.

The profession of electrical engineering which now plays a prominent part in human affairs and numbers many followers, may justly claim Lord Kelvin as its father. Although telegraph lines had been laid on land by others, he was the first to undertake the application of electricity on a scale and of a character that could properly class it as a branch of engineering. It is a fact also that the type of men and the methods employed in electrical engineering have followed closely along the lines laid down by him. The application of accurate mathematical calculations and refined physical measurements to everyday practical problems is characteristic of his work as well as of this branch of technology. It is a most fortunate fact that a great leader possessing the genius and training was found when needed, so that correct conceptions and methods were introduced at the very beginning.

Wolverine Motor Boats in the Harbor of Bocas del Toro.

MOTIVE POWERS FOR THE MODERN LAUNCH.

By E. W. Roberts.

The application of powers other than steam to marine propulsion marks the beginning of an era of increased use of waterways, which will be not only of great importance to the general economy of transportation and distribution, but of immense ultimate advantage to the old-established agencies—the steamship and the railway. The general relations of water transport to traffic interests will be strikingly presented in a succeeding number of the Magazine. Mr. Roberts discusses the mechanical features, at a time when the great motor-boat exposition at Berlin is directing general attention to the importance of this comparatively new department of marine mechanical development.—THE EDITORS.

WHILE the steam engine has been a faithful servitor, and is so at the present, it has many drawbacks for the smaller craft in which the owner is usually his own engineer and helmsman as well. As owner of a small steam launch for several years, I can speak upon this subject from the heart. A suit of overalls was the most appropriate uniform, and even with anthracite coal the fire door was ever hungry and calling for more fuel, which it was necessary to feed to it in homeopathic doses by means of a stove shovel. Then there was the injector to watch, and a close balance to be kept between a fresh fire on the one hand and a new supply of water on the other, lest you lie to for steam to come up, since small launch boilers are frequently none too large for their engines. True, there was the alternative of a kerosene-oil burner, with its delightful (?) odor but with many drawbacks. And as if these troubles alone were not enough, there came the many repairs in the shape of fixing leaky flues, and the worry of keeping up steam when a little stream of water was oozing down into the fire box, or the fun of paddling to shore with a seat or a piece of flooring when a hand-hole gasket blew out. In

THE LOZIER LAUNCH FAN TAN.

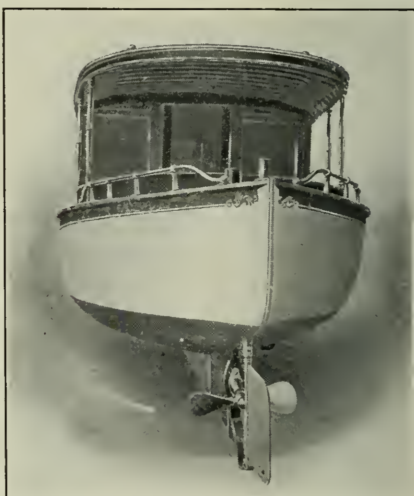
Running on Lakes St. Clair and Erie. 31 feet long, 6 horse power, speed 9 miles per hour; torpedo stern.

fact, I could continue this tale of woe several pages. Other powers do have their troubles, but they are few in comparison with the small steam launch, especially in the hands of the novice.

Yet until less than two decades ago the steam engine was practically the only available power for small launches, but within the past twenty years there have sprung up several methods of propulsion that are much better adapted to the needs of the smaller craft, and one at least of them has encroached to a considerable extent on the steam engine for business boats. These are the vapor, the gasoline, and the kerosene engine, and the electric motor. The vapor engine and the gasoline engine both came into use about the same time or in the latter part of the eighties; the electric launch saw its first practical introduction at the Chicago exposition in 1893; and the kerosene marine engine has been introduced only within the past decade.

In order to distinguish readily between the various classes of motive power, a short description of the principles of operation of each will be given. Of course there is little danger of confusion of the electric motor with the other powers, but there has, in the past, been considerable misunderstanding about the difference between the gasoline engine and the vapor engine.

The vapor engine, which finds its principal examples in the "Only Naphtha" and the "Alco Vapor" engines, is sim-



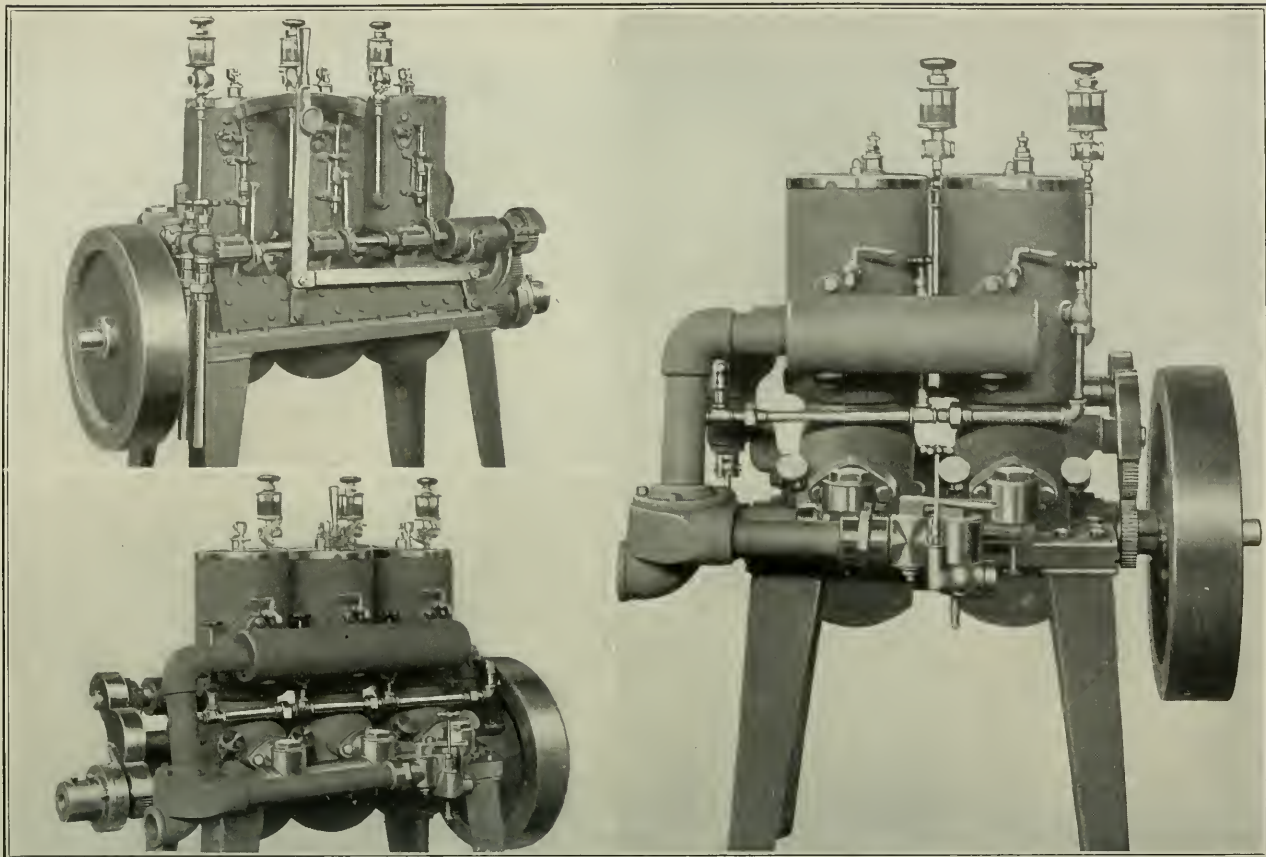
"TORPEDO STERN," TO PREVENT SETTLING AND DRAG.

Lozier Motor Co., Plattsburg, N. Y.

ply a pressure engine, similar in its general principles to a steam engine, but in which the vapor of the more volatile liquids is employed instead of steam. In the "Only Naphtha" engine gasoline is the liquid that is thus employed. The heat beneath the boiler is generated by means of a portion of the vapor from the boiler which flows to the burner. The remainder passes to the engine furnishing the motive power, and thence to the condenser, whence it is pumped back into the boiler. In the "Alco" engine, power is furnished by the evaporation of alcohol, with gasoline as the fuel, there being of course no connection in this case between the boiler and burner.

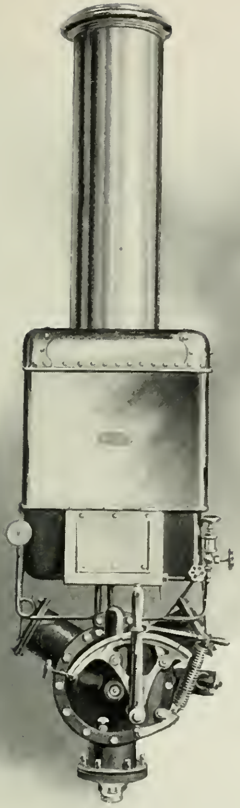
LAUNCH RAJAH, ON ST. REGIS LAKE, ADIRONDACK MOUNTAINS, N. Y.
31 feet long, torpedo-stern model, speed 9 miles. Lozier Motor Co., Plattsburg, N. Y.

The gasoline and the kerosene engine are each types of the internal-combustion engine of which the gas engine is the parent. Their general form is the same, the only difference between them being the means for vaporising the fuel and in some cases of igniting it. The principles of operation are alike in both cases. The modern form of gas engine employs a series or cycle of operations invented by Beau de Rochas in 1870 and put into practical form by Dr. N. August Otto in 1876. It was long known as the "Otto" cycle, but later writers on the subject usually call it by the name of its originator. Owing to the fact that four strokes of the piston are required to complete the



ON THE LEFT ABOVE IS FORWARD PORT VIEW, AND BELOW IT REAR STARBOARD VIEW, OF A TRUSCOTT THREE-CYLINDER TWO-CYCLE SELF-STARTING AND REVERSING VAPOR MARINE MOTOR; ON THE RIGHT IS A STARBOARD VIEW OF A TWO-CYLINDER TWO-CYCLE MOTOR OF THE SAME MAKE.

Truscott Boat Manufacturing Company, St. Joseph, Mich.

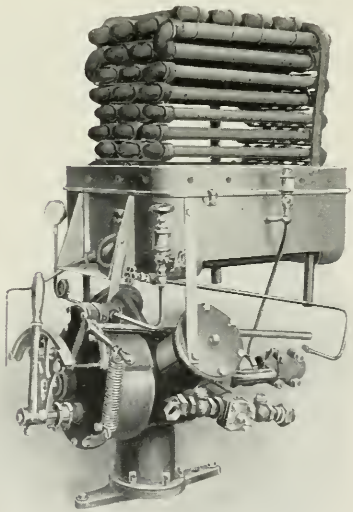


ALCO-VAPOR 7-HORSE-POWER RETORT AND ENGINE.

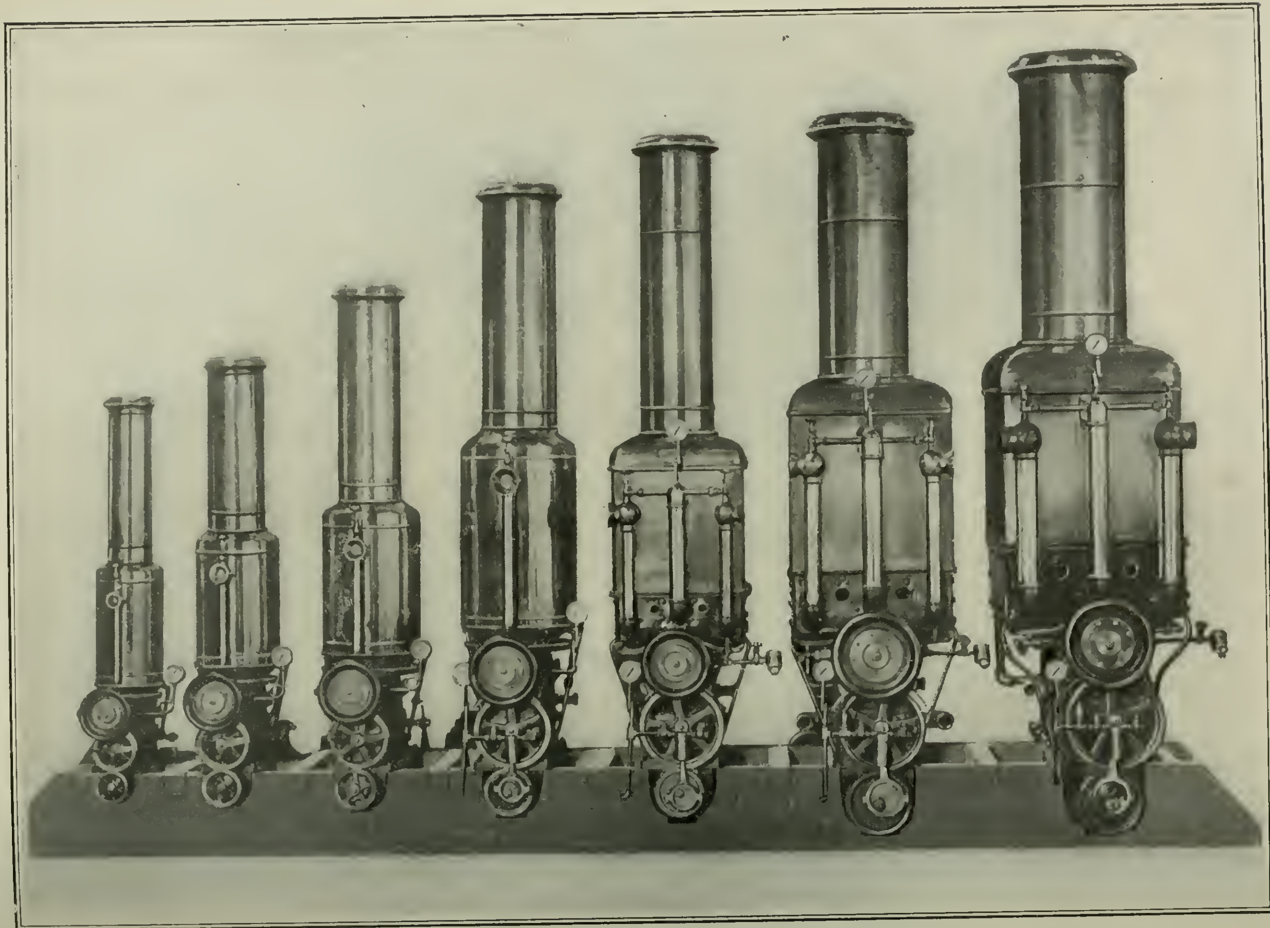
Marine Engine & Machine Co., Harrison, N .J.

cycle, it is often called "four-cycle" engine. This latter term, however, is used principally to distinguish it from a later modification in which the series of operations is completed in two strokes of the piston, and the latter form is therefore called "two-cycle" engine.

The series of operations which takes place in the four-cycle engine is as follows: Suppose the engine to be a vertical one, as that is the form quite generally employed for marine purposes. On the first down-stroke of the piston a charge of fuel and air is drawn into the cylinder through the inlet valve. Just as this stroke is completed, the inlet valve closes, and, the charge being confined, the return of the piston compresses it into a space between the end of the piston travel and the cylinder head. A little before the end of this stroke is reached, the compressed charge is ignited, usually by means of an electric spark, and the con-



VIEW OF ALCO-VAPOR RETORT WITH JACKET REMOVED.

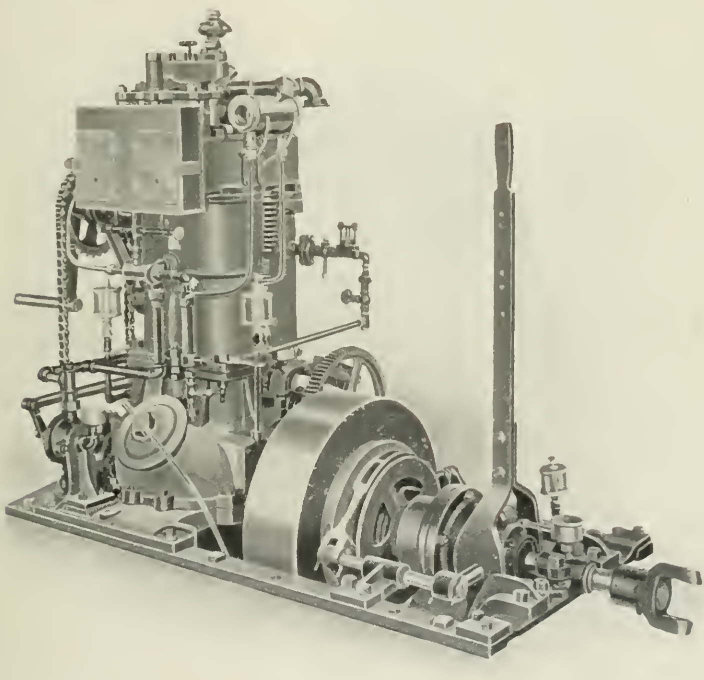


A GROUP OF NAPHTHA-VAPOR ENGINES FROM 1 TO 16 HORSE POWER.

Gas Engine and Power Co. and Charles L. Seabury & Co., Consolidated, Morris Heights, N. Y.

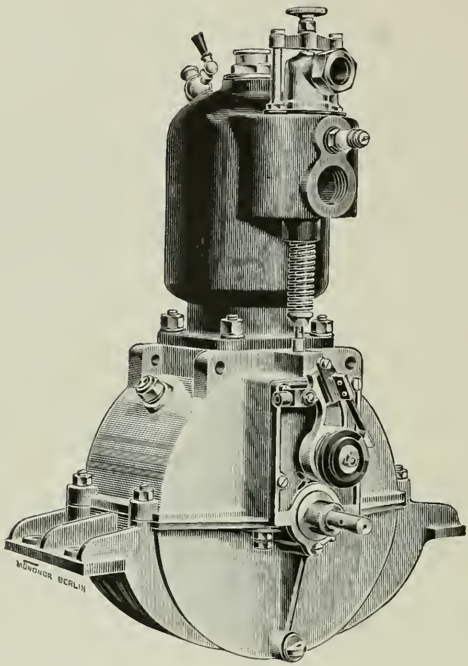
sequent generation of heat due to the combustion of the fuel causes a sudden rise of pressure which amounts to an explosion. The ignition is usually so timed that the maximum pressure is reached just as the piston starts on its downward stroke.

During the succeeding downward stroke, the products of combustion expand, driving the piston and giving the power to the engine. When the piston has reached nearly the end of the expansion stroke the exhaust valve opens, and the pressure within the cylinder rapidly falls to that of the atmosphere, which it has practically reached when the expansion stroke is completed. The cylinder is cleared during the next up-stroke of the piston, and the following stroke begins the cycle once more by drawing in a charge of fuel and air.



DAIMLER 7- AND 12-HORSE-POWER MARINE MOTOR. PORT SIDE.

In the two-cycle engine the exhaust stroke and the suction stroke are eliminated by drawing the charge into a chamber enclosing the crank, and called the crank case. On the up-stroke of the piston a vacuum is formed in the crank case, drawing in a charge of fuel and air, which on the next down-stroke is compressed to about two to six

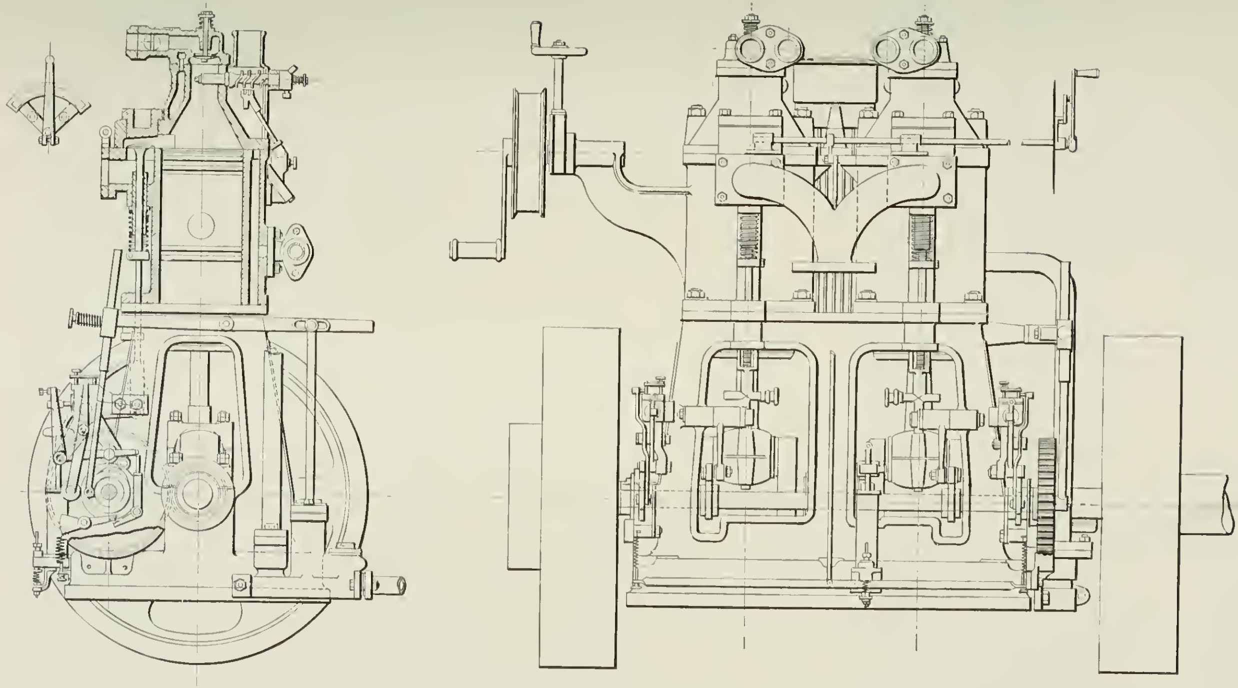


SINGLE-CYLINDER BENZINE OR PETROLEUM-SPIRIT MOTOR.

Heinrich Kämper, Berlin. Made in sizes from 3 to 7 horse power.

pounds per square inch. When the piston is nearly at the bottom of its stroke, it uncovers a port leading to the crank case and the slightly compressed charge rushes into the cylinder. Compression and expansion follow, and just before the port to the crank is opened, a port on the opposite side of the cylinder is uncovered through which the exhaust gases escape, and the fresh charge entering the cylinder is deflected toward the head by a plate on the piston and drives out the balance of the exhaust. The engine is therefore valveless and receives an impulse at each revolution.

For the purposes of the marine engine it is apparent that gas, unless manufactured as required, is out of the question. Even the manufacture of gas on shipboard would have many objectionable features. Fortunately the abundance of liquid fuel suitable for the operation of the gas engine makes the employment of a gas producer unnecessary. By the means of a very simple device the liquid fuels may be vaporized as used, and beyond a tank in which to store the fuel, no apparatus outside of the engine and a source of current for the igniter is required. Of the liquid fuels available for the operation of gas engines, or more strictly, internal-combustion engines, the following have been employed:—Gasoline, kerosene, distillate, alcohol, cocoanut oil and mustard oil. Distillate is a product of petroleum a little denser than gasoline, while not of as great specific gravity as kerosene. Alcohol has not, to my knowledge, been employed to any extent for the operation of gas engines in marine work, although it is being extensively experimented with in France for automobiles. Cocoanut oil and mustard oil would seem to a resident of the United States



SECTION OF A TWO-CYLINDER PETROLEUM MARINE MOTOR BY THE MASCHINENBAU-ACTIENGESELLSCHAFT, FORMERLY PH. SWIDERSKI, LEIPZIG-PLAGWITZ, GERMANY.

Made in sizes from 6 to 30 horse power, lower powers being furnished in single-cylinder machines.

36-FOOT ELECTRIC CABIN LAUNCH.
Speed 8 miles per hour. Operated on Hudson River and New York Bay. Electric Launch Co., Bayonne, N. J.

to be somewhat expensive fuels for a gas engine. They are, however, employed for this purpose in India where they are used on the score of economy. Probably nothing has been done with them in marine engines.

The electric launch needs very little explanation, as the electric motor is familiar to all of us. As in the electric automobile, current is furnished to the motor by a storage battery. Batteries of primary cells have been tried and even placed upon the market, but have proven more troublesome than otherwise.

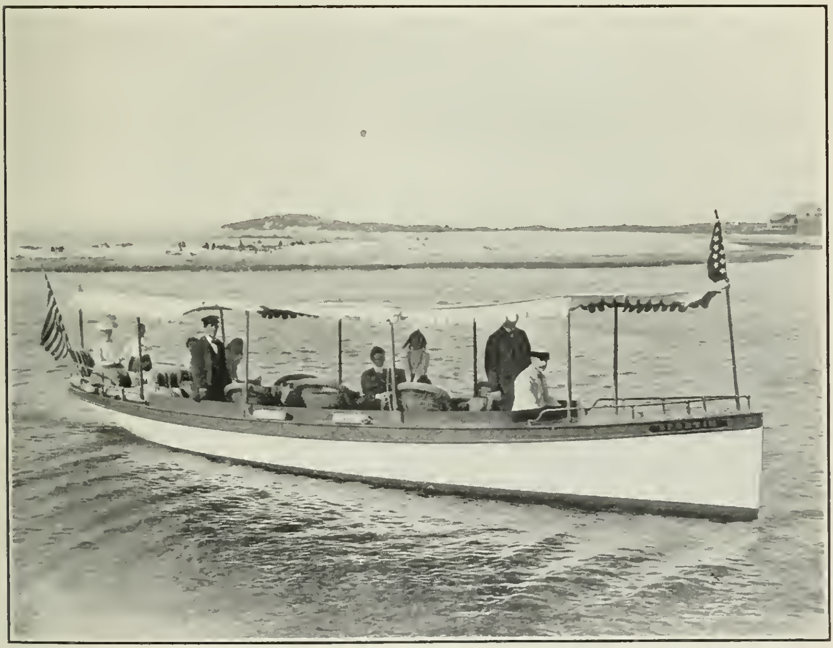
The vapor engine appeals to those familiar with the steam engine, owing to the similarity of its operation. It is practically automatic in its action, after once started, and takes up considerably less space than a steam plant of the same power. Quite a number of these engines are in use, especially for pleasure craft.

The gasoline engine is quite popular, particularly when operated with electric ignition as the majority of these engines are, since there is no flame outside of the engine. A gasoline engine using an electric igniter may be deluged with the fuel without fire resulting. The method of operating it is easily mastered, and no preparation is required to start the engine beyond turning on the fuel and closing the igniter switch. The fuel can usually be obtained anywhere, as it is quite generally carried in stock by grocerymen for gasoline stoves.

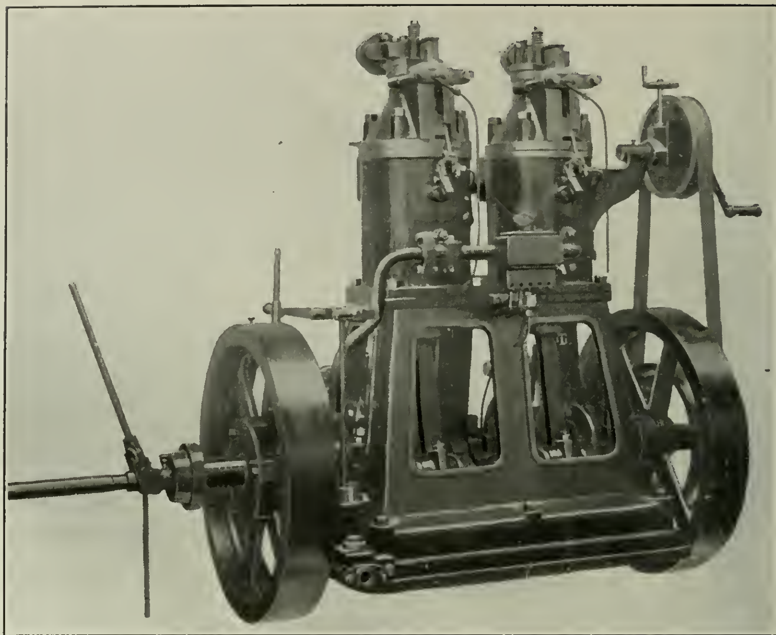
The kerosene engine is popular among many owing to generally exaggerated ideas about the "dangerous" nature of gasoline, and also to the great difference in the price of the two fuels in many localities. The widespread use of kerosene as an illuminant also makes it more readily obtainable than gasoline, which is probably one of the greatest arguments in favor of the kerosene engine. Usually, however, it is necessary to heat the vaporizer of a kerosene engine before it can be started, and it is not so quickly got under way for this reason.

The distillate engine is quite generally employed on the Pacific Coast owing to the large quantity of that fuel that is made as a by-product from California petroleum. As with the kerosene engine, the vaporizer must be heated before the engine can be started, although not so high a temperature is necessary as with a kerosene engine.

Of all the small-power boats, the electric launch probably approaches nearest to the ideal. Both the battery and the motor may be, and usually are, placed out of sight beneath the seats and the floor of the boat. So long as the battery is charged the boat is ready to start at the touch of a lever, and the motor is silent and cleanly. No reversing mechanism is necessary, and no odor is produced beyond the slight fumes of the acid which are scarcely noticeable in the open air. However, the electric launch is dependent upon an external source

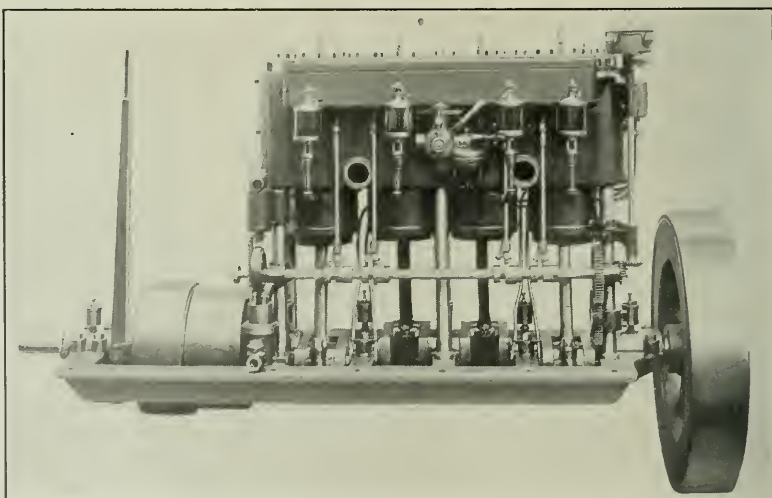


30-FOOT ELECTRIC LAUNCH ON LONG ISLAND SOUND.
Speed 7½ miles per hour. Electric Launch Co.



TOLCH DOUBLE-CYLINDER 10-HORSE-POWER MARINE OIL ENGINE.

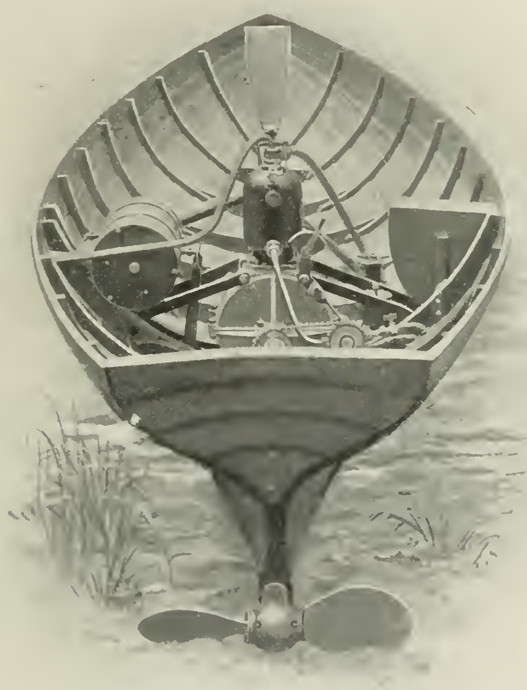
Tolch & Co., Fulham, London.



KING 30-HORSE-POWER MARINE ENGINE.

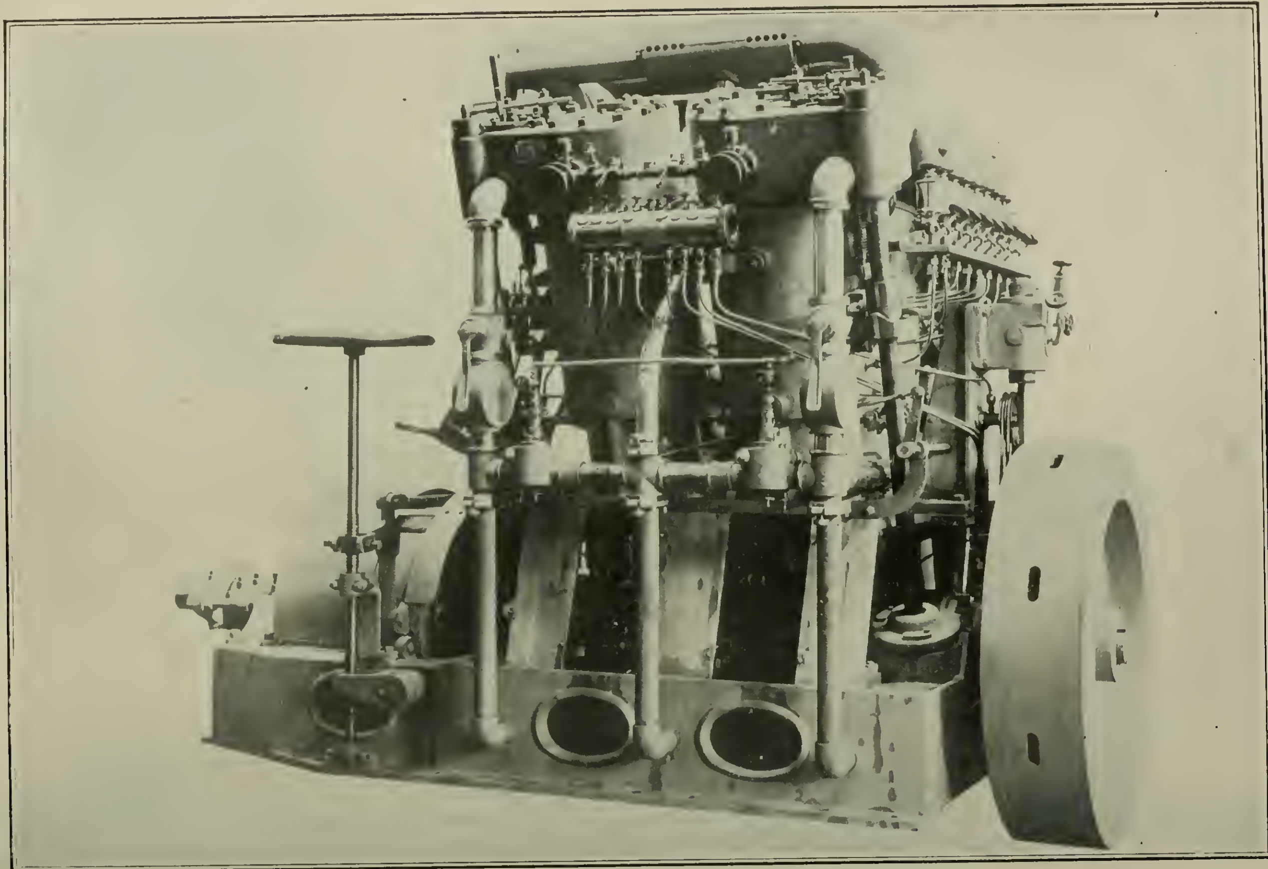
Four-cylinder four-cycle, weight 2,300 pounds. Michigan Yacht and Power Co., Detroit, Mich.

of power and unlike the gasoline engine, which can be replenished with fuel in a moment, several hours are required for recharging the battery of the electric launch. Again, its radius of operation is confined, and long trips without lying to for recharging are out of the question. Yet for many purposes these objections are not important, and the electric launch has a wide field of usefulness.



GASOLINE ENGINE BOAT BY HEINRICH KÄMPER, BERLIN.

Of all marine powers other than steam, the gasoline engine is without question that most used. It will be found on the majority of the waters of the world. The history of the gasoline marine engine dates from 1885. It was in this year that the first successful gasoline engine for any purpose was placed upon the market. The earliest attempts at using gasoline for an internal-combustion engine were made about the same time by Van Duzen Brothers in Cincinnati and the

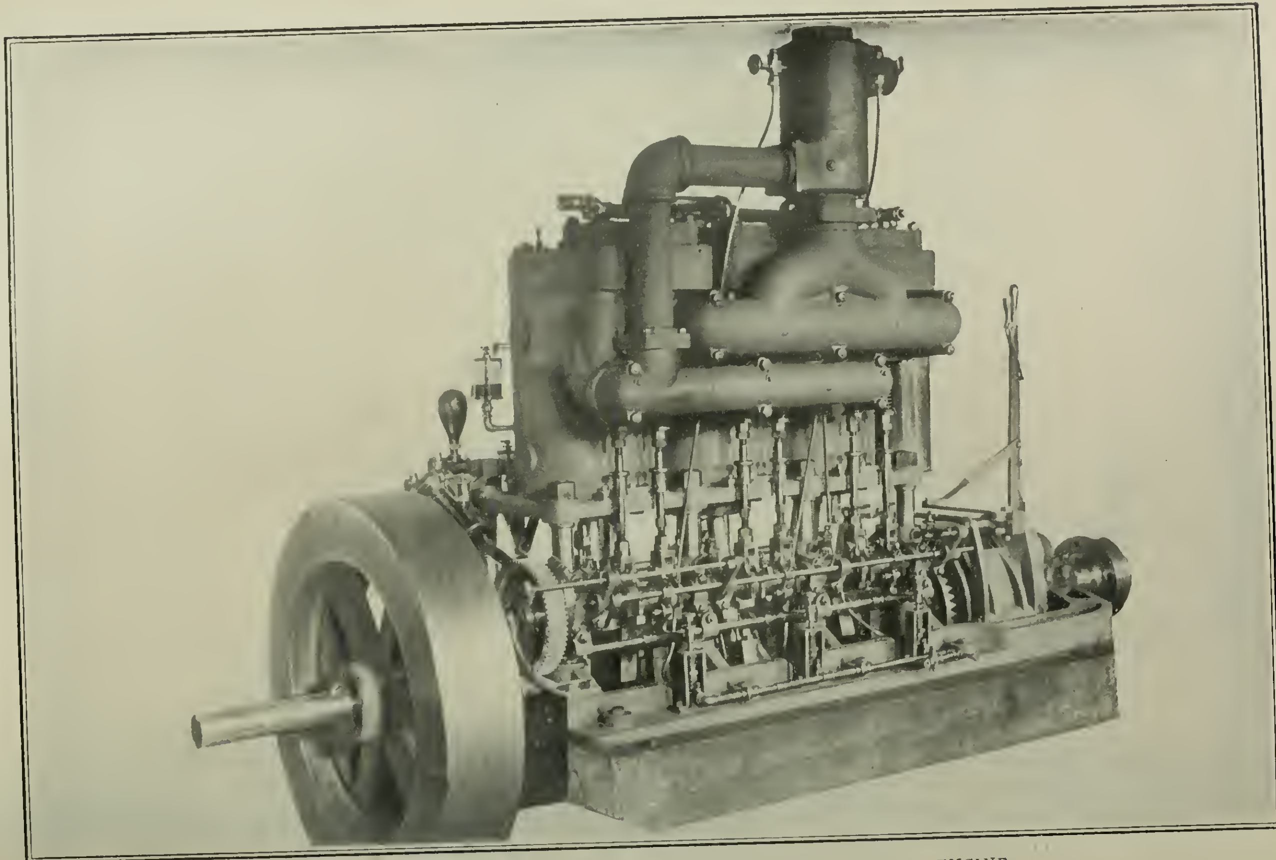


85-HORSE-POWER FOUR-CYLINDER FOUR-CYCLE ENGINE.
Union Gas Engine Company, San Francisco, Cal.

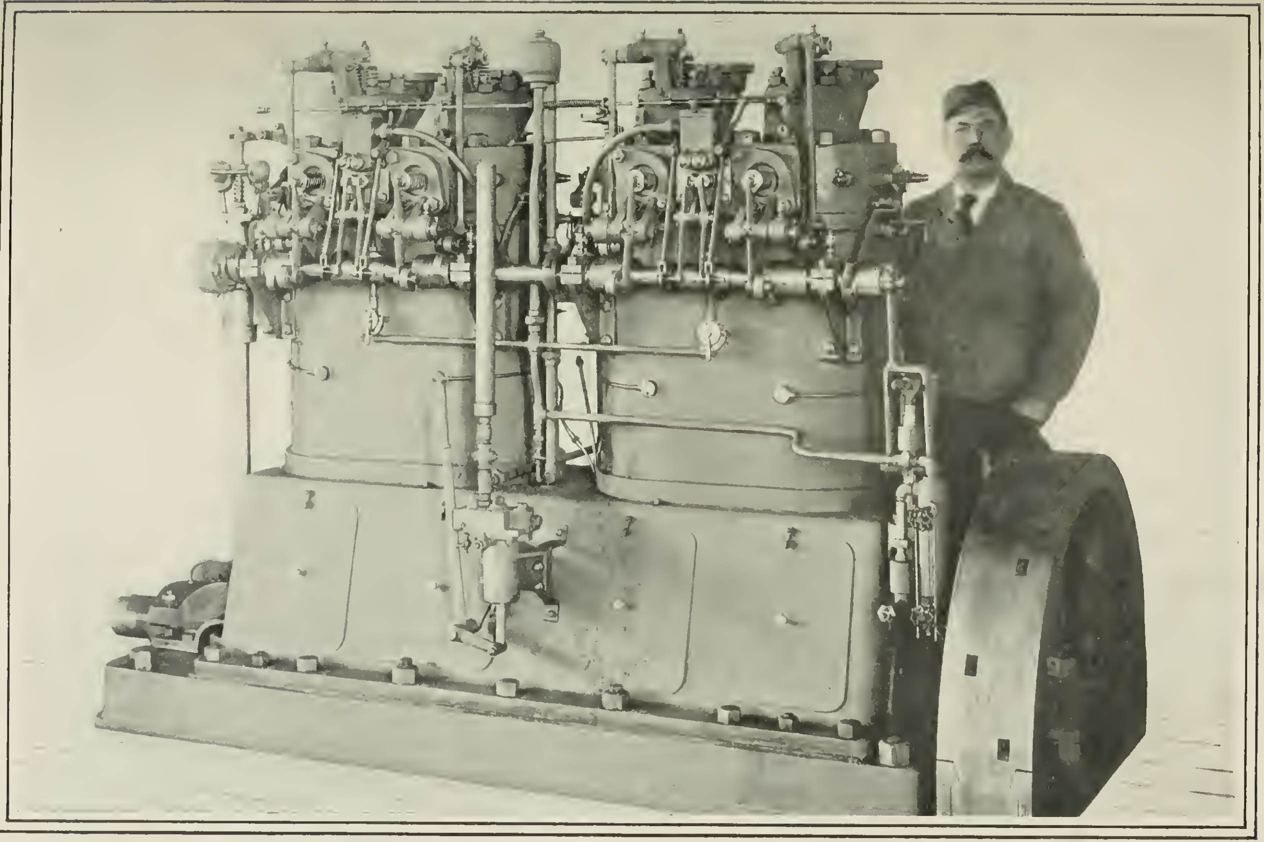
Union Gas Engine Company in San Francisco. The first attempts were fraught with many difficulties, owing to a misunderstanding of the fuel and of its behavior when mixed with air. At that time the most cumbersome and inefficient devices were employed for supplying the engine with gasoline vapor, while today a simple valve, scarcely more complicated than the ordinary check, is employed for this purpose. The industry remained practically in the cradle until the early nineties, but by the time of the Chicago Exposition quite a number of small gasoline marine engines were in use. After that time their introduction was rapid, and there is scarcely anywhere to be seen today an assemblage of pleasure craft in which the gasoline launch is not very much in evidence. From the 12-foot dingy with its one-horse-power engine to the 92-foot yacht with its 133-horse-power engine, the range of this class of power is even now considerable. The largest marine gasoline engine that has been brought to my notice is that furnished by the Otto Gas Engine Works of Philadelphia to The Holland Torpedo Boat Company for one of their latest submarine torpedo boats. This engine, which is illustrated herewith, developed 190 brake horse power at a speed of 360 revolutions per minute.

The tendency of all builders of gasoline marine engines is toward larger powers than heretofore. While for the smaller sizes the two-cycle engine has been employed to a greater extent than the four-cycle, the larger engines of the marine type are invariably four-cycle. The tendency toward the four-cycle engine for the larger sizes is shown by the fact that many builders of two-cycle engines choose the earlier type when they exceed 25 horse power in a single engine. As an example, note the illustration of the latest product of the Wolverine Motor works, an 85-horse-power engine of the four-cycle type. This concern has been building two-cycle engines for a number of years. The reason for this would scarcely be obvious to those unfamiliar with gas engineering. It is principally a choice between simplicity of mechanism and economy of fuel. The difference in fuel consumption is scarcely noticeable in the smaller sizes, and the extreme simplicity of the two-cycle engine makes it a favorite for the owner of the smaller craft. However, when 30 horse power is passed fuel consumption has a marked effect upon the operative radius and also upon the expense account.

Contrary to the usual opinion, the question of weight per horse power is not to the advantage of the two-cycle engine. If anything, the advantage is slightly in favor of the four-cycle. This is because it is not necessary to enclose the cranks on a four-cycle engine, while



WOLVERINE 85-HORSE-POWER THREE-CYLINDER FOUR-CYCLE MARINE ENGINE.
Wolverine Motor Works, Grand Rapids, Mich.



FOUR-CYLINDER ENGINE OF 190 HORSE POWER FOR SUBMARINE TORPEDO BOAT.
Otto Gas Engine Works, Philadelphia, Pa.

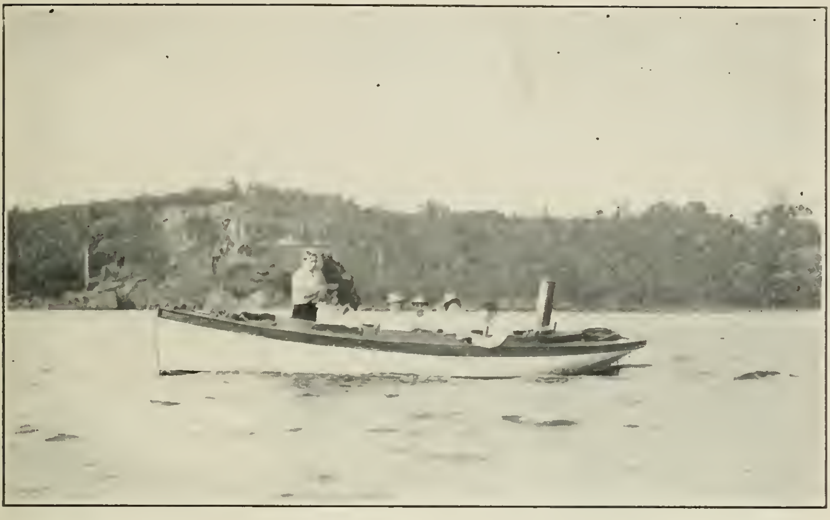
on the two-cycle, the crank must not only be enclosed but the crank case must be strong enough to withstand a low-pressure explosion.

The kerosene marine engine, while but lately introduced and therefore not yet subjected to an extensive trial, is quite likely to become an extensive factor in the launch trade. While I have had no personal experience with marine engines operated by this fuel, I have seen many stationary kerosene engines which gave excellent satisfaction. However

60-FOOT 16-HORSE-POWER CABIN NAPHTHA YACHT REGINA.
Gas Engine & Power Co. and Chas. L. Seabury & Co. Consolidated, Morris Heights, N. Y.

from experiments I have made, and which I am not at present at liberty to discuss, I have found that kerosene is not so difficult to handle in an internal-combustion engine as many suppose. In fact, but little more apparatus is required to handle this heavier fuel that when gasoline is employed.

The adaptability of the gasoline marine engine to special environments can be no better illustrated than by citing the conditions in



25-FOOT 4-HORSE-POWER OPEN NAPHTHA LAUNCH.
Gas Engine & Power Co. and Chas. L. Seabury & Co., Consolidated, Morris Heights, N. Y.

Bocas del Toro, United States of Colombia. This town is surrounded by a number of bays and lagoons which are lined with banana plantations. No fresh water is available except that which is caught on the

LAUNCH UTA, HARBOR BOARD OF WELLINGTON, N. Z.

64 feet long, 14 feet beam, speed 9 knots, 50-horse-power double-cylinder vapor engines, 4-horse-power windlass, $3\frac{1}{2}$-horse-power stationary vertical engine for electric light.
Union Gas Engine Co., San Francisco.

YACHT LA PERLE; PROPERTY OF THE FRENCH GOVERNMENT AT TAHITI.
40-horse-power vapor engines. Union Gas Engine Co.

roofs of the houses, and salt water being ruinous to steam boilers a steam launch may be operated for only a short time without being laid up for repairs. About eight years ago two gasoline engines were introduced, and they proved themselves to be so well-adapted to the conditions that at present there are over forty gasoline launches employed, as tugboats for towing banana lighters to central points where the fruit is transferred to ocean steamships. An enterprising planter secured an expert from one of the American factories and installed a complete repair shop especially adapted to gasoline engines. These tugboats are employed going from plantation to plantation gathering up the fruit, which, on account of its perishable nature, must be transferred in the shortest possible time to the ships. There are at present thirty-five of one make of gasoline engine in use in this district. The gasoline is shipped to the tug owners in 210-gallon drums, and the small space occupied in transport is especially in its favor as a fuel since there is no coal obtainable in the market and all of it must be shipped from the United States.

Another place in which the gasoline engine has proven itself to be the only available power is in the life-boat service. The United States Government has in use a life boat propelled by a gasoline engine. This boat may be upset any number of times and the engine be ready to start again as soon as the boat is righted, the engine being stopped automatically when the boat is capsized. The boat has been in use for a little over two years at a station near West Superior, Wisconsin.

On the Pacific coast and about many of the islands off the western American coasts may be found numberless craft operated by gasoline engines, most of which are manufactured in San Francisco. Many of these vessels are engaged in the coast trade, and a good many are converted steamers. Quite a number of sailing vessels are equipped with gasoline engines as auxiliaries and are thus independent to a certain extent of the weather and entirely independent of tugs when entering a harbor. The various Governments which have colonies in the Pacific islands use gasoline launches and tugs for various purposes. On the coast of Eastern Australia they are found everywhere, and even on the waters about Tasmania, while the New Zealanders are adopting them and have many in use. A few gasoline marine engines have been sold in Western Australia, where I expect to see them finally introduced in great numbers. Even on the Yukon river in Alaska gasoline launches have been in use for at least two years, and perhaps nothing was so thrilling to me as the story of the little launch Melrose which so successfully shot the White Horse Rapids in the summer of 1900. Last season the builders of the Melrose shipped another and larger boat, the Valdez, to the same district. The Valdez was shipped by

YACHT LUCERO, CONVERTED FROM STEAM TO GASOLINE ENGINES.
92 feet long, 16 feet beam; four-cylinder four-cycle engine of 133 brake horse power. Union Gas Engine Co.

rail to Seattle and thence made the run of 1,700 miles up the Pacific coast to the gold fields. Quite as remarkable a trip was that of the gasoline launch Zeta, owned in New Orleans. Starting from home the journey was up the Mississippi River, thence by Canal to Chicago and the Great Lakes, finally arriving at New York City and returning by the inside course and around the coast of Florida to New Orleans. Not only was this trip an enjoyable one because of its extent and the

THE YACHT VALDEZ.

52 feet by 9 feet, 20-horse-power Sintz engine; Michigan Yacht & Power Co., Detroit, Mich.

scenes through which it passed, but it was unmarred by mishap of any kind.

Not only is the gasoline launch adapted to long trips and hard service, but in matters of speed as compared with other boats of the same size and horse power of engine it is quite equal to any. Only last summer I tested the Caprice, a 42-footer built for a gentleman residing in Pittsburg for use on the Muskoka lakes in Canada. Four days after this boat was launched, and while the engine was still new and stiff in its bearings, it made an actual speed of 12.8 miles per hour. Better than 13 miles per hour has since been obtained from the same boat. The tests referred to were made in quiet water with a carefully calibrated log and on a perfectly calm day. The engine used was a two-cycle, rated at 20 horse power but capable of developing 30 horse power at the speed used in the test.

YACHT CAPRICE—20 HORSE POWER, 13 MILES PER HOUR.
Sintz engines, Michigan Yacht & Power Co.

The small amount of room required for a gasoline engine and the fact that the fuel tank may be placed in any position, either under the forward or the after deck or under the floor, makes this style of boat much more roomy for length and beam than a steam launch, with its boiler and large coal bunkers. The absence of smoke and heat is also a considerable factor and adds greatly to the comfort of a trip.

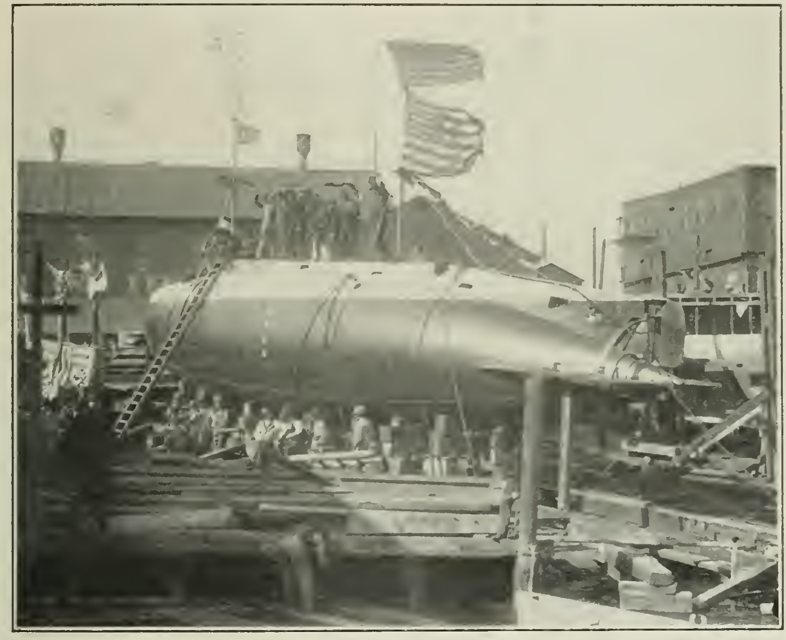
The great number of the manufacturers now making gasoline marine engines has been the occasion of considerable competition and a striving for improvements which now make the gasoline engine as

YACHT 53 BY 10 FEET, 18-HORSE-POWER THREE-CYLINDER SELF-STARTING AND REVERSING ENGINE.
Truscott Boat Manufacturing Co., St. Joseph, Mich.

17-FOOT "TORPEDO-STERN" LAUNCH, $1\frac{1}{2}$-HORSE-POWER.
Truscott Boat Manufacturing Co.

YACHT HELEN, 60 FEET BY $9\frac{1}{2}$ FEET, SPEED $13\frac{1}{2}$ MILES PER HOUR.
Two 20-horse-power two-cylinder two-cycle Sintz vapor engines. Michigan Yacht & Power Co.

reliable as a steam engine. One manufacturer, at least, makes an engine that may be reversed, and practically every builder of gasoline engines of over 20 horse power supplies a method of starting them without manual labor. Where the engine itself is not reversible, an attachment is furnished with the engine to reverse the propeller, or else the propeller itself is so constructed that the angle of the blades may be altered, thus changing it from a right-hand to a left-hand screw and vice versa. The reversing propeller is seldom used for engines of over 6 horse power, as it is not so efficient as a solid wheel. But for



HOLLAND SUBMARINE TORPEDO BOAT READY FOR LAUNCHING, CRESCENT SHIPYARD, ELIZABETHPORT, N. J.

Propelled by electric storage battery (Electric Boat Co.) when submerged and by Otto gasoline engines when running on the surface.

small boats, in which the amount of room that would be taken up by a reversing gear would materially reduce the available space, the reversible propeller is exceedingly well-adapted.

The reversible engine referred to in the last paragraph is of the two-cycle type, and the change of direction is accomplished by slowing the engine down until it has nearly stopped, and then giving it an extremely early ignition which stops the piston and drives it backward; the throttle is then opened and the engine continues to run backward until again reversed. Starting devices as employed for marine engines

A GROUP OF OIL-MOTOR BOATS BY TOLCH & CO., FULHAM, LONDON.

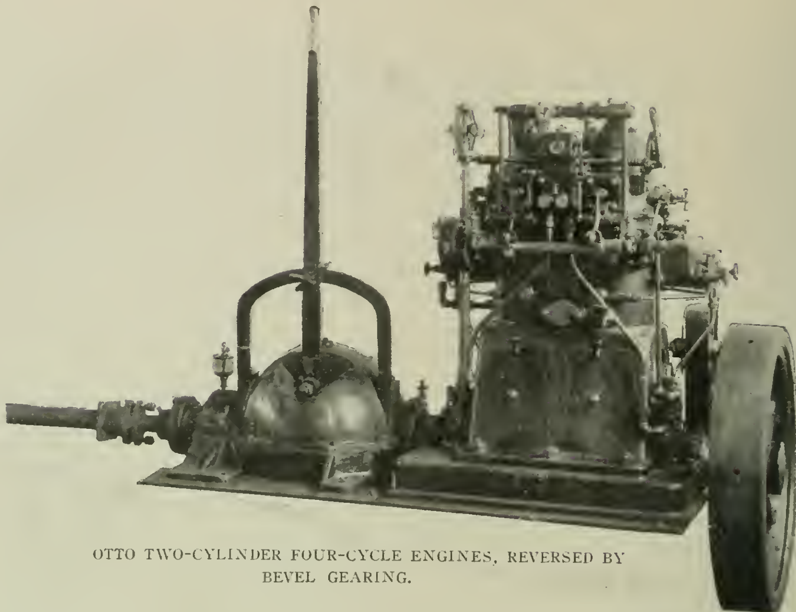
Above on the left is a 20-foot captain's gig, speed 7 miles; below it is a shallow-draught steel launch, 25 by 5¼ feet, 14 inches draught, running 7 miles an hour and powerful as a tug; the upper right-hand picture shows a 35-foot teak cruiser, with portable mast and sails; propeller blades feather in line with the keel when the boat is under canvas; in the lower right hand corner is a 40-foot steel launch with powerful engines, speed 10 miles an hour, controlled single-handed from the bridge above the engines; has also a mast and sail.

are of various kinds. In many an air pump geared to the propeller shaft is employed to keep full a reservoir of air at from 40 to 100 pounds pressure. The air is piped to the compression space of the engine and passes through an ordinary plug cock just outside the cylinder. To start the engine by compressed air the flywheel is turned over until the piston of one cylinder is just past the top of its stroke. The cock on that cylinder is then opened full and the pressure of the air drives the piston downward. The air is cut off before the piston reaches the end of its stroke and sufficient momentum is usually derived from this one impulse of the air to permit the engine to take up its cycle. In other engines a charge of gasoline vapor and air is pumped

INTERIOR OF THE HOLLAND SUBMARINE BOAT.

into the compression space with the piston on the upper center. The flywheel is then turned until the pressure of the charge just starts to move the piston, when the charge is ignited and the resulting explosion gives sufficient momentum to start the engine on its first cycle.

Reversing mechanisms, or as they are more generally known, reversing gears, are usually a combination of two bevel gears and pinions similar to the differential gear on automobiles and traction engines. When the engine is driving the boat ahead a clutch fastens both the large bevel gears together and the driving is direct and noiseless. When reversing, the pinions between the two large bevel gears turn on their own axes only, being held by a clutch from rotating with the



OTTO TWO-CYLINDER FOUR-CYCLE ENGINES, REVERSED BY BEVEL GEARING.

engine, and the propeller shaft rotates in direction the reverse of that of the engine. Other builders use a combination of spur gears, while still others employ paper friction cones.

Further improvements are the use of universal joints in the propeller shaft, thus permitting the engine to be placed with the crankshaft horizontal and not inclined toward the stern. The use of jump-spark ignition, as on automobile engines, was adopted by one manufacturer last season, giving greater flexibility in regard to speed. The problem of lubrication has been satisfactorily solved by the combined efforts of the manufacturer and the oil refiner, and the many minor difficulties have been surmounted until now the gasoline engine is in every way an ideal motive power.

A COMPARISON OF COAL RESOURCES AND COAL-GETTING.

By A. S. E. Ackermann.

Mr. Ackermann recently completed a tour extending over 5,000 miles in the United States and occupying four months, chiefly for the purpose of studying American methods of mining by machinery. In the following article he compares the methods of coal getting in Great Britain and the United States.—THE EDITORS.

THE very first feature that attracts the attention of the European visitor is the enormous difference in the total area of the coal fields of America and Great Britain, namely 222,500 and 9,000 square miles respectively, and also the fact that nearly all the British ones have been worked for so very much longer a period. The result of this is that most of the thick seams and those nearest the surface have been worked out; and while 10-foot and 12-foot seams are not unknown, nevertheless they are exceptional, and seams as small as 12 and 15 inches are being worked. In America, on the other hand, the coal fields are practically untouched. At present only the thick and upper seams are being worked, and these to a large extent with perhaps little thought for future generations of mining engineers. Another very great difference between the coal fields of the two countries is that in Great Britain faults are frequent and great, and the coal is found in various parts at almost all conceivable angles. In the Lancashire coal field, for example, the seams dip 17 to 33 per cent. In America, on the other hand, I did not meet with a single instance of a fault, and only with one man who said he had a friend who had seen one, while the greatest dip I met with was but about 5 per cent.

In Great Britain the coal lies at very great depths. In America a shaft of 200 feet is considered fairly deep while one of 200 yards in England is but a shallow pit, and same few workings are nearly 4,000 feet deep. I do not know of a drift mine being worked at present in England, but in America, especially in Virginia and West Virginia, they are extremely common. The result of this is that the cost of hauling the coal out and the pumping of large quantities of water from great depths make coal mining very expensive in Great Britain. A drift mine is also more cheaply ventilated than a shaft one, and the mines are much more fiery in England than they are in America. The presence of fire damp in British mines greatly impedes the rapidity of working and adds to the cost in many ways. There are many stringent regulations to be carried out with a view to the prevention of explosions, which nevertheless occur only too frequently, and when they do they are usually of a very serious nature, causing large loss of life and property. Frequently several months elapse before the mines are in complete working order again after such an accident. The cost of this loss of life and property naturally is very great.

The presence of combustible gas in the British mines further makes the employment of electrical machines of all kinds either impossible or very difficult, whereas in America the tendency seems to be to discard pneumatic machinery and use electrical, for cutting, hauling, pumping, and lighting; but in Great Britain even pneumatic machinery is but very little used, and in 1900 the total quantity of coal cut by machinery was only 1½ per cent. of the total output of the whole country, whereas the corresponding figure for the same period for America was 20 per cent., or 25 per cent., if bituminous coal alone is considered. The output per annum per person employed in coal mining in Great Britain is about 300 tons, compared with 526 tons in America, this difference of course being due to a large number of factors of which the natural conditions, as already indicated, are an important one. From a British point of view, however, it is significant that in spite of the much easier natural conditions that hold in the United States, machinery is being used there to such a very great and increasing extent, whereas in England, where natural conditions are more difficult and make coal getting more arduous, and hence where machinery ought to be made to lighten the burden of man, far less machinery is used, and I feel sure that were coal getting as easy in Britain as it is in America, machinery would be practically unknown in the British coal mines. On the other hand, American mining engineers were equally candid in telling me that they considered British mining engineers were much more successful in the handling of shaft mines than they were in the States. If this be so, to a certain extent it is only to be expected, as we have had so much larger experience with shaft mines; but to return the compliment, I expect that as soon as more shaft mines come into operation in the States, American engineers will get more skilled in the application of machinery to them, and may possibly even excel us as they have done in so many other mechanical things.

A shaft 12 or 15 feet in diameter for a depth of 2,000 or 3,000 feet, is a great expense, costing anything from $50 per yard of depth, or $1.75 per cubic yard excavated, to $600 per yard of depth. The shafts are usually circular and lined with bricks, but where the water pressure is great, with cast-iron segments.

In America one frequently meets with cases in which no pumping is required, the water running out of the mine by gravity, the haulage being practically horizontal is also a much less expensive item. The mines are almost entirely free from gas, which is no doubt greatly due to their being so much nearer the surface, thus permitting the escape of gas through fissures.

English mines are worked almost entirely on the "longwall" principle, and the use of this system is on the increase. The chief remaining system is that known as the "bord and pillar," which is more used in the north of England and in Scotland, while in America, of course, the system is almost entirely "pillar and room." In the best modern practice not more than 35 per cent. of the coal is removed when "working in the whole" (i. e., the preliminary work of driving the bords and walls). The removal of the pillars, which takes place as soon after the "whole" work as possible, is called "working in the broken" and the price paid per ton for the latter work is less than for the other.

To give actual figures referring to the use of coal-cutting machines in the two countries:—311 such machines were in use in Great Britain in 1900, whereas in America there were 3,907, or about 12½ times the number, this figure corresponding approximately with the ratio of the percentages cut by machines in the two countries, namely, 1½ per cent. and 20 per cent. It should be pointed out, however, that as British mining is very largely on the longwall system, the 311 machines include a large number of longwall and heading machines, while the 3,907 machines in America include 2,350 of the pneumatic percussive type, which is of course a much smaller and cheaper machine. Still, in the States there were 1,509 chain breast machines and 48 longwall machines, and the increase in the percentage of coal mining by machinery in West Virginia was from 9.27 per cent. in 1889 to 15.09 per cent. in 1900. The corresponding increase for Pennsylvania (considering the bituminous coal only) was 29.67 per cent. to 33,65 per cent.

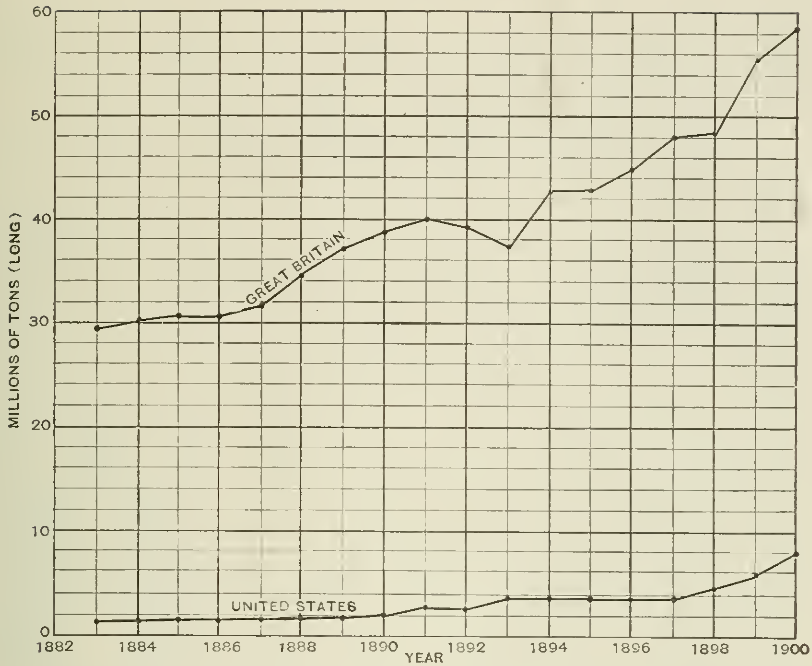
In the matter of electric haulage, I have not yet had an opportunity of visiting a British mine in which the trolley system is installed, though I understand that one or two are in use. I have, however, seen electric energy transmitted from the pit mouth to the bottom and there used for driving an endless rope for haulage purposes. Steel rope haulage (under and over) is largely used, the same three systems as occur in America being found, namely:—(1), direct rope haulage; (2), the main and tail rope system; and (3), the endless rope.

Electric energy is also used for pumping, lighting, and coal cutting, but all of this on a very small scale, and one likely to increase at the usual slow rate that such new ideas are taken up in Britain, where labour unions give considerably more trouble than they do in the States. The lack of the use of the machinery in Britain, however, most certainly is not due entirely to the unreasoning or incorrect conclusions of the labour unions, for there are many instances in other trades in which more and better machinery could be employed without displacing any men, though increasing the quality and output.

Another point which is in favour of America as regards cost of production is that in England in most cases subsidence has to be prevented as far as possible, on acount of damage to property on the surface. In America the land above the coal beds usually belongs to the firm doing the mining and does not have much valuable house property on it, but in England the land usually belongs to a large landowner who rents the mineral rights to various mining concerns.

The forms of energy used for haulage have already been mentioned. The gauge of the track is usually 24 inches, through it varies from 18 to 30 inches. The rails are of steel and rather lighter than those used in the States. They are spiked to the sleeper or ties much in the same way as is the American practice with the large railroads, thus differing from the English railroad companies' practice of using iron chairs. The mine cars are called tubs in England, and as in America are usually of wood, but their capacity is smaller, namely from 1,300 pounds to 1,600, though larger ones are used in South Wales.

Pumping is a very large subject, and the whole of this issue could easily be taken up with a description of it. There are plunger and bucket pumps and various combinations of the two, but the most interesting feature of British practice to an American colliery engineer would be the fact that many of these are worked by long wooden pump rods called "spear rods," some 10 inches square, extending right down the shaft from the surface and driven by beam engines, or by horizontal engines by means of a system of huge balanced timber bell-cranks. The old Cornish pumping engines are quite classic and their efficiency is higher than might be supposed. In the case of plunger pumps, the function of the engine is to raise these spear rods, and their weight is more than sufficient to force the ram back against the water pressure. Another system employs steam pumps fixed down the mine and oper-



CURVES SHOWING THE EXPORTS OF THE TWO GREAT COAL PRODUCING COUNTRIES.

ated by steam conveyed to them from boilers at the surface. Yet another is to generate hydraulic power at the surface and convey this down the shaft to pumps at the bottom. In this case the exhaust water from the power end of the pump is pumped up with the water from the mine, though in one arrangement there is a double set of high pressure pipes, one connected with each end of the pump power-cylinder. the water in these acting as a water rod for forcing the piston back and forth. Lastly, there are electricity and compressed air.

The coal is brought to the surface in the tubs or cars sometimes one at a time, sometimes eight at a time; in the latter case two are usually placed on each deck and there are four decks to the cage, which is a steel structure guided by fixed vertical ropes. On coming to the top of the shaft the two tubs on the bottom deck are pushed off, then the cage is lowered to the level of the next deck and so on. The methods of dealing with the coal after it reaches the surface are very varied, but on the whole they are similar to those in use in America. As the coal leaves the mine, however, a great difference is noticed. The British coal trucks hold only 6 or 10 tons each. These are almost the only two sizes made, though quite recently the Lancashire & Yorkshire railway have built some 30-ton wooden trucks, (the 6-ton and 10-ton size being also made of wood) and the London and North Western have some 20-ton trucks. In America, of course, the 50-ton pressed steel car is a familiar and fine sight.

The next considerable difference between the two countries is the freight charges per ton mile, this figure in England being about six times what it is in America. The difference in the sizes of the cars accounts partly for this, but the relative cost of the land is perhaps a larger factor. The cost of British railways, including rolling stock, is stated to be $235,000 per mile, while the corresponding figure for America is I believe $60,000, or only a little over one-fourth of the amount. This is an enormous handicap and one which I fear is not likely to be removed or reduced. On the other hand, the value of land is likely to increase in the States, but probably Americans will not pamper the landowner to the same extent as is done in Great Britain

On arriving at the docks the coal is handled by mechanical tipples much in the same way in both countries, but again to a less extent in pamper the landowner to the same extent as is done in Great Britain. is at present manyfold the greater, the figures being as follows:

	Imports. Tons.	Exports. Tons.	Excess of Exports. Tons.	Percentage that the excess is of the total product.
		1899.		
Great Britain...........	2,000	55,810,000	55,808,000	25.3
United States..........	1,329,950	5,752,150	4,422,200	1.95
		1900.		
Great Britain...........	10,000	58,405,000	58,395,000	25.9
United States...........	1,881,637	7,917,319	6,035,682	2.5

The *Daily Mail* of 6th Nov., 1901, stated that there was a "steady and considerable increase of American coal exports to France" and that "the exports of English coal to Marseilles for the first six months of this year show a decrease of 25 per cent. from those of the same time last year. American exports there for the same time show an increase of over 1,100 per cent! This latter figure is probably misleading, without knowledge of the total amount of American coal sent to Marseilles; and the decrease in the British coal sent to Marseilles is no doubt partly due to the coal tax. Still, the figures show the trend of affairs. As the pitmouth value of American coal is almost exactly half that of British, and as there is not a very great difference in the quality of the coal of the two countries taken as a whole, it would seem as if the whole question of the possibility of American coal competing with British in the European markets depended on the cost of freight and handling between the respective mines and the markets.

THE VEVEY-MONT PÉLERIN FUNICULAR ELECTRICAL RAILWAY.

By Enrico Bignami.

The installation described by Signor Bignami in the pages immediately following is not of great magnitude, but it exhibits an interesting and rather unusual combination of power applications. A problem presenting exceptional conditions is solved simply by combining the separate peculiar advantages of several distinct agencies—the gas generator and engine, electric transmission and driving, the storage battery, and cable traction. For this reason the short descriptive account is presented.—The Editors.

AMONG the numerous funicular or cable-operated railways with which Switzerland is provided, especially at much visited sites, perhaps the most perfect example is that from Vevey to Mont Pélerin. This line connects the city of Vevey with two villages, Chardonne and Beaumaroche, situated on the flank of Mont Pélerin, and having fine views as well as being pretty resorts for travellers in the neighborhood. It also greatly facilitates the ascent to the summit of the mountain which dominates one of the most beautiful panoramas in the world. The length of the line is 1,588 metres (0.984 mile), while the difference in altitude of the two termini is 416 metres (1,364 feet). The grades vary between 13 and 54 per cent., while the average gradient is 33.5 per cent. All curves are of 500-metres radius. There is one tunnel on the line 114 metres (377 feet) long. Retaining walls are built 5 feet thick at the top and 9 feet at the bottom. The line is ballasted for 960 metres and laid on mortar-jointed masonry for 660 metres. A gauge of one metre (3.28 feet) is used, the line consisting simply of two rails without a rack. The rail is 5 inches high and weighs 23.2 kilogrammes per metre (46 pounds per yard). Cross ties are of Zorès iron, 1.6 metres long at the bottom and 1.5 metres (4.92 feet) long on top. In all, the metal of the track weighs about 79 kilogrammes per metre, or 158 pounds per yard. The cable is 31.6 millimetres (1.26 inches) in diameter and weighs 3.25 kilogrammes per metre (2.18 pounds per foot). It is of twisted steel wire having a breaking strain of 134 kilogrammes per square millimetre, or, for the full cross-section of the rope itself, of 56 metric tons. Its maximum service load is 4 metric tons.

The mechanical equipment of the permanent way consists of pulleys for guiding the cable and keeping it from dragging on the ground. The rolling stock consists of two cars, one attached permanently to each end of the cable, so that as one goes up the other comes down. The cable is driven by means of a system of grooved pulleys worked by a 70-horse-power direct-current electric motor acting through a belt and gearing. Below is a detailed description of the machinery.

The motor is belted directly to a first countershaft. This, through simple gearing, works a second and more slowly turning countershaft which, in turn, drives in the same way a large countergear which is integral with the driving pulley. A guiding pulley is mounted near the grooved driving wheel. On the first countershaft are two powerful band brakes, one of which may be operated by hand while the other is automatic. The driving pulley is reversed by reversing the motor.

The electrical part of the installation was placed in the hands of the Société Anonyme ci-devant J. J. Rieter & Cie, of Winterthur, and comprises, in addition to the motor mentioned above, a battery of accumulators, placed at the upper station, a generating plant, and the transmission line. The generating station is situated about 40 metres from the stopping place at Chardonne. It consists of a trapezoidal building made of stone, having about 106 square metres of floor space and containing two generating units of 30 horse power each, of which one is held as a reserve. Each generating unit consists of a dynamo and a gas engine running at 150 revolutions per minute. The switchboard has white-marble panels supported on an angle-iron frame and is in three sections, one for each generator and an outgoing panel for the overhead transmission line and for the station lighting. On each dynamo panel is one amperemeter, one voltmeter, one field rheostat, one voltmeter switch, one 100-ampere switch, one minimum-current circuit-breaker and one pair of single-pole circuit-breakers. The middle, or line, panel has a rheostat, used in starting the gas engines by driving the dynamos as motors, an amperemeter, and two bipolar switches, one for the engine-starting resistance and one for controlling the lighting circuits in the station and its vicinity.

Current is taken to the upper station on two copper-wire cables, each 600 metres (1,968 feet) long and of 75 square millimetres cross section (about No. 00 B. & S. gauge). About 8 per cent. loss is encountered on this line at full load.

The line is attached to 50 double-bell porcelain insulators, supported by treated pine poles having pointed metallic caps. These are grounded by copper ground wires on each pole. To protect the in-

GENERAL VIEW OF THE RAILWAY LINE AND ITS SURROUNDINGS.

stallation as far as possible against lightning, a double-pole lightning arrester is placed at each end of the line.

The upper station contains a battery of 114 cells of Pollak accumulator, these having been made at the Marly works, near Fribourg. Their dimensions and constants are: Capacity, 402 ampere-hours at three-hours discharge, or 276 ampere-hours for one-hour discharge. Normal maximum charging current is 180 amperes. Sometimes, though, when the descending car is full and the car coming up is empty, as happens often in the evening, the motor works as a dynamo and its current of about 200 amperes charges the accumulators. Current on discharge varies up to 250 amperes according to the weight of the loads of passengers. The battery is intended to aid the generating station at the moments of heavy load, when it discharges in parallel with the generators. At times of small load it receives its charge, as it does also during the intervals of rest between trips of the two cars. By this arrangement the generators are driven constantly at full load, and consequently at maximum efficiency. Otherwise their power would be notably insufficient, as the generator output is calculated upon the basis of the average power consumption, instead of being provided to meet the maximum-load conditions. Except for a few trips in the morning and late in the evening, the battery is used alone. It serves also for lighting the plant stations and offices and, most important, the buffet at Beaumaroche.

A singular phenomenon takes places during the first part of the trip, when the ascending car is on a 13-per cent. grade and the car coming down is on a 54-per cent. grade. The motor is perfectly reversible and, driven by the descending car, is worked as a dynamo, restoring current to the battery.

In order to eliminate variations of voltage due to variations in load, the battery is provided with an automatic apparatus of the C. Schneider system which controls a group of end cells. The automatic apparatus is worked through a voltmeter contact-maker and a relay.

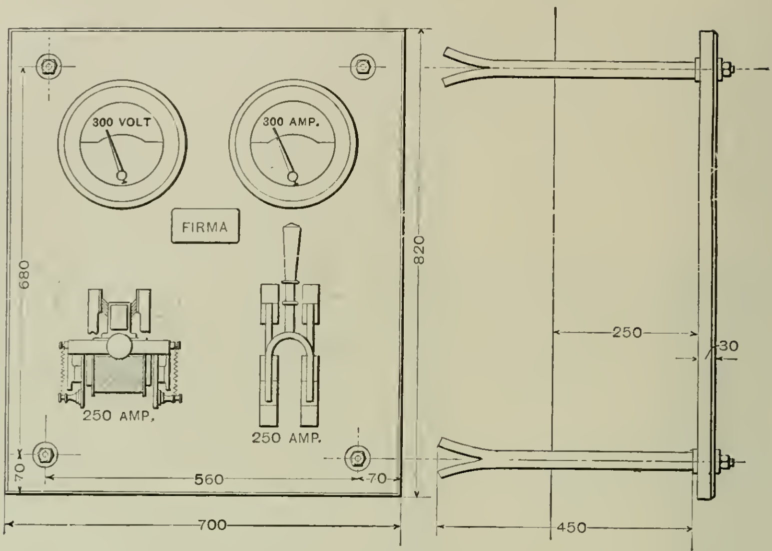
THE SUBSTRUCTURE OF THE VEVEY–MONT PÉLERIN RAILWAY.

The accumulators are installed in the basement, upon a wooden rack completely insulated from earth. The switchboard and all the other apparatus find place on the main floor of the building. The controller and the motor switchboard (page 364) are directly at the hand of the operator, who also controls the brakes. The motor switchboard is of marble and contains an amperemeter, voltmeter, bipolar switch, minimum-current circuit-breaker, and a pair of cut-outs. The battery switchboard, which is near the motor, contains two amperemeters, a 300-volt voltmeter, an 80-ampere throw-over switch, a single-pole 250-ampere switch, and a bipolar switch for the lighting circuits. The method of distribution is shown on page 370.

Each of the two cars composing the rolling stock has thirty seats and can carry also twelve standing passengers. Empty, these cars weigh 5,200 kilogrammes (11,440 pounds) each, and loaded, 8,140 kilogrammes (17,900 pounds). Their wheel-base is 4.3 metres (14.1 feet) and the permissible speed 1.5 metres (4.92 feet) a second.

Each car has both hand and automatic brakes, and in case of breakage of the cable both act instantly to secure the car to the track by means of solid steel wedges. The operation of the trains is controlled by the operator at the upper station who has command of all the machinery.

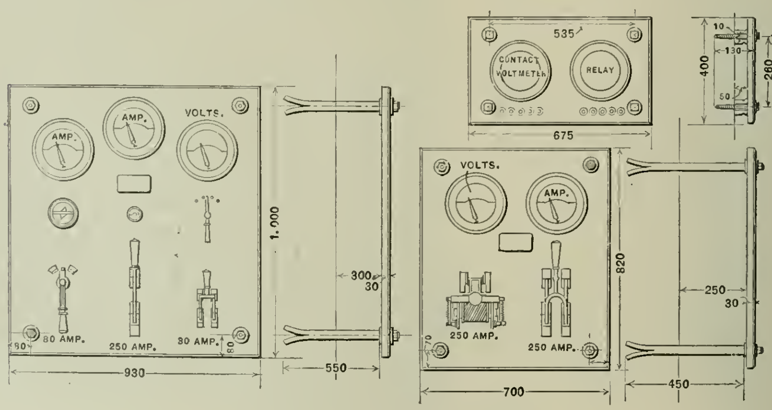
A word may be said here about the gas-generating engines, which were installed by MM. Gilliéron & Amrein, of Vevey. Each unit comprises the engine proper and a gas-making apparatus. The working of the apparatus is as follows: Gas is produced in a contrivance resembling an ordinary stove, in which steam and air are caused to pass through incandescent anthracite coal. The resulting combination is termed *gaz pauvre*—"poor



THE CONTROLLER AND THE MOTOR SWITCHBOARD.

gas." From the generator the gas goes to a second apparatus, called the washer, where it is cleaned and purified. From the washer it is drawn directly into the engine cylinders as demanded. The method of working one of these engines is thus:

A wood or charcoal fire is made up in the generator cylinder, A, preferably newly cleaned, and the two doors, B and B_1, are carefully closed. The three-way cock C is set so as to keep the smoke out of the washer D and to allow it to escape freely by the chimney E. The washer D is



THE BATTERY SWITCHBOARD.

now filled with water through the valve V until it overflows by the tube T after having filled the pot U. The vapouriser should also be filled half-full of water. If it is desired to force the fire and hasten the production of gas, use is made of the blower N by turning the crank energetically in the direction shown by the arrow. The current of air from the blower enters the lower part of the generator and, after passing through the grate, traverses the cylinder A. During blowing the cock Q of the water-level gauge should be open and the valve S of the steam pipe W closed.

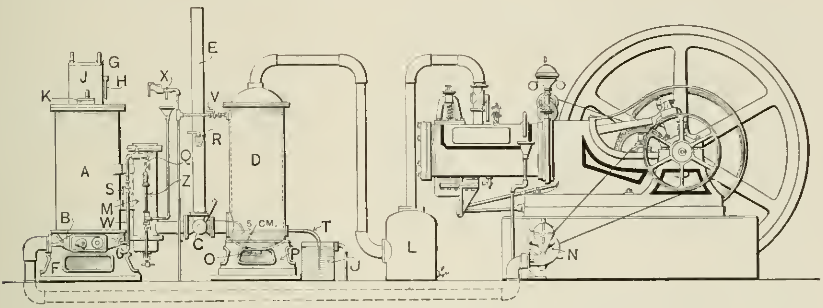


DIAGRAM OF GAS GENERATOR AND GAS ENGINE.

The fire being well started, the cover G is lifted and the charging hopper J is filled with combustible (anthracite or very lean coal in lumps of one inch or smaller). Replacing the cover G a gate is opened by lifting the lever H, permitting the coal to fall little by little into the cylinder A. Care must be taken always that too much coal does not enter the cylinder at once, as this would result in extinguishing the wood fire. It should be admitted in small quantities at frequent intervals. The generator A being filled in this fashion up to the conical funnel and all the fuel being well-ignited, a second charge is put into the cylinder A, the air outlet cock Q is closed, and the steam valve S is opened, the hopper J being at the same time filled with anthracite to be warmed for the next charge, thus avoiding cooling the fire.

In ten or fifteen minutes after firing the gas can be tested to see if it is of usable quality, which is known by the gas issuing from the test cock R burning fully under pressure with a blue flame. As soon as good gas begins to be generated, the three-way valve C is turned to shut off the opening to the chimney E and to allow the gas to pass to the washer D and the pot L. At the same time the crank of the blower N is uncoupled and a belt connecting it with the engine thrown on. The

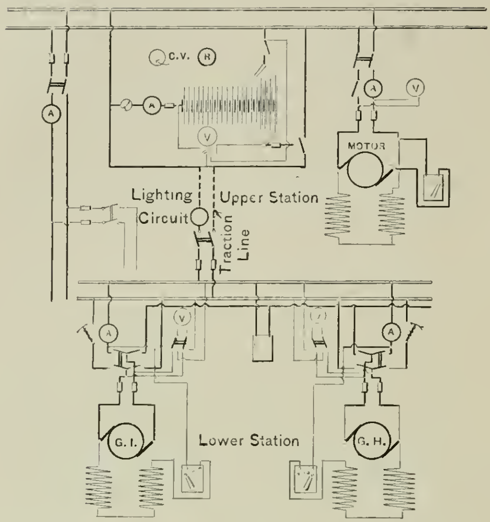


DIAGRAM OF THE METHOD OF DISTRIBUTION.

engine can then be started. The height of the incandescent column of coal will be maintained always at the point determined by the needs of the case and in the manner indicated. The progress of the operation is indicated by the peep-hole or window K. As soon as fire becomes visible through it a new charge of anthracite is fed into the cylinder.

The two doors, B and B_1, are provided with openings through which the fire may be raked and sliced with tools furnished with the machine. If the glow of the fire on looking in at these doors is not of a bright red, the grate must be cleaned with the pokers mentioned above.

The height of water in the boiler M should be kept the same by watching the indicator Z and using the feed-valve X. The washer requires a constant small supply of cold water which enters by the siphon T, and care must be taken to keep the latter free from obstructions. In going into the washer the gas should traverse a layer of 2 inches of water, which prevents its return to the generator.

After half-a-day's running the plug at the bottom of the washer is removed to flush out the dust and impurities which have accumulated in it. Every day, before putting the apparatus to work, the bottom of the evaporator is unscrewed and emptied. The tubes of this apparatus are also cleaned every few days by means of a brush of iron wire. At the end of a day's run the doors B and B_1 are opened, the grate is tipped, and the cylinder A is cleared of clinkers and ashes.

During short stoppages of running the fire is allowed to burn after all the openings and all the valves have been closed, except a small hole in one of the doors B of the base of the generators, and the three-way valve is turned so as to open a path to the chimney by the smoke flue E.

If it happens that the engine receives no gas, the cause may be an obstruction of the pipe between the evaporator M and the generator by fragments of coal, or the buckling or obstruction of the siphon T. In the latter case the water cannot escape and fills the washer D, the three-way valve C and the evaporator. It becomes necessary, then, to draw off the water by opening the plug O and to clean the siphon.

The consumption of the engines per horse-power hour is 0.60 to 0.65 kilogrammes (1.32 to 1.40 pounds) including the two startings necessary in a day. The same consumption calculated on an annual basis shows 7 kilogrammes used per double train trip, or about 2 kilogrammes per car-kilometre (7.1 pounds per car mile) in which is included lighting the line and the *buffets* of the terminal stations.

Preliminary diagrams showed that in working the line at the time when conditions would be the worst—that is, when the up train was loaded to its maximum and the down train was empty, about 60 horse power would be required. In practise the maximum often surpasses 100 horse power. In spite of this the engines and the electrical apparatus have given excellent service, even at the times of heaviest loads. On Sundays in the summer the service has been suspended during the greater part of the day.

The Vevey-Chardonne-Pélerin cable railway, installed under good technical conditions, gives also very good financial results. Since its opening it has carrried an average of 13,000 passengers a month

A PORTION OF THE COMPLETED PERMANENT WAY.

TUNNEL, PASSING POINTS, AND CARRIAGE DESCENDING.

and about 120 tons of merchandise under a schedule of 20 trains a day.

The time table shows a train every hour from 6.15 a. m. to 11.15 a. m., from 11.15 until 12.15 a train each half-hour, the same from 1.15 to 4.15, and from that time until 10.15 the trains are again run at hourly intervals. The trip is made in 24 minutes with a single intermediate stop at Chardonne.

The rates of fare are as follows:

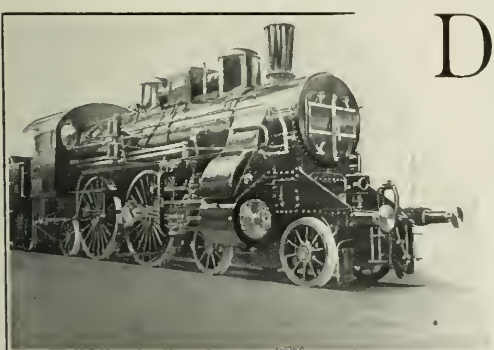
Ordinary ticket	2d class round trip, francs 2.10
" "	3d class, round trip, francs 1.50
" "	2d class, up trip, francs 1.40
" "	2d class, down trip, francs 1.00
" "	3d class, up trip, francs 1.00
" "	3d class, down trip, francs 0.75

The good technical and financial results shown by this enterprise will doubtless contribute to the development of working inclined cable railways by electricity.

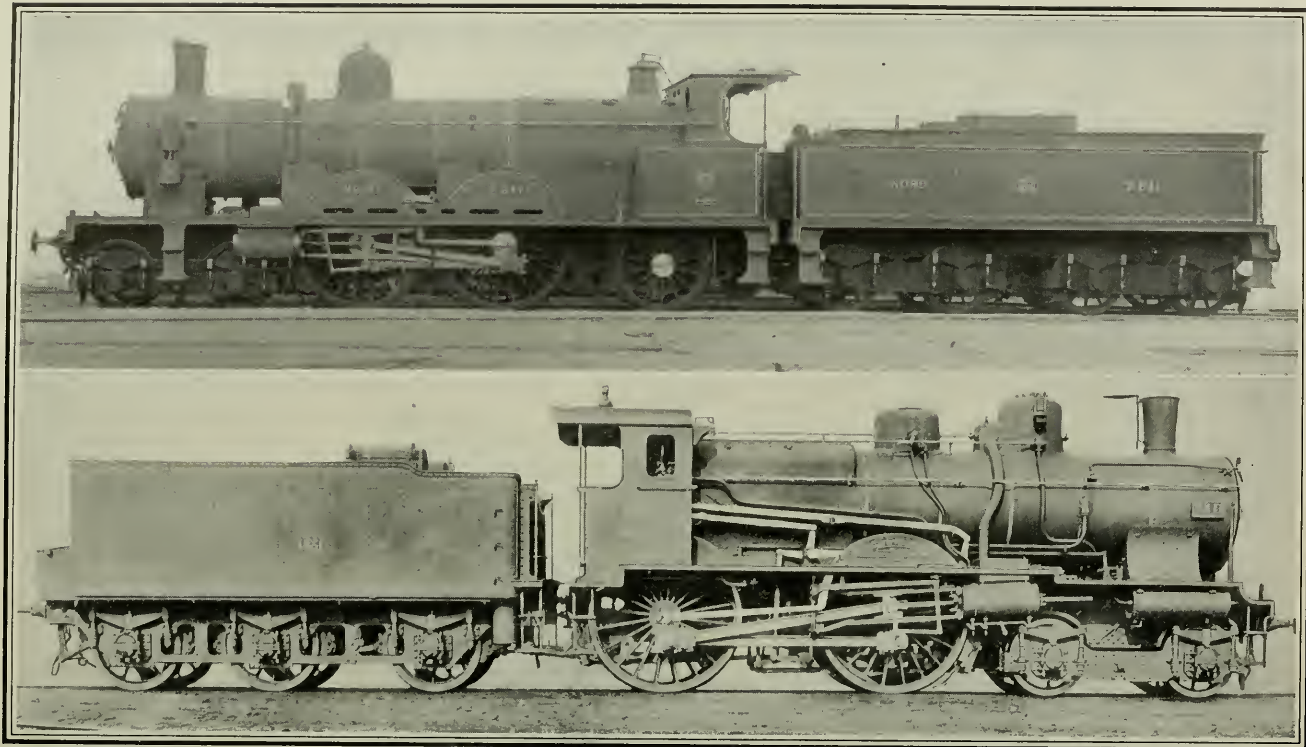
FEATURES OF CONTINENTAL LOCOMOTIVE CONSTRUCTION.

By Charles R. King.

The fact that the railway is essentially an agency of internal transportation, while the waterway is worldwide, has tended to keep locomotive engineering to a great extent within national boundaries in its development. This is particularly true of countries like Britain and the United States, which are isolated by their position. Britain, as the great engineering exporter of the world, reached farther abroad, but it was largely to extend her own practice into new lands. It is but recently, since the demands of the lately opened continents overtaxed the old sources of supply, that comparison between diverse types developed under differing conditions has become keenly interesting. Continental locomotive practice has afforded the freest opportunity for the interchange of ideas and systems developed separately under varied conditions of temperament and influence. It should afford the best examples of mechanical construction resulting from the co-operation of minds of many complexions. Mr. King's long and varied experience enables him to apprehend the characteristic points of the types he reviews, and his grouping of the subjects permits him to cover the field comprehensively in this article and the succeeding papers.—The Editors.



During and since the period of the recent Paris Exhibition much has been published upon the section there which was devoted to locomotive engineering. For the greater part these descriptive reviews, although at all times interesting, have either been very generalised or else confined to detailed descriptions of individual machines chines—excellent in themselves, but appearing in so desultory a manner as to require for many a considerable effort of memory to retain all that had appeared thus intermittently on the subject. A review of the whole which selected for remark the principal novelties of construction or other equally interesting elements of design, exhibited in each locomotive, accompanied by a short general and comparative description, would, it seemed to me after seeing in actual service many of those exhibited, form a useful record of a very remarkable exhibition—the greatest of its kind and representing, locomotives and cars together, an immense outlay of capital for the period of almost one year. Hardly sufficient justice appears even yet to have been done, many an ingenious



ABOVE IS THE WELL-KNOWN FOUR-CYLINDER NORD COMPOUND EXPRESS LOCOMOTIVE; BELOW IS THE FOUR-CYLINDER COMPOUND OF THE EASTERN RAILWAY OF FRANCE—THE ONLY FRENCH FOUR-CYLINDER ENGINE DIFFERING FROM THE NORD TYPE IN ITS STARTING GEAR. IT HAS THE "EST" STARTING VALVE.

mechanical contrivance having so far passed without notice. At first sight it might appear that the matter was now out of date; but machine design does not change or progress thus speedily, and the locomotives exhibited at Paris were, for the greater part, entirely new types. Some of them have not even up till now completed that experimental stage which precedes the establishment of a regular class of new locomotive, and such a type when thus fixed in Europe usually remains the standard for at least four or five years following.

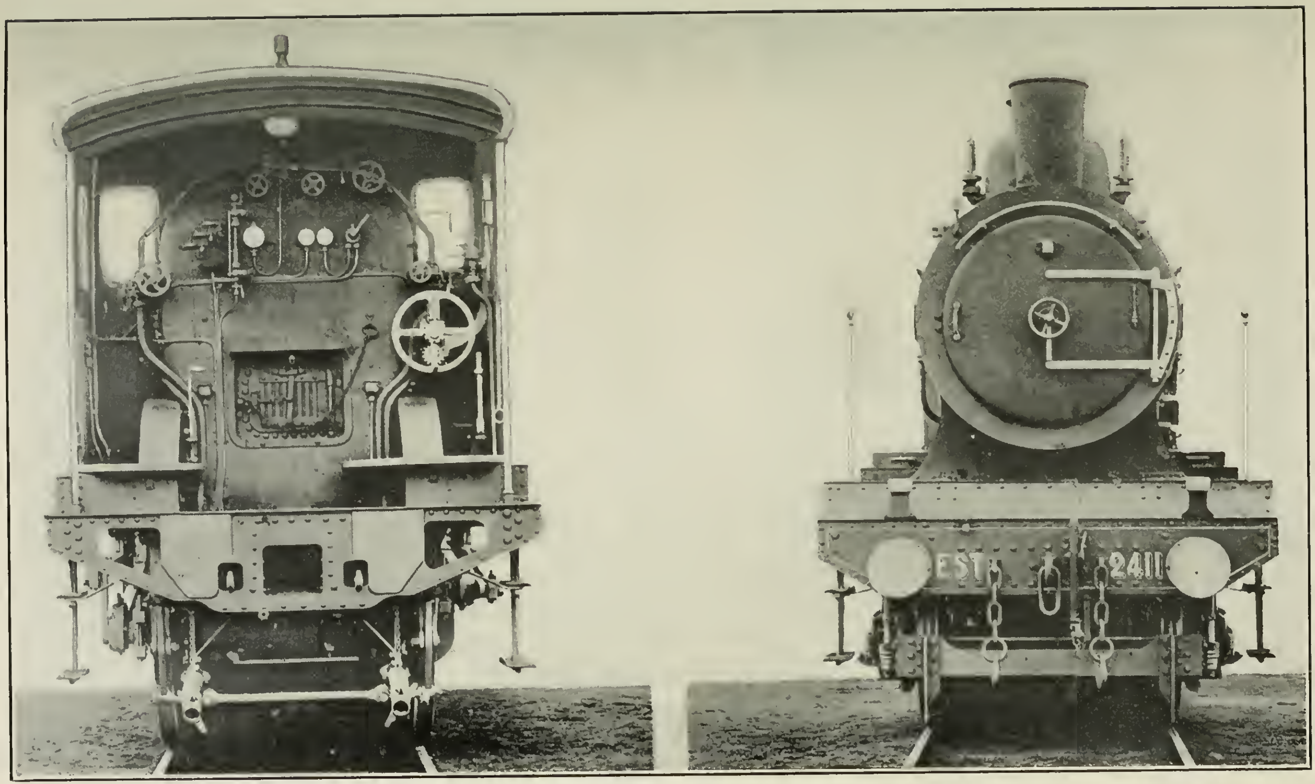
If anyone were to look for anything remarkable in European locomotives with regard only to mere size and power, as in America, he would certainly be disappointed. Continental exactions in the direction of luxury in travel follow but slowly—though none the less surely—in the wake of American progress. Moreover, the limit of the loading gauge presents, or will present very soon, an impediment to most European railways (always excepting those of Russia) ; in England, indeed, were it not for the great calorific value of the native coal, railway engineers would have long since been baffled to have kept their locomotives small enough to pass through tunnels of such rabbit-burrow like proportions (as compared with those existing abroad). And yet, very singularly, it was here that the great Brunel gave the country a width of railway unique in the world. But apart from mere size and from the point of view of shapeliness alone, something desirable might be learnt of the æsthetic in the forms employed for the parts in European locomotives.

Continental engineers have a sharp eye for harmony in design, and many a question is asked as to why American locomotive parts could not be lightened to give a little more semblance to elegance (*moins grossières*) without any loss of strength. It is also very interesting to observe in Continental locomotives the greater variety in the general external appearance, even in locomotives of the same type, and this is not without a picturesque effect, reflective surely enough of the innate sentiment of art possessed in many European countries by such unimpressionable men as locomotive designers. An example of pleasing harmony in mechanical design was particularly noticeable in two locomotives at the recent Paris exhibition, viz., the English Midland Railway single driving wheels express locomotive and the ten-wheeled four-connected express locomotive designed at the Chemnitz works for the Saxony State Railroads; but for crushing mass and even higher finish of parts there were many other examples to be seen.

Express Locomotive, Northern Railway of France. The first place in this notice properly belongs to French locomotives, and, of these engines, that one which was exhibited by the Northern Railway—a line which holds with the Paris-Orléans the premier position for the fastest regular services of passenger trains on the Continent. The latest type of Nord locomotive here illustrated shows nothing remarkably new in its construction, being the result of gradual changes effected in its prototypes; and a short description of its evolution will embody the history of the development of the four-cylinder express compounds in France and indeed in the world.

At a time (1886) when Mr. Webbs' English North-Western three-cylinder compounds had become a practical success, and a specimen had been sent to the Western Railway of France, as was done later (1888) to the Pennsylvania Railroad, the noted firm of French locomotive builders, the Société Alsacienne de Constructions Mécaniques of Belfort—the regular maker of the Nord locomotives—constructed a four-cylinder compound for the Nord Railway, taking as the model a precedent type of Nord six-wheeled four-connected engine having a large pair of leading radial wheels beneath the smoke box, but differing from all expresses of that time in having single instead of double plate frames. The high-pressure cylinders were placed inside the frames, working the forward pair of drivers, and the low-pressure bolted outside the frames, driving upon the trailing wheels, but without any side rods connecting the two pairs. This engine, designed by Mr. Alfred G. de Glehn of the Alsatian Company, at once effected an economy of 18 to 19 per cent. on coal. When it had been several years in service it was exhibited at the Paris Universal Exhibition of 1889. After running 390,555 miles it realised over single-expansion locomotives doing the same work an economy of 2,260,720 pounds of coal, which reckoned at $3 per metric ton represented $3,083 or, in deducting $160 for its extra cost in lubricating oil, a net saving of $2,923.

Between the years 1876 and 1891 the fastest Nord trains were, with the exception of two locomotives, worked by a very fine eight-wheeled four-connected type of engine known as the *Outrance*—created in 1876 by M. Delebecque and first exhibited at the Paris Universal Exhibition of 1878, and of these a total of 103 have now been built. With this engine 150 tons or 26 axles was considered to be a heavy load, and on the ruling gradients of 0.5 per cent. the maximum speed with such a train load did not exceed 40 miles per hour. Even when, later on, the boiler-pressure was raised from 134 pounds to 148 pounds and the cylinder rebored to a larger diameter, the engines could not, with the allowance of any margin for adverse weather, keep time on the same gradients with trains of more than 32 axles



FOUR-CYLINDER FOUR-CONNECTED EXPRESS ENGINE, EASTERN RAILWAY OF FRANCE.

or 200 tons. The experimental compound, No. 701, carried a pressure of 148 pounds and trials showed that it exerted a power of 750 metric horse power. Along with it, at the Paris Exhibition of 1889, there was shown also a new type of single-expansion engine designed by Chief Engineers F. Matthias and M. Sauvage with 19-inch cylinders, No. 2101; but being larger and more powerful than the compound and carrying 161 pounds pressure, this engine was able to mount the 0.5 per cent. grades with 190 metric tons at a speed of 45 miles per hour. It was soon found, however, that the work to which its crank axle was subjected was too great, and this fact added to the low cost of upkeep of No. 701, decided the final adoption of the four-cylinder-compound arrangement, which divided by half the work on the crank-pins and reduced the stresses on the cranked axle, while the superior twisting moments of the four driving rods, even without side connecting rods, greatly increased the regularity of the pull on the draw-bar, as I had several opportunities to notice during the early service of the compound No. 701. The Exhibition engine, No. 2101, with the addition of compound cylinders, therefore became the pattern on which succeeding and more powerful engines were built. The first of this primary class began work on August, 1891, and since that time, with various and successive alterations of dimensions, sixty of the series have been built. In these compounds, designed by M. du Bousquet (the then new chief of the traction department) the position of the cylinders was reversed from that in No. 701, the low-pressure cylinders being placed inside the frames where the momentum of their heavier reciprocating parts had the least disturbing effect, and the high-pressure cylinders being located outside—just as in Mr. Webb's three-cylinder arrangement, and although the first two of the new series had no connecting side rods, these were applied very shortly afterward in order to compensate the tangential efforts on the cranks, to insure promptitude of starting in all positions of the pistons, to diminish the maximum vertical oscillations, and to maintain the two sets of crank pins always at the same relative angle. In the new compounds it was moreover arranged to exhaust the high-pressure cylinders direct to the atmosphere whenever necessity occurred, and at the same time to send live steam direct to the low-pressure cylinders. The boiler pressure was augmented—188 pounds—and compared with No. 701 the new engine indicated a power, during trials, of somewhat over 1,000 horse power, although having a grate area less than that of the old *Outrance* type. The 0.5 per cent. grades were now ascended with 200 tons at 47 miles per hour. One of these first two engines was sent to Chicago in 1893,

VAUCLAIN COMPOUND, STATE RAILWAY OF FRANCE.

and the same type of compound was then adopted by the Southern Railway of France. Later—in 1896—the succeeding classes had boiler pressures raised to 201 pounds, the boilers were enlarged and fitted with Serve's ribbed tubes, the grate area was increased, and the engine supplied with modern double-truck tenders; the speed up grade with 200 tons was then augmented to 51 miles per hour. In March, 1897, one of the new engines hauled a train of 225 metrical tons up a grade of 0.5 per cent., at a speed of 53.7 miles per hour, and without forcing the boiler to its utmost the work developed on the pistons was 1,155 metrical horse power. In these trials certain abnormal fluctuations were noticed in the high-pressure valve-chest, as well as an undue compression on the low-pressure pistons; these defects were remedied by increasing the size of the dry pipes and the capacity of the high-pressure valve-chests and by giving an extra inside lead of 1/16 inch to the 1/8 inch already existing with the low-pressure valves. The maximum speed on the 0.5 per cent. rising gradients with 200 metrical tons now advanced to 53.6 miles per hour. Finally the lengthening of the firebox shell to 9 feet 10 inches compelled the adoption of a trailing wheel beneath the firebox (Atlantic type), as has been practiced for over twelve years by the State Railways of Belgium and the French Paris-Orléans line.

The following particulars of this engine are given at some length for the reason that most French lines have abandoned their former variable distinctive types by preference for this one. Thus the Midi, Paris-Orléans, and Ouest use the same form of compound locomotive with slight modifications of detail.* The fuel used is a mixture of coals obtained from the mines of the Nord and Pas-de-Calais departments, containing 20 to 23 per cent. of volatile matters and 5 to 6 per cent. of cinders, and is in the form of small pieces and slack mixed with briquettes. By dint of rapid firing about every five minutes and closing the door the instant the shovel is out of the firehole, this coal can be made to keep the steam pressure constant with an almost invariable water level while hauling loads of from 270 to 350 tons at speeds varying from 53 to 75 miles per hour. The consumption per American ton-mile, excluding the locomotive and tender, ascertained during certain trials is 0.111 pounds, or, including the locomotive, only 0.08 pounds. The average of the gross loads, from which these figures were supplied, was not given; but even supposing this to be 400 metric tons it is not possible to make out the train mile at more than 35.2 pounds, which is certainly a very remarkably low fuel consumption. The grate, taken horizontally, has an area of 29.5 square feet, the heating surface in contact with the fire is 2,243.4 square feet (ratio grate area to heating surface, 1:76); the pressure is 215 pounds; the cylinders 13⅜ inches and 22 inches diameter by 25¼ inches piston stroke, and the drivers 80¼ inches diameter; theoretical maximum tractive effort, 25,806 pounds. The boiler is of perfect telescopic type, the 11/16-inch thick rings diminishing in diameter from the smokebox backwards, in order to keep the boiler center as low on the wheels as possible—8 feet 3 inches. The material for the rings and firebox shell is mild steel of 32.6 to 36.6 (U. S.) tons maximum tensile strength with 33 to 31 per cent. elongation. The firebox shell is of the square-cornered or Belpaire pattern, with a very deep copper firebox contracted in its width below in order to find room for the firebox casing between the inside plate frames—an arrangement which makes it necessary to leave the shell plates open until the inside box is inserted in its place. To keep up the water circulation, and prevent steam bells forming between the narrow water spaces at the sides, the foundation ring has been increased in the width of its edges as compared with the previous engines. Ordinary vertical crown stays of iron are used, except for the two front rows which are expansible. All of the screwed stays are of manganese bronze, drilled

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* Those of the Paris-Orléans lines, while less powerful than the Nord locomotives, make, on an average, speeds of 56 to 59.7 miles per hour between Paris and Bordeaux.

right through, and their fire ends are opened out after rivetting. The flat sides of the firebox above the crown are stayed by a double row of transverse rods. Longitudinally the boiler head is stayed with four rods, screwed to girder stays on the back plate and to brackets on the rear boiler ring. There are 126 tubes (Serves) of 2¾ inches outside diameter. The tube plates (⅝-inch thick) and the boiler head, 1-inch thick, are of extra mild steel with an ultimate tensile strength of 29.3 to 32.6 tons (U. S. measure) with 36 to 33 per cent. elongation. All rivets, including those for the copper firebox, are of the best iron of 23.2 tons tensile strength and 23 per cent. elongation. The brick arch, which has long since replaced the water table or copper midfeather employed in the first compounds, is of circular form with vent holes against the sides and middle of the flue sheet. The grate is slightly inclined and divided into five short rows of multiple bars, the front one being a hinged dropping grate with transverse bars. Shaking grates are so far not used in France.

The petticoat pipe in the chimney is completely closed by a circular grating above the blast nozzle—a plan adopted from the first for these compounds—and although this pipe is large, yet its spark mesh is of very small area compared with the usual pattern of spark baffler; but as these engines have always steamed freely in spite of the confined area of the netting, it would appear that too much stress is sometimes laid upon the draft obstruction said to be created even by the regulation spark arresters. The blast pipe is surmounted by the standard double-wing variable nozzle permitting a perfect control of the fire, so important to firing with slack in mounting grades; otherwise, with fixed nozzles, a large proportion of the coal would be carried straight through the tubes, to the passengers' discomfort.

The spherical-topped dome incloses a semi-balanced throttle valve worked by the usual form of pivoted rod, and the dry pipe, as is the custom almost exclusive to France, is taken by a short way to the high-pressure cylinders in being passed through the boiler close to the dome and thence down, beneath casings, to the high-pressure cylinders; but whether the lessened frictional resistance effected by a shortened pipe is compensated by the increased chances of condensation outside appears doubtful. The high-pressure cylinders are bolted outside the frames in line with the steel-casting box frame, which serves as an inside transverse frame brace and also as a support for the low-pressure valve-spindle brackets at its front face and for the low-pressure cross-head bars at its back face. The small cylinders are bored clear through, but the large cylinders have semi-closed back ends. The serious loss by condensation resulting from the exposed position of the forward ends of the outside cylinders has obliged a thorough jacketing of their front heads with a non-conductor. The boxing in of the piston rods of such outside cylinders would appear to be a refinement that has so far remained unstudied, yet the loss of thermal efficiency due to each high-pressure piston rod spending half of its working time in the outside air, oftentimes of a temperature in winter below zero, might well be worth prevention by the use of a few square inches of sheet iron, of a flexible jacketing, or of closed cylindrical guides. In an engine normally working at high speeds the bridling effect of excessive compression has been counteracted to some extent in the clearance volumes, and for these, in per cent. of volume of each piston-stroke, 14 in the high-pressure and 9 in the low-pressure has been considered enough by the Nord engineers, although as much as 18 and 12 per cent. respectively are allowed in Est express engines. Both sets of valves have also been given, in place of usual inside lap, an inside lead of 1/16 inch for the high-pressure, and 3/16 inch for the low-pressure, thus reducing the period of compression.

The proportion of volume, high-pressure to low-pressure cylinders, is 1:2.71; in the earlier compounds that ratio was 1:2.42 only. The total cubic capacity of the receiver is 5 times the volume of that due to the stroke of one of the high-pressure cylinders.

The relief valve is mounted on the left side of the smokebox, and in connection with these reservoir passages is set at 80½ pounds. Its pipe is placed symmetrically to that of the live-steam pipe on the opposite side of the smoke box, the two entering the saddle casting on either side of the blast pipe. The pistons are steel castings, the high-pressure having straight and the low-pressure conical webs. Extensions are provided to the low-pressure piston rods with a view to preventing the too frequent recurrence of broken cast-iron segments and also to save some amount of grooving from their relatively heavy weight. The cross-heads are of iron cemented and case-hardened and their slide blocks are of cast iron lined up with white metal. The main driving rods and the side rods are of forged iron and their channelling to I-section is effected by drop-forging. The high-pressure main-rod big ends are of open-forked pattern with their brasses held up by single gibs and cotters, and the inside low-pressure main rods and the side rods have strap ends with longitudinal screw adjustments.

Walschaert valve gear is employed for both groups, the inside gear being driven from eccentrics and the outside gear, as usual, by cranks. In these new engines special care has been taken to avoid wear wherever that was possible; thus, to diminish bending stresses and lessen the work on the various pins and studs of the links, the eccentrics have been so keyed that the lower half-sector of the link drives the valve when in forward gear—that being of course the motion most frequently used. A new arrangement has also been adopted to suppress the torsional strain due to the different vertical planes usually occupied by the valve spindle and the advance lever. The valve rod is mounted in an extension buckle the cheeks of which are saddled upon a bracket guide, at the same time embracing the upper end of the vertical advance lever, which is now not bent laterally as usual, so bringing the various joints of the gearing into the same vertical axis. All the slide valves are of ordinary unbalanced pattern. At the lower outside edge of each low-pressure valve chest is located the compounding valve designed by Mr. de Glehn. Cylinders, boiler saddle, valve chests, and starting-valve cylinders are cast together in one piece and the latter are bored to receive a hollow rotary starting valve of the same internal diameter and lying in the same longitudinal axis as the exhaust pipes from the high-pressure cylinders. This valve has ports so located in its circumference that when the larger opening arrives opposite to the passage leading into the low-pressure valve chest the smaller port, farther forward, is blind; a quarter turn brings the latter opposite the passage to the valve-chest exhaust after closing the low-pressure hole. Another portion of the circumference opens the drain holes both for purging the valve chest and the starting valve itself. Motion is imparted to the rotary valve by a spindle passing out through a gland at the forward end, opposite to the high-pressure exhaust pipes, and there operated by a small air-cylinder and piston located beneath the front platform perpendicular to the axis of the valve and controlled, of course, from the footplate, as too is the special cock for admitting boiler steam to the low-pressure valve chest. The following effects are thus obtained:—Compound; single expansion in each group of cylinders when required for starting or auxiliary aid; disconnection of the groups and working either pair alone, as in case of accident.

The reversing-screw gear consists of two differential screws on the same horizontal axis, the turned-down or loose tail end of the front screw passing concentrically through the back screw, either one being disconnected at any desired point of cut-off by means of latches, and thus operated singly or together with the same or different relative degrees of expansion; while a third latch locks all movements of the hand wheel. Although steam reversing gear had been installed on the first Nord compounds, now in France, and almost everywhere else on the

Continent, this form of power gear is not used. The axles are of Martin steel. The crank axle, of Worsdell type, with strongly-hooped circular webs, is of gun steel tempered in oil. The main object in bringing the two driving axles so close together was to shorten and reduce the weight of the coupling rods. The introduction of the fifth axle is however considered by some French engineers more objectionable than the use of long rods. The wheels are of forged iron. An angle of 180 degrees has now been resorted to for the keying of the two groups of engines coupled by the side rods, in this point differing from the previous locomotives wherein the angle employed was 162 degrees. As now arranged the rotary masses are balanced without consideration to those of the reciprocating parts. On other railroads 162 degrees is found quite satisfactory with regard to the multiple conditions to be realised; on the Nord, however, calculation and experience have proved that with coupling at 180 degrees the side lash due to the alternating movements of four almost self-balancing engines has been reduced to a minimum, and that it is quite possible to ignore the latter masses in calculations for the wheel weights, as could not be done with keying at any different angle. Additions to wheel weights for equibalancing the maximum velocities of the reciprocating parts, while diminishing side lash (so aggravated in engines with free swinging or flexible bases at either end, as in the ten-wheel type) introduces vertical oscillation or galloping, attended with pounding of the rails; the engine under mention has therefore only counterweights of low value for balancing the revolving parts on each axle, and as these are symmetrically disposed on either side the same matrix can be used for forging each pair of wheels—a practice not convenient with the unsymmetrical locations of the heavier wheel weights in engines keyed at 160 degrees. The final result is that with 180 degrees the difference between the mean twisting moment and the minimum moments is scarcely higher than when 162 degrees is employed, so that the starting power is practically much the same whatever be the stationary position of the driving cranks. The slab frames are of extra mild welding steel 1 3/16 inches thick and stiffened over the leading driving-axle box guides, or horn blocks, by steel plates of horse-shoe form. The horn blocks are steel castings; the binders or yokes are cast iron and the wedges are of bronze. All the springs of the two pairs of driving wheels and the large trailing wheels are connected together by longitudinal balance beams.

The engine truck is of the model most generally employed in France, with plate frames outside the wheels and journal boxes outside the frames. Its transverse steel casting frame supports the engine solely by means of two spherical feet, bolted beneath the sides of the main frames and sliding in grooved channels in the bed casting. The work of the pivot pin in having no step bearing is therefore confined to pushing the truck and to resisting the lateral thrusts of the latter, which are flexibly transmitted through the intermediary of two traversing helical springs of very different strengths threaded concentric-wise, one within the other, upon two independent rods and set in place at an initial tension of about 3,700 pounds, the amount of direct lateral play being 1⅝ inches on each side. The pivot pin is slightly tapered towards its neck and merely to avoid strain, for any independent vertical obliquity of the truck frame sides—as in flexibly running swing trucks—is prevented by the rigid side supports mentioned.

The boiler mountings are: two 3⅛ inch safety valves, one ordinary and one Adams' pop, mounted on a bronze pedestal; two large Friedmann's variable-feed restarting injectors, one of 9½ millimetres for supply and one of 10½ millimetres as assistant or reserve; water-level glass with Serveau's automatic closer operating when glass breaks; Bourdon's steam gauges; oil force-pump, located on right-hand running board, etc. The lubricant used is a mixture of 80 per cent, naphtha oil called *mazout* and 20 per cent. colza, serving alike for journals, cylinders, and motion, although the engine men use colza pure for a very few parts of the mechanism. The consumption is 11.26 pounds per hundred miles run.

A blow-through steam-tube sweeper is provided in the smokebox, and a perforated pipe, fixed along under the transverse locking stanchion, enables the dust to be laid and diminishes the chances of ashes getting into the low-pressure valve chest if ever the engine is run against reversed steam. The equipment comprises also Gresham sand jets to the fronts of both sets of drivers—the sand boxes, always so unsightly, being concealed by the wheel covers; an electro-motor whistle for receiving signals when the contact brush—visible at the back of the trailing drivers—sweeps the brass-backed *crocodiles* that are placed at intervals along the middle of the track on the Nord main line, and finally the Westinghouse brake with the latest type of air pump, the brakes acting upon the fore-ends of all wheels save those of the trucks. The peak on the chimney-front edge breaks the force of the wind and facilitates the egress of smoke when steam is cut off.

THE FACTORY OFFICE AS A PRODUCTIVE DEPARTMENT.

III. RELATIONS TO THE STOCK ROOM AND THE SHIPPING DEPARTMENT.

By Kenneth Falconer.

Mr. Falconer's articles in this series, which began in THE ENGINEERING MAGAZINE for April, are conceived on the idea that the properly equipped and properly managed factory office has profit-bringing functions extending from the time quotations are asked for on raw material until the finished goods are delivered and billed to the customer.

His first paper presented the general theory of this view; his second discussed specifically the relations of the factory office to the stores department and the shops. The succeeding paper will take up the relations of the office to the manager, and its value to the executive. The papers make a valuable complement to Mr. Carpenter's articles appearing currently. They show the possibility of money-saving organisation in the office, as he shows the value of money-making management in the works.—THE EDITOR.

In planning a system whereby the operations of the factory office may be of the greatest benefit to the stock room and shipping department, the word "factory" must not be understood in the somewhat limited sense of a productive organization, but rather as covering all the departments of a manufacturing business, including the drawing office and pattern, stores, stock, and shipping rooms—in a word, all departments, except only the selling and the financial.

Where the technical accounting of a productive or industrial business is under the control of a staff maintained for that purpose only, and kept separate and distinct from the commercial or accounting office, the chief advantage looked for or expected is generally more efficient cost accounting. Factory accounting and cost accounting are, however, two different things, and the value of the former may be greatly lessened by limiting it to bounds which might very properly comprise the latter. In some instances the advantage of extending the technical accounting system so as largely to include the operations of the stores and purchasing departments has been recognized, but this, while a step in the right direction, does not afford a proper system of factory accounting full scope for its widest and best results. The work of the factory office, its information, records, and data, should cover all the operations of the stock and shipping rooms either past, present, or prospective, and also all transactions and correspondence with customers about orders or goods.

The objects sought by a thorough and complete system of technical accounting should be:—(1) the ultimate reduction of cost of production by means of the records and information obtained, by a close watch on the operating and maintenance expenses of the productive departments, and also by an intelligent supervision of the stores and purchasing, with the object of cheapening the raw material consumed; (2) an increase of profits by a lessening of the cost of operating all departments, including those whose expenses are not properly chargeable to the cost of production, and the adoption of such a system of information and records as will best facilitate the work throughout the entire organization; (3) an increase in the amount of sales by keeping the manufacturing departments in closer touch with the requirements of customers than can be done by either of the two alternatives usually tried, viz., affording customers (either actual or prospective) direct access to, and communication with, heads of the various departments, or, on the other hand, using the general or commercial office as a channel for such communications, inquiries, and replies.

In extending the work of the factory office to cover such a broad field it must be assumed that, to a very large extent, that department exists to represent the customer and his interests, as regards execution of orders without delay, prompt shipment when completed, and last, but very far from least, immediate notification when, through lack of full information or any other cause, delay is threatened or the fulfillment of definite or implied promises rendered doubtful or impossible. The factory office stands for the customer's interests in following orders through the shops from the time they are received until final shipment has been made and the customer notified. It stands for his interests even to the extent of seeing that the stores department, as far as possible, is always in a position to supply immediately all parts or material required for any article which the firm is liable to be asked to supply at short notice. In addition, the factory office should look after the customer's interests by ensuring delivery of goods at the date promised, failing which they should be sent out at the earliest possible moment, even at the cost of some inconvenience, or shipped by the quickest means practicable, even at the cost of an increased expense, which expense the customer should never be called upon to bear. In a word, the factory office in its relation to the stock and shipping departments should represent the customer in insisting upon just such attention to inquiries, orders, promises, and agreements as the management of the concern itself would feel fairly justified in asking and expecting under similar circumstances.

This policy carried out, and the customer always promptly replied to when inquiring concerning goods—promptly notified of any circumstance that would in any way affect his interests concerning articles being manufactured or work being done on his behalf, and immediately notified of any shipment, and in case of part shipments, of the date he may expect the balance—will soon justify the claim that the factory office may readily be a strong aid to the selling force and in itself a factor making for increase of business.

To accomplish these ends, it goes without saying that the factory office must have access to all sources of information concerning prices or purchases of stock and communications with customers; also, it must have a large control over the operations of both the stock room and the shipping department. Complete and accurate records of all quotations received or given should be kept; if a catalogue is issued and different discounts given to various classes of customers, records should be kept in such form that the proper discount to quote a named customer can be instantly ascertained. For this purpose the factory office should be provided with a catalogue interleaved with blank pages, and all current discounts marked opposite the article to which they refer, specifying to what class of customers such discounts are applicable. Whenever the name of a new customer is put on the firm's books, record should be kept of the class to which such customer belongs; the order clerk being supplied with a similar catalogue, these two books alone, supplemented by the index showing the class in which the customer's name has been placed, should be recognized as authority to quote a discount or make a price.

From the time an order is received from a customer until complete or final shipment has been made, the factory office should be in constant touch with each article being manufactured, and should know at all times the exact status of each and every order and the location of the goods called for. In the case of goods being especially manufactured this necessitates considerable detail, and to do it satisfactorily by means of bound books is almost impossible. By the use of cards, however, ruled and printed to suit the circumstances prevailing in each case, the information may be procured in such manner that it will reach the factory office almost automatically.

A card should be made out for each manufacturing order issued, and kept in a card cabinet arranged numerically until the article called for has been delivered to the stock or shipping room from the shops. It is then transferred to another cabinet and becomes a record of finished work. Form 1 is given as an example of the ruling and print-

Section of Index	Order No.
Index	For
Sub-Index	Date

Order

Wanted for

Route of Manufacture.		Transfers and Deliveries.
Drawing Office	1	
Pattern Room		
Shop A.	2	
" B.		
" C.	3	
Photo. Room	4	
Stock "		
Shipping "	5	

REMARKS:

FORM I. ORDER CARD—FRONT.

ing on these order cards; it of course must be adapted to suit special requirements. These cards must be made out by some one thoroughly familiar with the work, who indicates, in the column opposite the names of the departments or shops, the sequence in which the material must be sent from the time the order is put in hand until completion of the goods. The card which accompanies through the shops the articles being manufactured is practically a duplicate of this, thus showing the foreman of each department to which department he must send the material when he has completed his work upon it. In the example given, the order is evidently sent first to the drawing office, then to shop "A," then to shop "C." The card also shows that the management requires a photograph of the article before it is shipped.

When all or part of the goods called for by order are transferred from one shop or department to another, a transfer card, Form 2, is made out and sent with such article. The only writing required on this card is the shop letter and the order number and quantity, the date being stamped in when the card ultimately reaches the factory office. The foreman of the shop or department receiving the goods signs for them, and the card is taken back to the shop from which they have been sent; it is there placed in a box from which it is taken to the factory office at certain hours each day, and on receipt the date is stamped on it. The card showing transfers from one shop to another may then be filed behind the corresponding order card, or the information on them may be noted in the spaces opposite the shops concerned. If conditions are such that a large number of orders go through the shops and reach the stock room in a very short time, the former will be found the better plan as regards all cards excepting those showing final delivery to shipping rooms; these are noted on the order card, and in the case of delivery to shipping room the card reporting such delivery is handed to the billing clerk. If this plan is adopted 5 inches by 3 inches will be found a suitable size for the order card. If all the various transfers of the material throughout the factory are to be noted on the card, 6 inches by 4 inches will be better. Reference to the cabinet containing these cards will thus show the exact location of the goods being manufactured.

Where there is constant trouble in getting goods out in a reasonable time, it will usually be found that some one shop or department is responsible for practically all of it. In such cases the first step to remedy the trouble is to locate it. This may be effectually done by keeping all the transfer cards showing delivery to the shop it is desired to watch, with cards showing deliveries from that shop, in a tray or card-drawer, sorted by order number and filed behind guide cards indicating the date the goods reached the shop in question and the date on which they were delivered from it. The result will be an index forcing attention to the date on which the articles have been received by the shop, the length of time they were retained, and the date they were passed on to the next department. A glance over this index each morning will show if goods are being pushed through with all the promptness and judgment possible. The question of giving to certain orders priority over others of an earlier date is one upon which the management of the factory office will find room for the exercise of its best judgment and discretion. Any promise or *implied* promise of delivery on a certain date is entered in a scribbling diary under that date; daily reference to this book and to the card index of orders will show how the various articles are progressing. If they are found to be getting behind, the card which was made out when the order was first put in hand and sent to the shop with the material is called in and replaced by a similar card of bright red color containing exactly the same information, and also the required date of delivery. Other things being equal, an order with the red card always has precedence over those with cards of the ordinary color. Care must be taken, however, not to use these "rush" cards to such an extent that they become so familiar as to be ignored.

Of the transfer cards received at the factory office, the only ones put to further use are those showing delivery to the shipping room. After being noted on the order card these are handed to the billing department, where they are kept until advice of shipment has been received and charge has been made against the customer; the date, day-book entry number, and amount charged to customer for the articles they represent are then entered on them, and they are returned to the clerk in charge of the order cards. A close watch upon the transfer cards in possession of the billing department and the dates thereof will enable the factory office to secure shipment to customers immediately after the completion of manufacture.

On receipt of transfer cards showing delivery to stock or shipping room, the order card is removed from the index of orders in progress; the cost is made up and entered on the reverse side, which is ruled as in Form 1A*, and the cards are filed away as records. When the transfer card is returned from the billing clerk the selling price, day-book entry number, and date, as shown, are entered on the order card

* In the case of goods manufactured for stock the right-hand side of the card is left blank, or may be used as a record of prices current at date of manufacture.

Date Finished | Order No

Entered Record Book No.______Page

COST					SOLD						
					Date	Quantity	Entry No.				
Material,	0	00									
Wages,	0	00									
Shop Expenses,	0	00									
Total cost in stock,			0	00							
Selling Expense,			0	00							
TOTAL,			0	00				TOTAL, . .			

REMARKS:

Examined,______________
Fact'y Acc't.

FORM I A. BACK OF ORDER CARD FOR GOODS MANUFACTURED FOR CUSTOMERS.

			Order No.
DATE			
FROM	Shop Dept.	Shop Letter	
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REMARKS			

FORM 2. TRANSFER CARD.

It will be seen that Form 1 is so ruled that the article manufactured can be classified by section, index, and sub-index. All the particulars on Form 1 A being entered in a record book, the card is then filed permanently away. If the book record is arranged according to article, the card must be filed alphabetically, according to customer's name. If, however, the record book is so laid out as to keep together the records of all goods manufactured for the same customer, the card is filed according to article. The latter is the better plan, as it enables order cards representing goods manufactured for stock to be filed with those representing similar goods manufactured for customers, thus keeping all cards for the same article together. An intelligent use of variously colored guide cards for section, index, and sub-index will afford instant access to all records of costs for the same article or class of goods for any given period. This plan, besides enabling the factory office to follow the orders closely through the various stages of manufacture and to secure prompt shipment, totally eliminates all possibility of shipping any article manufactured for a certain customer and failing to make a charge. It also provides a double record of both cost and selling price of each article so manufactured and shipped, and also the cost of all articles manufactured for stock, this information being readily obtainable from the record book when looked for by customer's name, and from the cards when looked for according to class and name of article.

There are many smaller matters in which attention to a customer's interests may result in establishing relations that will ultimately secure a larger share of that customer's trade than might otherwise be had. All acknowledgments of orders received should quote the number which has been given the order, with the request that in any further correspondence that number may be referred to. When shipment is made of any article for which the invoices cannot be sent forward at once, a memorandum of quantity and route of shipment should be mailed at once; this will enable the customer to check and stock the goods immediately on receipt. These and many other little things will more than repay the time they occupy, by tending towards that good feeling between the concern and its customers which goes so far to help the traveling salesman in his work. There is many a man on the road today who could sell more goods, and sell them to better advantage, if he knew that "the house" would at once either ratify and live up to any promises he might make, or else on receipt of the order promptly advise the customer that to do so was impossible. On the other hand, a better understanding would result if travelers would make promises only condition upon approval of the management. These, and many other matters small individually, may in the aggregate seriously affect the feelings of "the trade" towards "the house" and, as a result, the volume of business done.

In a previous article I endeavored to show how a factory office, efficiently organized and properly equipped, may be of great benefit to both the stores and the shops. The plan there outlined of keeping record of the supply and demand for finished parts, and of watching the amount on hand of special articles, may with advantage be applied to many standard lines of stock. Given a factory office operated on the lines indicated, absolutely independent of both the superintendent of works and of the commercial organization, responsible alone to the executive —and with the right man in control—the results will be a smoother and more rapid working of all the departments and shops, from the pattern room to the plating room, from the foundry to the finishing shop. A close watch will be kept upon purchases, a saving of time in obtaining desired information will be effected, and the mechanical and material departments will be practically relieved of all clerical work. In addition to these results, which are in themselves direct factors of cost reduction, detailed and classified records of all costs, expenditures, and expenses will be constantly undergoing comparison with like results of previous years. It lies with the executive to obtain the greatest value from such records by their use as guides for other operations.

THE PROGRESS OF ECONOMY IN MARINE ENGINEERING.

By Walter M. McFarland.

IV.—ECONOMIES PARTICULARLY AFFECTING NAVAL ENGINES.

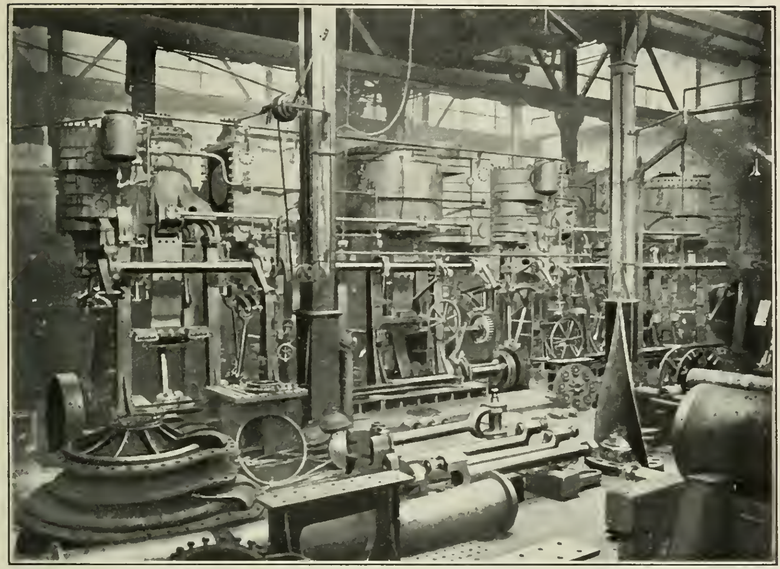
This article concludes the fine series by Mr. McFarland which began in The Engineering Magazine for March, 1902. The four numbers constitute a wonderfully interesting and luminous review of one of the most remarkable developments of the last century. Marine engineering, more clearly perhaps than any other branch of mechanics, shows the commercial value of applied science. Within the period covered by Mr. McFarland's study, the fuel consumption of the steamship has been cut down until the economical marine engine of 1902 gives ten times the power per pound of coal that was given by the engine of 1825.

Mr. McFarland's first article dealt with the simple engine and the work of the pioneer investigators; his second paper covered the period of the compound engine; the third took up the development of the multi-expansion engine; in this concluding article he sums up and traces the progress to the very latest epoch—the appearance of the successful steam turbine. —The Editors.

EARLIER in these articles, mention was made of the fact that the engines of naval steamers have been modified from time to time to conform to the general progress in marine engineering, but it is now proper to note a very marked difference between the conditions under which the two classes of engines operate. The merchant steamer, as an almost invariable rule, runs at a uniform speed for which the engines have been designed, so that they work constantly under maximum conditions and they can be so designed within reasonable limits as to give the highest economy under those conditions. The naval vessel, on the other hand, is designed to secure a very high maximum speed which it is expected will be called for only occasionally, while almost the whole of her cruising is done at a speed varying from a little more than half the maximum down. This means that the engines of naval vessels ordinarily develop only about one-eighth of full power, or less, although the capacity must be provided for full power. Particular stress has been laid in these articles upon the fact that even with high pressures expansion cannot be carried beyond a very reasonable degree without entailing serious loss from liquefaction, and a very little consideration will show that, altogether apart from this feature, it would actually be impossible to cut-off short enough in the high-pressure cylinder to give the reduced power necessary when working with full boiler pressure. So long as the maximum speeds of naval vessels did not exceed fourteen or fifteen knots, the reduction in power for a cruising speed of, say, ten to eleven knots, did not entail a very serious decrease of economy, because by some reduction in the boiler pressure and some increase in the ratio of expansion it was possible to get the desired power; but when maximum speeds had risen to twenty knots and upwards, while cruising speeds were from ten to twelve knots, the problem was changed and became immensely more difficult.

Several methods have been proposed and tried for securing good economy, both at maximum and at reduced powers, to which we shall refer immediately, but it may be said that the reduced power is obtained by a reduced boiler pressure and a great amount of throttling, with some increase in the ratio of expansion. The result is certainly anything but economical, because the coal per horse-power hour with triple-expansion engines under these conditions will be in the neighborhood of three pounds. It is possible that somewhat greater economy might be obtained by lowering the boiler pressure still more, opening the throttle wider, and increasing the degree of expansion, but practical considerations make it desirable that the boiler pressure should not be reduced too low. It often happens in handling the vessel that an increase of speed of several knots for ten or fifteen minutes is very desirable. With the higher boiler pressure it is perfectly practicable to secure this, as the pressure will not be run down too low during the spurt.

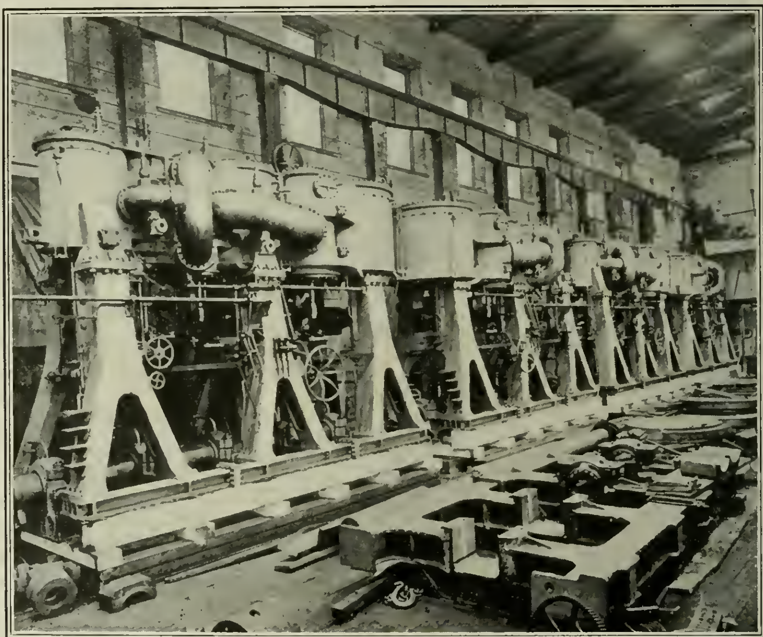
One method of securing economy at cruising speeds was adopted in the U. S. S. Maine (which was destroyed in the harbor of Havana in 1898) and it was also tried in a Russian vessel about the same time. This consisted in arranging the engines with the low-pressure cylinders forward and with a coupling in the shaft so that the low-pressure cylinders could be disconnected, leaving the working engine as a two-cylinder compound on each shaft. The Maine was not in commission long enough to have a thorough opportunity for testing the economy of this method, as compared with that of using the whole triple-expansion engine, although such experience as was obtained tended to indicate that there was no very great saving. The same system was used in the U. S. S. Nashville, which has quadruple-expansion engines arranged to be worked as triple-expansion for low powers. The maximum speed of this little vessel is only about seventeen knots, and as ordinary cruising is at from eleven to twelve



ONE SET OF TWIN-SCREW INVERTED TRIPLE-EXPANSION ENGINES FOR H. M. S. BLAKE.
Built by Messrs. Maudslay, Sons, & Field. Photo. by courtesy of John Sampson, Esq.

knots, the increased economy due to the use of the smaller engine is not very marked.

In the U. S. S. New York and Brooklyn and H. M. S. Blake and Blenheim another method is used, by which the gain in economy is unquestionable. These are all large vessels with engines from 16,000 to 20,000 horse power, and they were designed with two complete triple-expansion engines on each shaft, the idea being that at anything below half power only one set of engines on each shaft would be used, and this is actually the practice in ordinary cruising. The greater economy due to using an engine of 4,000 horse power maximum to develop 1,000 horse power, as compared with the same horse power developed from two engines with a maximum power of 8,000, is so obvious that no attempt has ever been made to compare the two. From the standpoint of economy alone this system is admirable, but the multiplication of parts, the great space occupied, and the likelihood of unequal wear when one engine on a shaft is used much more frequently than the other, are serious objections. Special objection to this type of engine was developed at the time of the naval battle of Santiago. On both the New York and the Brooklyn there was a comparatively simple coupling for connecting the two engine shafts, but it required about half an hour to perform the operation. During blockade both the New York and the Brooklyn had been kept under half power, using only the after engines. When Cervera's fleet came out so unexpectedly, it was not deemed wise to lose half-an-hour in coupling up, so that it was possible to work the engines up to half power only. The poor work of the Spanish engineers rendered this lack of efficiency less important than it would have been had the enemy's fleet been possessed of skilled engineers; but the lesson was learned and this, added to the other objections already mentioned, renders it unlikely that this type of engine will again be used.



TWIN-SCREW ENGINES OF THE U. S. S. NEW YORK.

Each set is divided into two complete engines, giving full power when coupled or half power when uncoupled and the rear set only in use.

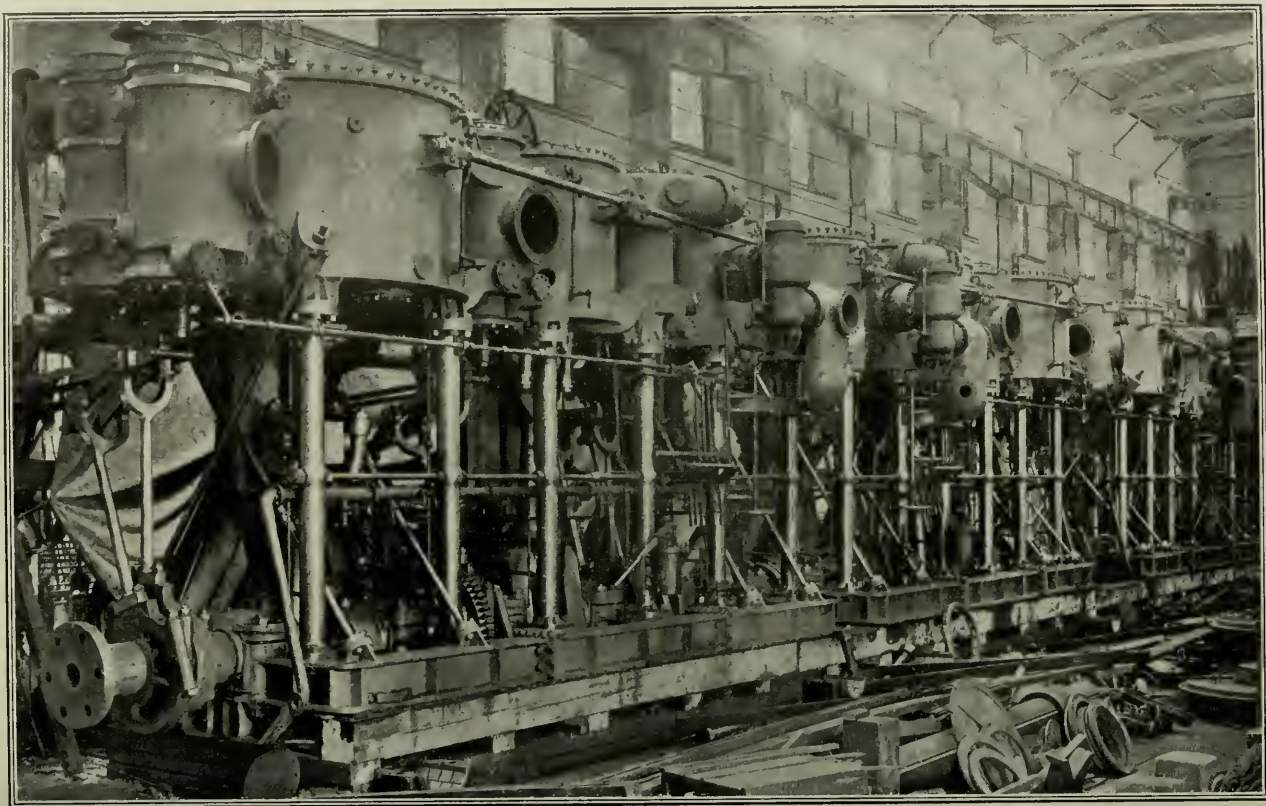
Ships with three screws are now becoming favorites in a number of the European navies, and they possess some special advantages for war vessels which would seem to render this type the best one for large high-speed ships. They were first* used in some small torpedo vessels for the Italian navy, and their efficiency at full power was satisfactorily demonstrated. A series of very careful experiments was also conducted on a French steam launch called the Carpe, which

* Four screws were used on some very light-draught river steamers in the American civil war, called "tin-clads."

REAR ADMIRAL GEORGE WALLACE MELVILLE, U. S. N.

Engineer-in-Chief 1887 to date. During his administration the Department of Steam Engineering, U. S. N., adopted the uniform policy of making their own designs. Up to 1900 his administration had prepared designs for 120 ships and 700,000 horse power.

gave a great deal of valuable information to designers, and, as a consequence, the Dupuy de Lôme was built for the French navy. The Kaiserin Augusta was also built for the German navy. About this same time (1890) in the American navy it was decided to build a very fast commerce destroyer, which was wittily named the "Pirate" by Chief Engineer Towne, who was then one of Admiral Melville's assistants. When Admiral Melville considered the question of designing the machinery for this vessel he decided, after careful study, that it would be best to use triple screws for structural reasons. I



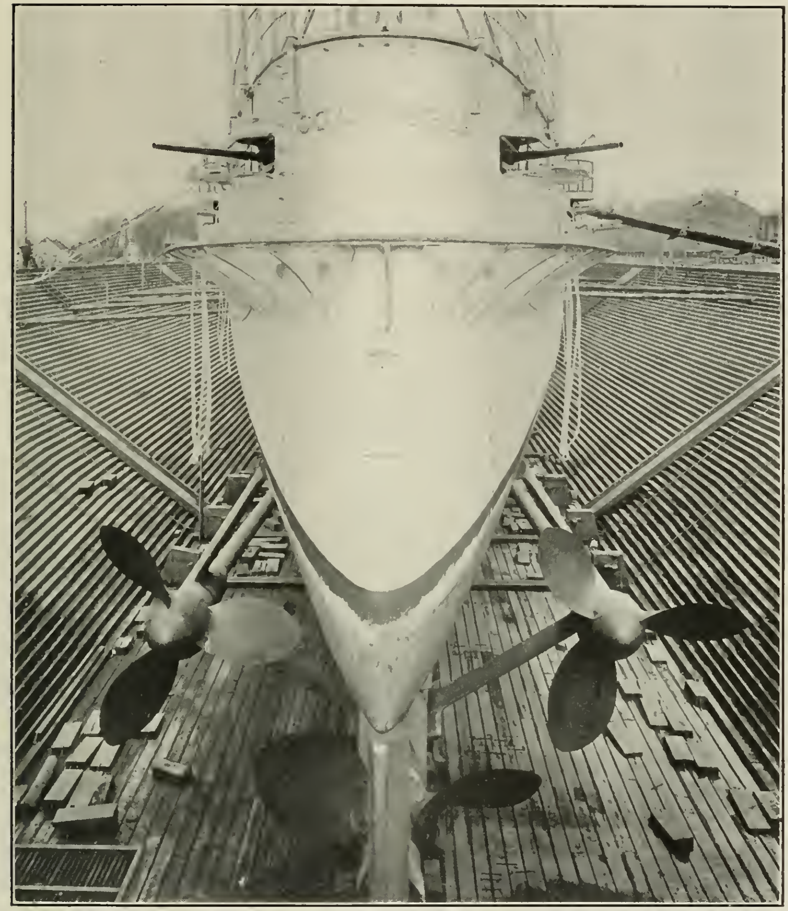
TRIPLE-EXPANSION ENGINES OF THE U. S. S. MINNEAPOLIS, IN THREE SETS, ONE FOR EACH OF THE THREE SCREWS.

was at that time one of his assistants, and have frequently heard the admiral express himself in detail as to his views of the design. He did not anticipate any economy at maximum power, and, on the contrary, was prepared to accept as probable the predictions of professional friends of eminence that the use of triple screws would be found to require a greater expenditure of power than would be required with twin screws. It was anticipated that there would be a gain in economy at low powers from using one engine, while the screws of the two idle engines would be disconnected and allowed to revolve freely. When the Columbia was tried it was found, to everybody's great surprise, that there was actually a decided economy in the power required to obtain the maximum speed; or, in other words, the speed attained for the power developed was much in excess of what had been anticipated. Before the Columbia was tried, the second triple-screw ship—the Minneapolis—had been designed, and her trial confirmed the experience gained with the Columbia.

The fact of the unexpected relation of speed and power on these two ships is undoubted, but the explanation that it is due to the use of triple screws is not universally accepted. The British navy has never built a single triple-screw ship, and it is asserted that tank experiments have shown that the same hull when driven by twin screws would give better results than when driven by three screws. The Italian navy has likewise never built any triple-screw ships of large size, although, as already stated, they were the first to use this method for vessels of high speed. On the other hand, the French, German, and Russian navies have built and are building large numbers of vessels with triple screws, showing that they believe this type to be the best. Just why the use of triple screws has never been repeated in the American navy is difficult to say, although possibly it may be attributed to the same influence which came so near causing the battleships contracted for in 1898 to be of sixteen knots speed while all the rest of the world were building them of eighteen knots. It is well-known that Admiral Melville is an ardent advocate of their use, but his influence alone does not seem to be sufficient to secure their adoption.

With respect to the matter of economy at low powers from the use of but one engine, the results at first were not entirely satisfactory. An analysis of the records of the Columbia and the Minneapolis, and particularly of the extended trials of the Kaiserin Augusta, goes to show that it is somewhat more economical in coal required to make a given distance to use two engines rather than one This appears, however, to be due to the fact that these ships were all built with the three engines of the same size and with the same sized propellers. The single screw under these conditions has an abnormal amount of slip, running up to more than 30 per cent. The steam economy is materially higher—that is to say, the cost of a horse power in coal is decidedly less—but owing to the abnormal slip of the propeller, the horse power required is so much increased that it more than offsets the decreased cost per unit of power. In 1899 Admiral Melville read a paper before the Institution of Naval Architects in London, in which he proposed a different arrangement of the three screws, making the center engine half the total power and the wing engines each one-quarter. While this arrangement of triple screws has not thus far actually been applied in any ships, the experience gained with the other triple-screw ships, and the knowledge of the conditions necessary for efficiency in propulsion, all indicate that this is a combination which possesses great advantages from every point of view. The propeller of the center engine would be sufficiently large to keep the slip within reasonable limits, and the conditions as to steam economy would be more favorable than in the case of the after engines of such ships as the New York, because there would be the absence of the radiation and liquefaction losses due to two sets of engines as compared with the one of the center screw. At the same time, it would be possible to use the two wing engines, which would be in exactly the same condition as the after engines of the New York—that is, half the total power—except that they would have to drag the idle propeller of the center engine. From a tactical standpoint, the three-screw ship has the enormous advantage that it would not be necessary to lose any time in connecting up the idle engines. It was found by actual test on the Minneapolis that it was possible to connect the center screw when the wing screws were driving the ship at the rate of seventeen knots, so that this is a very decided merit in this arrangement of machinery.

Another point of difference between naval and merchant steamers is in the auxiliary machinery. For convenience in handling the main engines, which is of vital importance in a war vessel, all the auxiliaries of naval vessels are independent, while in all of the smaller merchantmen, and in some quite large ones, all such auxiliaries as the air pump are worked from the main engine. Most of these independent auxiliaries, for simplicity and convenience, have hitherto been operated almost entirely by simple engines using steam with scarcely any expansion, and even where the air pumps have had compound engines



STERN VIEW OF U. S. S. COLUMBIA IN DRY-DOCK, SHOWING THE ARRANGEMENT OF THE THREE SCREWS.

By courtesy of the Wm. Cramp & Sons Ship & Engine Building Co.

the speed is so slow that the economy is very low. At maximum powers the steam and coal expenditure for the auxiliaries is not of so very great importance, but at cruising speeds the percentage of the total coal expenditure due to the auxiliaries rises to a very appreciable figure. Professor Hollis of Harvard University, in a lecture before the Naval War College (in 1892), while he was still an officer in the navy, gave some very interesting data on this point with respect to the machinery of the U. S. S. Charleston. From these it appears that when the main engines were working at half power the coal for auxiliaries was 21 per cent. of the total coal used, while at one-eighth power, for ordinary cruising, this percentage had risen to 34. One of the methods proposed for making the auxiliaries more economical is to deliver their exhaust to one of the receivers of the main engine, from which it can be used economically in the other cylinders, and an extension of this principle is to have the auxiliaries take steam from the first receiver and exhaust into the second, which would make them in effect a part of the intermediate cylinder of the triple-expansion engine. My attention has been called to a saving of some five or six tons of coal per day on one of the large American cruisers, due to turning the exhaust of the auxiliaries into the low-pressure receiver, when the total coal used was some sixty tons per day. Another method of securing economy is to have the exhaust from the auxiliaries pass through a feed-water heater, and this method has been adopted in some of the later ships.

So far as can be seen at present, it would appear that the simplest and most economical method of operating the auxiliaries which are actually in the engine and fire rooms is by steam, although, as has been noted, in the past these auxiliaries have nearly all been simple engines, and there may be cases where they could be compounded to advantage. For the auxiliaries outside of the machinery compartments, electric driving has been seriously considered, and in some cases has been tried with considerable satisfaction. The experience with electric transmission on shore would indicate that this method of driving the outside auxiliaries ought to give great satisfaction, both on the score of economy of operation and the avoidance of long leads of steam and exhaust pipes through living quarters and other places where they are undesirable. Thus far the electric machinery installed on board ship has been exclusively of the direct-current type, as the electric experts in the navy have been remarkably conservative. The present practice on shore for power plants is almost entirely to use the alternating current with induction motors, and these seem peculiarly adapted to the conditions on board ship. When some navy shall have been sufficiently progressive to use these motors and give them a thorough test, it seems probable that it will lead to their general introduction. The remarkable simplicity of induction motors and their ability to withstand rough usage and neglect make them particularly adapted for use in situations where their manipulation would fall into the hands of people who are not trained mechanics, as is the case with the deck force on board ship.

The subject of forced draught has already been discussed, but it may be interesting to note that, while with the use of forced draught to an appreciable extent (that is to say, where it gives a material increase in the amount of coal burned) the economy of steam production is reduced, the moderate application of artificial draught, or, as it is sometimes called, "assisted draught," is really attended with a slight economy. This seems to be due to the ability to regulate the amount of air required for combustion more closely than will ordinarily be the case with simple chimney draught. In my own experience this was tested on the U. S. S. San Francisco, where it was

H. M. S. BLAKE—PROTECTED CRUISER, I CLASS, 20,000 HORSE POWER, 21 KNOTS.
The ship is 375 by 65 by 25½ feet, 9,000 tons displacement. She was built at Chatham in 1889 and engined by Messrs. Maudslay, Sons, & Field. The engines, shown on page 393, are in two complete triple-expansion sets on each shaft. Photo. copyrighted by West & Son, Southsea.

found that the revolutions could be increased from sixty to sixty-two per minute with exactly the same consumption of coal by running the blowers gently on the closed ash-pit system as against natural draught. The men enjoyed this plan, and the steam pressure could be kept much more uniform than under plain natural draught. All persons interested in the great Transatlantic steamers must have noticed that in the last ten years there has been a tendency to use funnels which are much higher than formerly. The first vessel to adopt this method of increasing the draught was the steamship Scot, of the line running to the Cape of Good Hope. This, of course, is simply adapting to steamers what had been the practice for many years on shore, where tall chimneys had been the rule. For naval vessels this has the added advantage of increased cleanliness, because with the tall funnels the particles of dust and soot are carried clear of the ship, while with the short funnels they are likely to dirty the after decks. The Brooklyn was

THE PROTECTED CRUISER KAISERIN AUGUSTA, OF THE GERMAN NAVY.

Built at Kiel, 1892. 388 by 49¼ by 23 feet, 6,300 tons displacement; 12,000 indicated horse power (forced draught), 20.7 knots. Like the Minneapolis and the Columbia, she has triple screws driven by three triple-expansion engines. Steam is furnished by eight double-ended cylindrical boilers.

the first of the American vessels to have these tall funnels, but since then it has been common practice. Roughly speaking, each additional ten feet of height in the funnel increases the draught by an amount equal to an air pressure of one-eighth of an inch of water, so that an additional forty feet of height would be the equivalent of about half an inch of air pressure. In the case of the Brooklyn it was estimated that this (half an inch air pressure) would be equivalent to an increase of power sufficient to raise the speed from about sixteen knots to seventeen and one-half knots. It should be noted that this increased height of chimney is a more economical method of getting increased combustion than the use of blowers, as it involves no attendance, no steam expenditure, and no cost for lubrication and for repairs.

A subject which is of great interest to all who study marine economy is the use of liquid fuel, and it is appropriate in these articles to discuss this subject briefly. It is well known that crude petroleum is not adapted to use on board ship on account of its containing volatile constituents, which at moderate temperatures are given off, and which involve serious danger because some of them form explosive compounds. Under special circumstances the use of crude petroleum might be permitted, but certainly on naval vessels it is entirely inadmissible. The refuse which remains after the distillation of the crude petroleum is, however, perfectly safe, and it resembles in appearance and some properties the oil used for cylinder lubrication. This refuse has a high calorific value, giving about 21,000 thermal units per pound, which is about one and a half times the calorific value of the best steam coal. Notwithstanding the lower density of the oil, the fact that there is absolutely no waste in stowage enables about the same weight of oil to be stowed in a given space as of coal. To burn this refuse successfully it has to be sprayed, or atomized, either by a jet of steam or by the use of compressed air, and under moderate rates of combustion it gives highly satisfactory results, as the combustion is complete and there is neither refuse nor smoke. The reduced personnel required to handle boilers with fuel oil, and the ease and cleanliness with which it can be taken on board, all tend to commend it very highly. Under existing conditions there are, of course, the objections to the use of liquid fuel that it can be obtained in only a few places, and that any attempt to use it on a large scale would probably raise the price to such a degree as to make its use very much more expensive than that of coal. Some years ago one of the great American railroads was considering the use of liquid fuel for trains running through thickly populated districts. Experiments showed that, as far as manipulative considerations were concerned, it was a great success; but when the question of the amount to be used came up it was found that if this road had attempted to use petroleum refuse alone, it would have taken up nearly the entire amount available in the United States at that time.

Notwithstanding these considerations, the obvious advantages of liquid fuel have made it seem peculiarly adapted to use on torpedo-boats, and during the last few years Admiral Mellville has been carrying out experiments to decide the question and to find by actual practice just what advantages would accrue. It may not be amiss in this connection to remark that, on the whole, the simplest method of spraying the oil is by the use of steam, and that this is entirely practicable in spite of the commonly held opinion that sea-going vessels could not afford to spare the fresh water required. The Italian experiments* of about 1892 demonstrated that the steam required for spraying is less than 2 per cent. of the amount evaporated in the boilers, so that evaporators to make up the necessary amount of fresh water would weigh less than the air-compressing machinery which would be necessary if air were used for spraying. The pre-

* See paper by Colonel Soliani in Proceedings of Engineering Congress at Chicago, 1893; published by John Wiley & Sons, New York.

liminary experiments on the torpedo-boat Stiletto, at moderate powers, were very promising and enabled an excellent form of atomizer to be thoroughly tested. After the close of the Spanish war the experiments were resumed upon a small sea-going torpedo-boat called the Talbot, but when the effort was made to get as good results as had been obtained with coal, a difficulty was encountered which had developed in previous experiments with liquid fuel, namely, that, as far as experience has gone, it seems impossible to get as great a power out of a given boiler plant with oil fuel as can be obtained with coal. Admiral Melville states in his report for 1900 that the highest power obtainable on the Talbot was only about three-fourths of that obtained with coal, and this last for only a short time. There was also another serious objection which had not been anticipated, namely, that at this power there was a great deal of smoke. It thus appears that, in spite of its many promising features, liquid fuel is not likely to play any large part in marine engineering. It has long been used on the steamers of the Caspian Sea, which are near the Baku oil fields, and it is quite likely that steamers which operate near the newly developed oil fields in Texas may also use it, but it does not seem possible that it can play any large part.

Any series of articles treating of marine machinery would be incomplete which did not make some mention of the new motor which is attracting so much attention, and which at last has been applied to a commercial vessel, namely, the steam turbine. This invention of the Hon. C. A. Parsons, of England, has been developed by that gentleman from a light but extremely wasteful engine to one which compares in economy very favorably with all but the most economical engines of the ordinary type. For marine purposes it was first used in a little vessel of the torpedo-boat class, called the Turbinia, in 1897, and the results there obtained in the way of enormous speed for such a small hull and great power on light weight were so phenomenal that two larger vessels—the Viper and Cobra*—were afterwards built to give it a further test. The Turbinia was only of 44.5-tons displacement, and there were three shafts driven by three turbines, each of the shafts carrying three propellers in tandem. The revolutions were 2,100 per minute, and the horse power developed 1,576. The Viper and Cobra had four shafts with two propellers on each, and the aggregate horse power developed was about 11,000. The steam pressure was 165 pounds and the revolutions about 1,050 per minute. There were two sets of compound steam turbines for driving the vessel

* These vessels have both been wrecked.

THE TURBINE-ENGINED STEAMER KING EDWARD ON THE FIRTH OF CLYDE.

250 by 30 by 10½ feet, 20.48 knots, estimated horse power 3,500. Built by Messrs. William Denny & Brothers, and engined by the Parsons Marine Steam Turbine Co., Ltd.

ahead, and special smaller turbines were provided for driving the vessel astern. The speed obtained by these vessels, which were of 370 tons displacement, was about 37 knots, which is considerably higher than the maximum speed attained by any vessel driven by ordinary engines.

It is, of course, somewhat difficult to get exactly the horse power of these engines, as the ordinary indicator cannot be used and the horse power has to be estimated from the known results in similar vessels driven by ordinary engines. In America the Westinghouse Machine Company is building these turbines for driving electric generators, and experiments have been made on some turbines of more than 400 horse power which showed a steam consumption of 18.8 pounds per kilowatt hour, which, by allowing for the known efficiency of the generators and for the usual efficiency of good engines of the ordinary type, would be equivalent to 14 pounds per indicated horse power in an ordinary engine. These results are for full-power conditions. At half power the steam consumption had only increased to 20.7 pounds per kilowatt hour, or, as already explained, 15.4 pounds per indicated-horse-power hour.

The firm of William Denny & Brothers of Dumbarton, Scotland, who are well-known for their great progressiveness, have recently built a vessel called the King Edward, which is an excursion steamer for plying on the Firth of Clyde, and which is the first commercial vessel to be fitted with turbines. While no reports of specific tests of the performance of the King Edward have been published, the comparative statement given below of the performance of the Duchess of Hamilton and of the King Edward gives a good idea of the economy of the turbine:—

COMPARATIVE STATEMENT OF SPEED, MILEAGE, AND COAL CONSUMPTION OF THE PADDLE STEAMER DUCHESS OF HAMILTON AND THE S. S. KING EDWARD.

	Duchess of Hamilton.	King Edward.
Total coal	1758 tons 13 cwt.	1429 tons 16 cwt.
Miles run	15,604	12,116
" per ton	8.87	8.47
Number of days running	111	79
Daily average consumption	15 tons 17 cwt.	18 tons 2 cwt.
Average speed	about 16½ knots.	about 18½ knots.

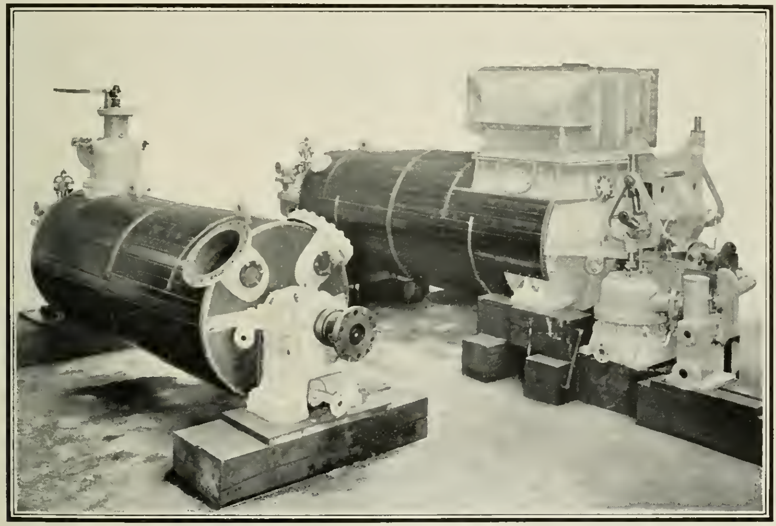
The Duchess of Hamilton is one of the crack boats on the Clyde, so that her performance may be considered as representative of excellent economy for machinery of the ordinary type. We have not the data of the dimensions of the two vessels at hand, but if they were of about the same displacement the increased speed of the King Edward would justify an increased expenditure of 40 per cent. in coal. As a matter of fact, the increased coal expenditure is only about 14 per cent., thus showing a decided economy for the steam turbine.

The performance of the King Edward has been so satisfactory that it has been decided to build another boat of the same type, although somewhat larger, her length being 20 feet greater and her speed 21 knots. The Parsons Marine Steam Turbine Company have also on hand at the present time turbine machinery for three high-speed yachts, the largest of which is for Mr. A. L. Barber, of New York, and is to be of about 1,400 tons, yacht measurement. The turbines will develop 3,500 horse power.

It is most unfortunate that both the Viper and the Cobra were lost at sea before there had been time to gain experience with their machinery under the conditions of regular service, but it is interesting to note that the Parsons Company are building another destroyer which will have about the same speed as the Viper but which is designed to have a superior performance to hers in regard to coal consumption at cruising as well as at higher speeds.

The advantages of the turbine are the reduced weight of machinery due to the very high rotational speeds, the reduction of vibration, the smaller amount of space required, and the relatively small attention needed for adjustment. A further advantage is the complete immunity from any danger due to priming, or carrying over of water from the boilers, although in modern engineering this is of very infrequent occurrence. Mr. Parsons has devoted great engineering ability to the development of the turbine, and he believes that it is destined ultimately to supplant the ordinary type of engine. Whether this will prove true or not, the remarkable successes of the boats in which it has been fitted make it worthy of very serious consideration.

We have now concluded our brief survey of the growth of economy in marine engineering. The subject is one that covers so many details that it has been impossible to consider them all, and undoubtedly it will be found that some subjects have been given but scanty notice. This, however, is unavoidable in any consideration of the subject which would not be so elaborate as to preclude its appearance in the pages of a magazine. The progress which has been made in less than a century is enormous, as the figures already given of a reduction in coal expenditure from ten pounds to one pound per horse-

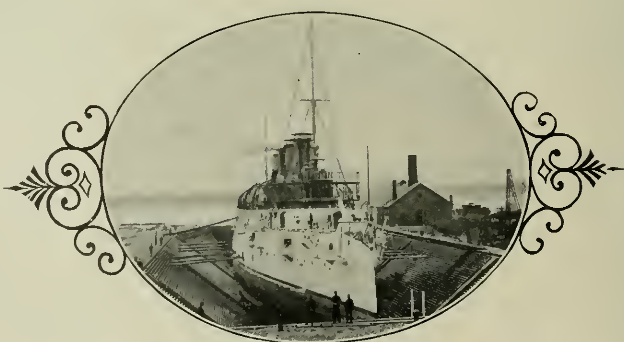


THE TURBINE ENGINES OF THE STEAMER KING EDWARD VII.
Photo by Parry.

power hour show very strikingly. We hear a great deal about the inefficiency of the steam engine when the comparison is made of the useful work done with the total calorific value of the fuel used. This, however, is a very unfair comparison, because there are natural limitations to the heat engine which effectually prevent the ratio of the useful effect to the total energy of the coal ever rising very high.

In the case of the steamers Inchdune and Inchmarlo, which have already been quoted, the thermal efficiency of the engine is 23.7 per cent. The efficiency of a perfect heat engine working between the same temperature limits is 43 per cent., so that the real efficiency of these engines, or the ratio of their efficiency to that of a perfect engine, is 55 per cent.

When we consider the way in which the more recent reductions in coal expenditure have been secured and the perfection of the machinery now used, it is certainly difficult to suggest any lines along which future increase of economy is likely to occur. Suggestions have been made by some of the talented leaders in the profession, but it has been found very difficult in practice to make some of them workable, and the practical side of marine engineering limits others. There has been a mutual interaction of land and marine engineering in the adoption of improvements, and we may expect this to continue. We cannot believe that finality has been reached, because there have repeatedly been periods when the machinery as then developed seemed to the engineers of the time as nearly perfect as that now existing seems to the engineers of today. We may sometimes be inclined to think that the geniuses in engineering passed away in the early days, but this is undoubtedly only because the general level of engineering ability and knowledge is so vastly higher than it was in the early days of the marine engine. While any such actual decrease in coal expenditure arithmetically as has occurred in the past is obviously impossible, we may still expect that there will be an increase of economy which will give a percentage decrease in expenditure comparable to what has already occurred. The engineers of the past recorded many great triumphs, and we cannot doubt that their successors will make a record which will show that professional skill has steadily advanced.



MONEY-MAKING MANAGEMENT FOR WORKSHOP AND FACTORY.

By Charles U. Carpenter.

V.—A SYSTEM OF STOCK-TRACING, INSPECTION, AND SCRAPPAGE.

Mr. Carpenter's articles began in The Engineering Magazine for February, 1902, the first and second papers dealing with factory organization in its general principles and concrete examples. the third with departmentalization and systematization of the works, and the fourth with the stock department and its systems. This phase of the subject he concludes in the present number. Mr. Falconer's article on pages 386-394 is an interesting supplement to Mr. Carpenter's discussion.—The Editors.

A LACK of an efficient stock-tracing system is very common. Many manufacturers have become so accustomed to delays in getting finished parts to the final assemblers that they regard these delays as unavoidable, even though such delays and the consequent losses show very clearly that some very efficient system is necessary. But important as is the avoidance of delays, it is but one of the important functions of stock tracing. These functions might be analyzed as follows:

A. Putting the stock through the machine rooms, or producing rooms, in such time and with such regularity as to prevent delays to assemblers.

B. So directing the machining or producing of parts that the entire factory is working to the best advantage.

C. Keeping up of records that will show immediately, first, the location of stock in the factory; second, time required by the different departments; third, the cost of the labor together with the workman's time and name; fourth, all losses with the reasons for them.

D. Directing the transportation of all stock in the factory.

Even a slight consideration to this subject as outlined in the subheads will show its great importance, not only for getting out individual jobs, but also for efficient factory management in its broadest sense.

I strongly urge the formation of a stock-tracing department upon which the *sole responsibility for such important work is placed and to which the authority necessary to carry out the work is given.* The responsibility for getting out work on time, and the care and worry incident to securing it from the different departments at the proper time, should be taken away from the foremen entirely. It is absolutely impossible to leave such duties to the foremen to carry out and to have the factory itself run to the best advantage. The foremen's work should be confined to their own department strictly, and their chief concern should be, and their greatest value is, securing for the firm the highest grade of work at the lowest possible cost. All possible opportunities should be given to the foremen to concentrate their attention solely upon improving their departments and their output. The large amount of worry and time consumed when the foremen's attention is given to the question of stock tracing certainly makes it impossible for them to concentrate their energies upon this most important work. Again, the foreman of a department is never in a position to know the actual needs of the entire factory. His duties should be far removed from those of stock tracer.

There is but one way to accomplish the desirable results that are so necessary to good factory management. Select as your stock tracer a man of good judgment, firmness of character, and one thoroughly familiar with the business, and place him upon as high a plane as any of the foremen in the factory, giving to him the *absolute control* of all stock in the process of manufacture. Give this tracer such authority that the foremen will understand that his requests for stock must be complied with under any and all circumstances, and then hold him responsible and accountable for all stock in the factory and subject to censure for all delays. Give to him the sole authority to secure stock from any department in the factory, either for any foreman, or for the assembling rooms. As stated in a former article, "helping one's self" should be absolutely prohibited. Put under his charge all the records for stock in the course of manufacture. Under such conditions no other man in the factory can possibly judge of the conditions and needs in the factory and the stock rooms as well as he. His records will enable him to locate all stock (as will be shown later) with more certainty and dispatch than is possible under any other system. Again, the superintendent or his assistants always know where to go for any information regarding stock, its location in the factory, and the time that they may expect to have it in the assembling rooms.

Experience has shown that this plan will produce the most desirable results. In one very large establishment connected with my experience, where there are over forty-five separate departments and an immense variety of work, the foremen follow the stock-tracer's orders implicitly in getting out the stock. They look to no one else for direction and do not lose any time "looking for work." Any foreman will tear down a job immediately to comply with the stock-tracer's orders. The motto in this factory is "Delays are absolutely inexcusable." The results are what might be expected; even the slightest delays rarely occur, and the company receives full value for the high-priced foremen, who are thus enabled to give their close attention to the turning out of the very best class of work at the lowest possible cost.

Description of the System. Central Depots. Whatever the nature of the system, the advantages of having central depots, in which all stock not being worked upon is kept for storage and distribution, are very apparent. In this way no stock can be lost. The foreman of any department can see at a glance how much stock there is waiting for him to work upon, and it is a great aid to the superintendent in getting a clear idea of the conditions of his factory. It is also a great aid in taking inventory. These central depots can be located at any number of points, if necessary; they should contain platforms for the storage of stock, these platforms to be of the same height as the trucks used in the transportation of stock through the factory. Each department should have its own platform, and only the stock ready to be worked upon by that department should be placed upon it. These depots are especially advantageous where any system of inspection is followed.

Many superintendents, while admitting the advantages of such depots, will deny their feasibility. It is comparatively seldom that one department can take up work from another department without some hours, or even days and sometimes weeks, intervening. If the stock is allowed to stay in either department it is very apt to be overlooked or forgotten, and certainly hard to find when wanted. I maintain that the very great advantages of having this stock placed in central depots, as described, compensate many times over for the small amount of time required to haul the stock to one of the depots, put it on a platform, and then take it to the proper machine in the next department.

The stock tracer and the stock departments are so closely related that it is necessary to keep in mind carefully a few of the points brought out in the article on The Stock Department in the May issue of this Magazine. I there treated of the manner in which a perpetual inventory is kept and the methods by which the order clerk in the stock department is immediately notified when the stock in the bins has reached a point so low as to be dangerous.

Short List. It is clear that if this order clerk sends to the stock tracer each day the names of parts, together with the amounts, which are in this dangerous condition, the stock tracer will then be in the best possible position to push the proper stock through the factory and into the stock bins, provided he has the proper records by which he can promptly locate the stock in the course of manufacture. Such a report may aptly be termed the "Short List."

Stock-Tracing Card. The next record that is important is the Stock-Tracing Card. This card accompanies the stock in its entire course through the factory and has already been described in the May issue of this Magazine.

Form No. 724

Dept ...... PIECEWORK TICKET Machine No ....

Name of piece ....

Operation ....

No. Ordered	No Finished	LOSS	No. Accepted	PRICE	AMOUNT $	AMOUNT Cts.	Time Commenced	Time Finished
							Total Time	

Box No.

Workman ....

Foreman ....

Inspector ....

Check No

1-3-00-10m p—F 12

FORM I. PIECE-WORK TICKET.

The duplicate, folded behind this by the lower edge, is precisely similar except that it has the word "Duplicate" across the face.

Day-Work or Piece-Work Tickets. The form of these tickets varies greatly in different factories. Not only do the forms differ, but also the methods of recording the time consumed by the workman. In come factories this time is put down by the workman himself, in others by the clerk, and again in others a special form is used containing the hours and minutes on the sides, the time consumed being punched by the workman or the foreman. The form of piece-work ticket given herewith is very simple. The ticket for day work is so similar to the ticket for piece work that no extra description is necessary. This piece-work ticket is made out in duplicate. In a department where there is no department clerk, the workmen will soon learn how to make out these tickets. They will be checked up for accuracy in time by the foreman. In a factory, however, where the work in the different departments is so large in amount as to necessitate the employment of a department clerk, this work can be done by him. The price should invariably be put upon the ticket by the foreman or the clerk, and some simple method adopted for checking the workman for accuracy as to the actual time consumed. The two columns headed "Accepted" and "Loss" are filled in by the Stock Inspector, the ticket being O.K.'d by him to certify that the work is accurate and that the amount is correct. The "Machine Number" represents the number of the machine upon which the work was done, this information being used in the cost system as will be shown later. This ticket is important, as from it are obtained most of the records for the Stock-Tracing and Cost Sheet.

Stock-Tracing and Cost Sheet. This is one of the vital records of this entire series of systems and deserves especial attention. This sheet will contain a full history of each lot or box of stock; it will show the full list of mechanical operations; the quantity of stock delivered to the different departments, together with the date of delivery; the date it was returned from each department; the time consumed by the workman; the piece-work price per one hundred; the machine number; the name of the department and workman. These data will be secured from the time ticket shown above. In addition to this, it will also show the number of pieces lost, give room for any explanation necessary, and also the date and amount of any stock which may be "sent ahead" of the original or main lot, in case this is necessary to avoid delays.

At first sight this appears complicated, but an investigation will show that these data are secured very easily and simply. This record, when properly filled out, will show clearly the location of the stock in the factory, whether it be in the machining departments or in the central depots. The stock-tracer's headquarters should be near the central depot and should contain the Stock-Tracing and Cost Sheets.

Some simple form of notification is necessary so that the different foremen may know what stock is in the central depot ready for them to work upon. Thus the foremen and the stock tracer are in close touch with that work which is ready for their departments, and the foremen can, without trouble or loss of time, give great assistance to the stock tracer in notifying him when they are ready to work upon the stock which is waiting for them, even though the demand for this particular stock should not be urgent. In large manufacturing establishments where an immense quantity of stock is handled, it is of course advisable that a simple notification to the stock tracer be used by the foremen. This may appropriately be called a "Moving Ticket."

Application of the System. I have already described, in the section on Stock, how the orders for stock were placed in the factory, the stock delivered to the proper department, the foreman's receipt secured, and the stock tracer notified that the order had been placed and the stock delivered. As already shown, each lot of stock will be put into a box bearing its distinctive number; this lot of stock would have its own sheet upon which this box number would be placed, thus forming the connecting link between each box of stock and its own sheet. When the stock tracer is notified of the delivery of stock to a foreman, he makes the record on his Stock-Tracing and Cost Sheet bearing the proper box number, showing the stock has been delivered.

As will be shown later, the most efficient manner of organizing a shop requires the division of the shop into departments according to the distinct lines of machines required for the work; for instance; the milling machines would all be in one department under one foreman. Even, however, where this is not the case, a little thought will show clearly that this system can be adapted to meet such conditions.

When the work on the stock is finished in this first department (requiring either one or more operations), this stock together with the Stock-Tracing Card and the Time Tickets is taken to the central depot by the truckers. Probably the most simple means of notifying the truckers when stock is ready to be moved is by using a heavy card with the words "Move It" on them, these cards being thrown into the boxes by the workman as soon as the work is finished. As the stock goes into the central depot, the Stock-Tracing Card and the Time Ticket are handed in to the stock tracer, or his clerk. The clerk can very readily find the corresponding Stock-Tracing and Cost Sheet by the box number shown on the piece-work ticket and the cards, or the lot number on the Stock-Tracing Cards which is identical with the number on the Stock-Tracing and Cost Sheet for this particular stock.

The stock is then put upon the proper platform, the proper entry having been made on the Stock-Tracing and Cost Sheet from the time ticket, and these tickets, together with the Stock-Tracing Cards, are turned over to the inspector. The inspector checks up the stock with the time tickets by counting the stock and also inspecting it where inspection is necessary. In counting the stock the work can be very greatly facilitated by the use of a pair of counting scales as described in a previous issue.*

It is clear that it is not at all necessary to bring the stock into the central depot after each operation in the machining rooms. The frequency with which this should be done will be determined entirely by

* The Engineering Magazine, May, 1902, page 196.

the conditions surrounding each case. In fact, this system can be handled even where a central depot is not used at all. In this case it will become necessary either for the inspector to go out into the machine room and check up the work for quantity and quality, or else to hold the foremen themselves responsible for these details. In my opinion, however, it is always inadvisable to have the inspector go amongst the men except in cases where absolutely necessary. It is necessary, however, that some absolute check be kept upon the workmen in such matters. One great advantage of the use of the Stock-Tracing and Cost Sheets in this case is the fact that it absolutely prevents the duplication of piece-work or time tickets on the same box of stock for the same operation. In cases where the stock is not brought into the central depot, the O.K. of the stock-tracer's clerk should be required on all piece-work or time tickets, in addition to that of the inspector, so as to insure the impossibility of the duplication of tickets.

As the stock is taken into other departments, by order either of the foremen or of the stock tracer, this fact is recorded on the Stock-Tracing and Cost Sheet. In the example shown on the sketch (form No. 2) this stock has already gone through the operations of punching and striking and it is now delivered to the next department for shaving operation. When the record is completed for any one operation, and there is no record of delivery for the next operation, this fact indicates that the stock is in the central depot. In cases where a central depot is not used, it indicates that the stock is waiting in the factory for the next operation. Thus, as the stock goes from one operation to another throughout the factory, the records of its movements can be shown on the records of the stock-tracer's office at all times, through the simple expedient of referring the time tickets to him.

Of course the details of applying such a system as outlined must be worked out for each individual factory. It is my intention to give only the fundamental ideas of these systems so they can be adapted to meet the requirements of any line of business. This stock-tracing system, together with a simple and efficient piece-work system, will give all the necessary checks for any business. That stock should be counted often in its course through the factory so as to insure that the men produce what they are paid for is, of course, very necessary. It is also self-evident that stock which must be produced with great accuracy should be carefully inspected. When either counted or inspected, the workman's time ticket, as already indicated, should be O.K.'d by the counter or inspector for accuracy of the parts.

This time ticket should then be sent back to the stock-tracer's office,

Operations	Quantity	Date Delivered	Date Returned	Time Consumed		P. W. Price Per Hun.		Depart-ment	Machine No.	Workman	No. Pieces Lost	Sent Ahead		Remarks
				Hrs.	Min.							Date	Amount	
Punch	*1,000*	*4/23*	*4/25*	*9*	*30*		*.07*	*Punch*	*1140*	*John Smith*	*10*			
Strike	*990*	*4/26*	*4/26*	*2*	*15*		*.02*	"	*120*	*E. Barr*				
Shave	*990*	*4/27*												

Box No. . . . .

Date. . . . . .19. . . . .

Name of Stock. . . . .

. . . . Lot No. . . . .

. . . . .Pieces Received by. . . . . .Date. . . . . .Entered on Invoice Card. . . . .

STOCK TRACING AND COST SHEET.

In the form as prepared for actual use, the number of horizontal lines is larger, allowing for any probable extension in the number of operations.

the original and duplicate of the time ticket torn apart by him and properly stamped with the date. The original of this ticket will then be sent to the piece-work department, which will make up all the vouchers for pay for the piece-workers. The duplicate of this ticket will be returned to the department from whence the original ticket came.

In large departments, where it is impossible for the foremen to keep in close touch with all the details of the work, it is necessary that these duplicate tickets be entered in a book to the credit of the workman. These duplicates are then turned back to the workman, who can thereby note if there have been any rejections of stock for which he will not receive pay. In cases where an unusually large amount of stock has been lost, it is advisable to notify the man immediately concerning this loss, not waiting until the duplicate ticket is returned to him. The detailed description of this part of the system comes properly under the piece-work system, but is introduced here briefly so as to give a general idea as to the course these time tickets take.

In considering any system of stock tracing, inspection, and piece work, it must be borne in mind that one absolute necessity is the providing of perfect checks upon the workman, and if possible the inspectors, at all points. In my experience, I have found many systems which were considered perfect, which, however, upon a close examination, proved defective. In many cases the workmen were taking advantage of these defects.

Inspection. It is hard to convince the average manufacturer that it will pay him to employ a number of high-priced men to do nothing but inspect the work done by other men. His thoughts are concentrated upon the fact that his payroll for these inspectors, who are producing nothing, is but a constant expense, and he can not realize the very large economies which their work, if efficient, will bring. I have seen many cases, however, in which a simple and thorough system of inspection of parts in the process of manufacture would have brought large profits to a concern at that time operating at a loss. The advantages of having accurate tools and gauges and a first-class system of inspection are so great that they can not be discarded lightly by any manufacturer. Workmen generally will do no better work than they are required to do. Any system of inspection must be thorough, and the limits given to certain work must be adhered to uncompromisingly. The slightest show of weakness on the part of the inspector will be noted immediately throughout the manufacturing establishment and the consequences therefrom are what might be expected. The elimination of defective parts by an inspector, important as it is, is only of minor significance when compared to the general effect. It would astonish the average manufacturer to find how soon his workmen will come up to any standard set by the inspection department, and how very small the loss will be, no matter how close the limits may be held. I speak from the experience of a concern where many parts are held to within five ten-thousandths of an inch and in some cases even less.

Authority of the Inspectors. The inspector's authority to reject stock should be unquestioned, and the superintendent should never, unless under the greatest provocation, reverse his decision. The advantages of an efficient inspection department might be thus analyzed:

First; it instils into the minds of the workmen the fact that the work they produce must be up to a high standard, and that if it be otherwise it will be thrown out without question, at their loss. This one feature will result in very marked improvement in the character of the work.

Second; imperfect parts are eliminated before the stock goes to the assemblers. The elimination of filing and fitting of parts in the assembling room will result in economies that are in many cases startling. A walk through the assembling room of the ordinary manufacturing establishment, by one who closely observes the assemblers at their work, will convince him that if conditions were changed so that the parts would come to those assemblers so they could be put together without fitting or filing, the cost would be reduced very materially.

Third; an inspection system provides protection to the company, in that the workmen get pay for good work only and are properly charged with that which is defective. The great importance of this from an economic stand-point can be readily appreciated.

Fourth; the fact that the parts are practically duplicates of each other will result not only in ease of assembling, but also ease of repairs. It will also mean fewer repairs, inasmuch as much less fitting in the assembling room is required.

Consideration will show that a system which will bring such results will produce large economies in every direction, but principally in the assembling rooms. The parts can be assembled so much more accurately and so much more quickly by the assemblers that the saving in these rooms alone will pay many times over for the original cost of inspection. Again, the machines, whatever they may be, will be much more accurate.

The inspectors should be provided with the best possible gauges for all stock which must be accurately machined. In many cases it is not necessary to employ an elaborate system. However, it will be found by experience that the inspection of parts is the key to cheaper production. Of course, on parts requiring accuracy it is necessary that the men in the machine rooms be provided with gauges which are exact duplicates of those in use by the inspectors. It is important, too, that in all cases there should be some regular system by which these gauges, both in the machine rooms and in the inspector's care, will be examined carefully at certain intervals and compared with the tool model to ascertain whether or not they have become worn. Many firms have suffered large losses through neglect of this small but very important fact. The tool models should be kept in the possession of the head tool maker, or some one especially appointed for that work. A card index of all tools and gauges outstanding throughout the factory should be kept by the tool maker, and he should determine how often a tool or gauge should be examined to insure its being in the proper condition. Then, he should arrange these cards so the proper ones are brought to his attention each day for examination. Accuracy of the tools and gauges can in this way be very easily insured.

Scrappage. It is unnecessary to go into detailed description of a special plan. The details of a system of scrappage can be very readily worked out by any one. There are, however, a few general rules which should be adhered to in the institution of any system. It must first be generally understood throughout the factory that stock can not be got out of the factory without passing through the hands of the inspectors. It is very easy to accomplish this when the stock movers, or truckers, are placed under the control of either the stock tracer or the inspectors. The inspectors should never scrap stock from any department without a full explanation from the foreman of that department as to what is broken up and why it has been done. It is important that this one rule be adhered to, as if the attention of the foreman is not called to this, waste will occur.

Inexpensive printed forms that will make this work much easier and simpler can be readily got up to meet the conditions of any business. In many cases it is advisable to hold the scrap stock in the inspection department and to call the superintendent's attention to the amount of waste that is going on. Reports should certainly be made by the inspectors at least once a month, showing the amount of stock scrapped by each foreman, together with his reasons. The effect of this upon the foreman will invariably be beneficial. If the foremen realize that they are liable to censure for the excessive amount of scrap coming from their departments, they will soon give this their personal attention.

A trial of a simple system of this kind for a few weeks will prove to any manufacturer that the unnecessary waste in his factory is astonishing. In large establishments, especially, it will be found very advantageous to separate the different metals which are usually mixed in the scrap. A very much higher price can be secured for scrap metal when it is separated in this manner than if it is mixed together.

Stock Transportation. The effective and quick transportation of stock around a large factory has become an important problem. Of course, in handling large work, the system of cranes is almost universally adopted. However, I treat here of the handling of a large quantity of small parts. This work should be put in charge of an organized body of men with an efficient man in charge. This organization can be made particularly effective where there are central depots and where the stock transportation is put directly in charge of the stock tracer.

This force of men (truckers) will deliver stock to all departments in the factory as it is called for, and upon their returning to the central depot they will be expected to bring in the stock that is on the machine-room floors already finished. The fact that this stock is finished is indicated by "Move It" cards, already described, which have been thrown into the boxes by the workmen. In cases where stock is urgently needed, or can be used to great advantage, another card, which may be termed the "Special Rush" card, is used. This card should be about 4 inches by 5 inches in size, and be made of very stiff tarboard or tin, the words "Special Rush" being printed in very striking colors.

The stock tracer alone should have the authority to put these special rush cards in a box of stock, as otherwise so many of them will be used as to make them of no value. A rule should be made to the effect that, whenever stock is sent to a foreman with a special rush card in it, this is equivalent to a positive order that this stock must be got out immediately. It should also be understood by the truckers that under no circumstances should boxes of stock with these special rush cards in them be allowed to remain on the machine-room floor after the work has been completed. The foreman of each department should of course make it his business to see that stock when finished is pushed out of the department as soon as possible, and he should notify the stock tracer immediately should he desire stock taken away.

Experience has shown that this system has decided advantages over that of allowing any foreman to have his own gang of truckers. This is, in fact, the centralization of the trucking force throughout a factory, placing it under the charge of the man most competent to handle this part of the business—the stock tracer.

Editorial Comment

The horror at Martinique is so frightful—so overwhelming in its proportions—that it has almost blotted out of remembrance the closely preceding earthquake disaster at Guatemala. There is possibly no physical connection between the two disturbances, but there is a very close logical connection between the lessons as to seismic possibilities they afford and the decision yet to be made as to the route of the Isthmian canal.

In the editorial pages of this Magazine for June, 1900, enumeration was made of three great geophysical difficulties in the way of successful construction and operation of the Nicaragua canal, the second being "The menace of earthquake disturbance sufficient to imperil not only the stability but the very existence of a construction so dependent on dams, embankments, locks, and cuttings." This consideration might properly have been placed first, except that it was potential, while certain others are ever present. How utterly overwhelming and irremediable the ruin would be is now vividly apparent. Congress may well pause to consider this phase of the question very thoroughly before taking any action which would expose to such destructive forces the hundreds of millions invested in an Isthmian canal, the countless and measureless interests which would become dependent upon its stability.

* * *

The fear of earthquake or volcanic overthrow of a Nicaraguan ship canal is no vision of an over-fearful imagination. In the Review of the American Press in this Magazine in June, 1901—just one year ago—an abstract was given of a series of studies of this phase of the subject, made by an able French engineer, M. Bunau-Varilla. It is pertinent to quote anew a brief statement of his conclusions.

* * *

First, as to actual topography:—

"In the very center of Lake Nicaragua is a volcano in constant activity, the Omotepe, whose last great eruption occurred in 1883. Between this and the volcano Coseguina we find a series of volcanoes in recent or continuous activity—the Hell of Masaya, on the shore of Lake Nicaragua, the celebrated Momotombo, on the shore of Lake Managua, the volcano of the Pilas, which was born in 1850, the Santa Clara, the Zelica, the Nindiri, being the best known of them."

Second, as to manifest seismic tendencies:—

"1. The Lake Nicaragua is one of the three lines of least resistance in Central America, which are a site of election for great seismic disturbances. It is the line of depression between the Costa Rican volcanoes and the Nicaraguan, and plays the same part as the other two (the bay of Fonseca, which is a volcanic lake characterizing the depression between the Nicaraguan and Salvadorian volcanoes, and the Lake Pacayan, characterizing the depression between the Salvadorian and Guatemalan volcanoes). These two last lines of least resistance have been the site of the most terrible convulsions, owed to the Coseguina for the former and to the Fuego (Fire) for the latter.

"2. The underground fire is going south, and increasing in Nicaragua. From the figures given by M. Bertrand I calculated that before the nineteenth century, out of all the great explosions or earthquakes recorded, 45 per cent. belonged to Guatemala, 35 per cent. to Salvador, and 20 per cent. to Nicaragua, whereas in the nineteenth century only 30 per cent. belonged to Guatemala, 45 per cent. to Salvador, and 25 per cent. to Nicaragua, showing an evident tendency to a displacement of the activity southward and an increase in Nicaragua.

"To justify these figures one can say that several volcanoes became extinct in Guatemala, and that none was extinct in Salvador or in Nicaragua, but, on the contrary, that two were born in Salvador, Izalco, in 1770, and Ilopango, in 1880, and one was born in Nicaragua, that of Las Pilas, in 1850."

Third, as to recorded experience:—

"The explosion of the volcano Coseguina in 1835 lasted 44 hours; the noise was heard at a distance of 1,000 miles; the ashes were brought 1,400 sea miles by the winds; * * * during these 44 hours the volcano ejected every six minutes a volume of stone and ashes equal to the total volume of the prism of the Nicaragua canal."

And even as the words are being written, report is received that the volcano Momotombo, on Lake Managua (which is an extension of Lake Nicaragua) has been "discharging showers of ashes accompanied by great quantities of smoke and a rumbling noise. This was followed by an earthquake that destroyed the docks at Momotombo and the terminus of the railroad running from the lake to Corinto on the Pacific." It need scarcely be pointed out that a canal supported by dams, embankments, and locks is immeasurably more vulnerable to seismic attack than even docks and railway structures.

* * *

The appendix to the Canal Commission's report contained the statement that "in the northwestern part of Nicaragua, slight earthquakes are frequent. Scarcely a month passes without one or more being noticed." In Panama, on the other hand, to quote M. Bunau-Varilla, "there is no volcano within a distance of 180 miles." The isthmus there has not been modified since the quaternary period. Its "rare and small seismic vibrations come from distant centers."

Here again new data just to hand strongly reinforce the older evidence. Gen. Henry L. Abbot, whose article in our February issue was so widely quoted, has just contributed to the *Evening Post* a summary of a year's seismographic observations in Central America—probably the first systematic, scientific comparison yet made of the two routes in this particular. Briefly, the Panama record for 1901, taken in the city of Panama, showed five movements—one "sensibly felt," three "very light tremors," one so slight as to be questionable. All came from the east or northeast. The disastrous Guatemalan earthquake of April last produced not even a tremor at Panama. But at San Jose de Cost Rica, the observing point near the Nicaraguan route, *fifty* seismic movements were recorded during the year, twenty-seven being classed as "shocks," seven as "strong shocks," while two others, though defined as "light shocks," were sufficient to cause people to run out into the streets. And General Abbot points out the grave significance of the fact that the disturbances in nearly every case "came from the projected canal route."

* * *

Surely, with the very slightly disturbed Panama region as alternative, it would seem nothing but madness to locate the Isthmian canal on the Nicaragua line—a line of manifest crustal weakness, destructively shaken by earthquake throughout almost its entire length as recently as 1844, and marked at its central and key point by the smoking volcano Omotepe in Lake Nicaragua, whose last great eruption occurred only nineteen years ago.

REVIEW OF THE BRITISH PRESS

Locomotive Performance.

The subject of the comparison between engines of British and foreign make has been going on for many years, and will doubtless continue, but at the present time it has been brought conspicuously to the front because of the report which has been made to Lord Cromer by Mr. Trevithick concerning the performance of British, Belgian, and American locomotives in Egypt.

We have no intention at this time of going into the relative merits of the various engines as regards their nationality; the question of the performance of a piece of machinery certainly may be judged on its merits, without permitting the question of its origin to enter at all. Rather may we be permitted to call attention to the fact that the question of the cost of railway transport should be taken as a whole, and that each element should be considered as a part of that whole and not as an isolated question.

Thus, in comparing the locomotives under consideration the points taken into account were: price; time required for construction; quality, including cost of repairs and consumption of oil; and consumption of coal. Calling the various engines under consideration by the countries of their origin merely as a means of identification, the result of the report is broadly, that the British engines consumed less oil and coal, and required less for repairs, but were of higher first cost, and slower in delivery. The Belgian engines cost somewhat less, and were economical of fuel, but needed more repairs, while the American engines were decidedly lower in cost and quicker in delivery, but the most extravagant in fuel consumption, besides requiring much repairing.

These are interesting points, and an examination of the detailed construction of the various locomotives should make the causes of these differences in performance and other qualities evident, independently of the geographical location of the works in which they were built. At the same time it appears that there are some other points regarding the locomotives which should be taken into account before their actual adaptability for the service required can be intelligently determined. The true value of a locomotive is known only when its life history has been recorded. Like a human being it is brought into the world and prepared for its work at a certain cost, and during its life a certain ascertainable expense is incurred in its maintenance. Like a human being also, the value of its life is measured, not by the time of its existence, but rather by what it accomplishes during its working life. There were patriarchs in days of old whose entire centuries of existence did not accomplish one-hundredth as much as has been given to mankind in the few years of a Hertz or a Maxwell; and there are engines in South Kensington to-day whose age is interesting out of all proportion to their performance.

As M. Sauvage has pointed out elsewhere in this issue, there are two sides to the account, and on one of these only we have entries from the data above mentioned. On the other side should be entered those much more difficult to obtain, as the distances and the loads hauled, together with the speeds made, grades overcome, and, in general, the income produced. Above all it should be remembered that a locomotive, again like a human being, has not an indefinite life, which can be usefully prolonged by continual patching, repairing, and replacement of parts. Far more important than either repairs or fuel consumption is the total amount of paying work to be gotten out of an engine during the limited life period which, in the course of mechanical progress, it should be permitted to have. It has been naively said of these Egyptian engines, that after the lapse of ten or fifteen years the defective parts of the Belgian and American engines will have been replaced by parts of British make and that they will then be equal to each other. By the expiration of fifteen years all three groups should have served their time and be lying in unrepaired equality on a common scrap heap, their work being done by successors of admitted superiority.

The engine which hauled the World's Fair Flyer from New York to Chicago in 1893 in record time is to-day doing occasional duty as a switch engine on some unrecorded siding, although not yet ten years old, and this in the ordinary course of railway progress. When it is thus realised that the entire value of an engine is to be charged to the depreciation account in ten to fifteen years, the relative proportion of repairs to service becomes an almost negligible quantity.

It is surely time for engineers in all parts of the world to recognize the fact that the variations in design and construction in such an important machine as a locomotive are the result of its environment, and that each type can do its best only under the conditions in which it was produced. When a locomotive is put to its maximum possible duty and the coal consumption per ton-mile recorded, we have some measure of the energy in the fuel which it is capable of converting. When against this is charged a depreciation of 7 to 10 per cent. per year, as well as its full share of all the operative charges of the railway system in which it is worked, it will be seen that the fuel consumption per engine is hardly a safe basis on which to make a comparison of performance.

It is interesting to note that while American engines are stated to consume nearly twice as much fuel as those of British build, the cost of merchandise transport is more than four times as great in England as in America, so that the superior fuel economy of the engines can scarcely be taken as a correct index of the cost of railway transport.

The fact is clear that no useful conclusions can be drawn from the performance of any detail of a great and highly organised system like a railway company, but that the whole system, with all its involved and correlated departments must be considered if useful or even intelligible results are to be expected.

The Future of Naval Warfare.

We have referred more than once in these columns to the importance of engineering in warfare, both on land and sea, and have ventured to express the opinion that the warfare of the immediate future would be carried on by engineers and by engineering methods alone, to the practical exclusion of the antiquated methods of the existing military establishments. We now have an interesting paper presented before the Institution of Naval Architects by Mr. W. Laird Clowes, upon recent scientific developments and the future of naval warfare, which concurs with these views in many points.

One of the strongest points made by Mr. Clowes is the neglect, or even unwillingness of those in authority to consider valuable inventions which are submitted to them.

"At a time like the present, which is one of extremely rapid scientific progress, it is especially incumbent upon us not to neglect, even for a single unnecessary day, any device which may possibly enable us, either in peace or in war, to defeat our rivals by honourable means. Scientific discovery tends ever more and more to obliterate the significance of those physical and moral differences which anciently rendered one race superior to another; and brain and thought are already more potent factors in the world than mere muscles and animal courage. Moreover, we know from experience that to-day, or to-morrow may produce a complete revolution of method in almost any of our processes.

"We ought, therefore, never to sleep, save, as it were, with our ears and eyes open. Yet, strange to say, the amount of practical attention which we give to new machinery and appliances is often, I am afraid, inversely proportionate to the novelty and ingenuity of the device in question. We are too prone, when examining new inventions, to admire the cleverness displayed in them, and then to reject them, wholly and finally, for one of two reasons, both of which are in reality quite inadequate.

"One reason frequently alleged is that the invention has yet to be brought to absolute perfection, and that, pending its complete evolution, we may safely neglect it. The other reason is that the machinery or apparatus is too delicate or complicated for use by the class of workmen who are accustomed to handle the appliances which the new apparatus would supersede. The evils resulting from such an attitude, which is characteristically a national one, are twofold. On the one hand, we snub and starve the inventor, and possibly drive him elsewhere in disgust; on the other, we make the far more dangerous mistake of assuming that the tide of technical education will not rise elsewhere so long as we choose to batten it down in our own little hold. What we ought to do is, surely, in the one case to take up promising inventions, and, turning them over for development to the brightest intellects at our command, to enjoy the exclusive profits of them as soon as they shall be practically perfect; and, in the other, to educate our men up to the point of being able to use delicate and complicated appliances instead of rejecting the appliances because our existing men are incapable of handling them."

Recognising that the fundamental principle of naval warfare is now, as it was in Nelson's time, to have at the right spot, and at the right moment, a fighting force superior in *personnel,* as well as in *matériel* to the force of the enemy at the same time and place, it is still important to realise that this end must be obtained to-day by different means than those of Nelson's day. Speed, above all things, is the controlling factor to-day, and speed is a matter entirely in the control of the engineering department of naval warfare. Speed is the soul of all effective combination for offence, and is also a very effective means of defence against certain weapons, such as submarines, which can hardly perform effective work against a mobile enemy.

The use of wireless telegraphy, protected against tapping by suitable tuning, and the employment of proper cipher codes, may double or treble the offensive usefulness of speed, and here again it is the engineer who is required and not the seaman.

Next to speed comes the question of rapid and accurate gun fire, and although gunnery has been arbitrarily appropriated by the executive branch, it is really a matter of engineering. The gun is a most complete piece of machinery, and there is no doubt that some of the modern range finders are altogether superior in accuracy and efficiency to the most experienced eye and judgment, certain executive officials to the contrary notwithstanding.

The whole question is not in the development of engineering appliances in warfare, but in the supply of proper men to handle them.

As Mr. Clowes well says:

"Our best available tools are rapidly getting beyond the effective control of our best available men, and the real lesson of the situation undoubtedly is that if we would properly utilise all the resources which science has placed, and will presently place, at our disposal for the prosecution of naval warfare, we must greatly improve the scientific standard of the *personnel.*

"It is significant that Lord Charles Beresford, without committing himself to any expression of opinion as to the merits of certain types of water tube-boilers, has hinted his belief that many of the breakdowns of those boilers may possibly be attributable, not so much to defects inherent in the boilers, as to the incompetency of the working staff, an incompetency due to lack of training and experience, and perhaps also to short-handedness."

The dire foolishness of all this business appears in the fact that it is assumed to be necessary to take executive officers, and by some sort of hocus-pocus convert them into capable and competent engineers upon the moment. Apparently the executive branch must be taken care of, though the navy fall hopelessly behind its possible and probable opponents. Boer farmers seem to have made good soldiers and formidable enemies, though they never saw a military academy, and are profoundly ignorant of the manual; but their military effectiveness depends upon the fact that they are "men who can shoot and ride." The modern battle ship must be able to shoot and steam, and these features being provided it matters little whether there are executive officers aboard or not.

Overheating of Boilers.

Overheating is well known to be one of the most frequent sources of injury to steam boilers, and hence the paper of Mr. C. E. Stromeyer, presented before the Institute of Naval Architects upon the distortion of boilers due to this cause demands notice, since the experience of the author renders him especially well qualified to speak upon the question.

Considering first clean boilers, Mr. Stromeyer examines the question of the degree of forcing which will cause boilers of otherwise satisfactory behaviour to show evidence of distortion from heat. Fires may be forced almost any rate of combustion, but it is not the hardest-forced fire which is the hottest, since with very high rates of combustion the products which leave the fire consist almost entirely of carbonic oxide and nitrogen, and the temperature is relatively low. When complete combustion is attained, however, it is shown that the maximum temperature attainable with a coke or anthracite fire is about 4,000 degrees F., the location of the hottest portion depending upon the arrangement of the furnace, and the management of the air supply.

Two effects of high temperature upon the metal are to be considered, one the internal effects, due to the temperature gradient in the thickness of the metal, and the other the action of the pressure, modified by the distortion caused by change of shape. These are examined both for internally and externally fired tubes, and it is shown that an internally-fired furnace of 40 inches internal diameter, although clean and free from scale or grease, will be distorted so that the horizontal diameter will be about 41 in., and the vertical 39 in., a change of 2 in. From an examination of the stresses in water tubes, it appears that when the thickness is less than ⅛ inch the tube diameter must be made smaller than 6.4 in. on account of stresses due to internal pressure, while for greater thicknesses the diameter has to be reduced on account of stresses caused by the temperature gradient in the metal; this is therefore a maximum diameter for either case.

In considering the effects of scale and grease, Mr. Stromeyer assumes that scale of 1/10 in. in thickness offers as much resistance to the passage of heat as does a film of grease 1/100 in. thick, or a plate of steel 10 inches thick. Taking into account these various rates of heat transmission, Mr. Stromeyer computes that for a clean furnace plate ½ in. thick, transmitting 20 evaporative units per hour, there will be a difference in temperature of 10°F., between the furnace and the rest of the boiler, while for a transmission of 140 evaporative units the difference in temperature will reach 70°F.; these differences producing expansion stresses of 1,700 pounds and 12,000 pounds per square inch, respectively. With 1/10 in. of scale the temperature gradients are so increased that the stresses in the metal would reach 60,000 pounds, and 350,000 pounds for the same evaporative units, providing the plates were rigidly held. Such stresses are of course impossible, and something must yield. In the case of furnaces, the front plate may be pushed out, while in water-tube boilers the tubes are bent, and the necessity of providing some degree of elasticity in the construction is evident.

Mr. Stromeyer gives some interesting computations, showing the very short time required for metal to become overheated under the conditions which may occur in steam boilers, and emphasises the important matter of the reduction in strength which takes place under even moderate overheating.

Concerning the influence of grease in boilers, some curious facts have been developed. There is no doubt that the introduction of grease will cause furnaces to bulge and tubes to burst, but at the same time an examination of the injured parts shows grease to be absent from them, although present in other parts of the boiler. It also appears that grease has a more marked effect in otherwise clean boilers than in those covered with scale, and it is far more injurious with forced than with natural draught. Comparing the relative resistance to heat transmission of scale and grease, it seems as if there must be some other reason for the injurious action of thin films of grease, and it may be that the grease undergoes a chemical change which renders it a far worse conductor of heat than it was. Various theories have been advanced to account for the contradictory phenomena. Mr. Stromeyer himself suggests the influence of retarded ebullition, and the action of hammer-blows, but this view, as he himself admits, does not agree with the observed fact that collapses due to grease occur gradually and not suddenly.

Nevertheless the injurious action of grease in boilers is fully established, and this alone must be appreciated and the explanation sought in the meantime. At least the fact is emphasised that boilers should be kept clean, and that the best way to keep them clean is to put nothing but clean water into them. Scale can be kept out by using surface condensers or purifiers for the feed water, and grease con be filtered out or separated. These two points attended to, it only remains to adopt such designs as shall avoid undue thicknesses of metal in the highly heated portions, and provide means for permitting unequal expansion and contraction without producing excessive stresses. Under such conditions distortion may be kept altogether within reasonable limits, and accidents from this source practically eliminated.

The Efficiency of the Nernst Lamp.

NEARLY a year ago we noticed in these columns the progress which has been made in connection with the development of the Nernst lamp in America, and now we have the valuable paper by Mr. R. P. Hulse presented before the Institution of Electrical Engineers, giving the results of tests for endurance and efficiency upon some of the 1902 model lamps now on the market.

The general construction of the Nernst lamp is now well understood, the illuminating element being a pencil of incandescent earths, similar in composition to the material of the Welsbach mantle, this being rendered a conductor by a preliminary heating, and then maintained in incandescence by the heat of the current. Since the material is non-combustible, no vacuum is necessary, as a high temperature can be maintained the efficiency can be made higher than in the ordinary carbon-filament incandescent lamp. Until now no very definite information has been accessible concerning the efficiency of the Nernst lamp, and hence there has been a general interest evinced in Mr. Hulse's experiments.

These tests comprised the measurement on a direct-current circuit of life, candle-power, and watts under the following conditions: continuous run at normal pressure; continuous run at a pressure above normal; continuous run at a pressure below normal; continuous run with constant current; continuous run with constant watts expended in rod; test with varying volts (increasing till burner is destroyed); resistance test on the iron regulating resistance; heating effect of coil. In each case 100-watt 110-volt "burners" were employed. The candle-power of the lamps was ascertained by comparison with standard Ediswan incandescent lamps.

As a battery of accumulators was used to supply the current, a very much more steady pressure was maintained than would have been possible with the mains, the excess volts when charging the battery being cut down by a regulating resistance. The average variation in pressure for any long time was certainly not more than half a volt, and generally less, and it will be seen later that since that under perfectly steady conditions the lamp itself varies 2 to 3 per cent., sometimes more, a steadier run was hardly required. The life was in all cases, unless otherwise stated, perfectly continuous, only one break occurring in the circuit during the seven weeks during which the tests lasted.

As in the case of incandescent gas light mantles, a material falling-off in candle-power was shown almost immediately, this amounting to ten to twenty-five per cent. in the first half hour, according to the voltage. This was followed by a much slower drop for about 20 hours, followed by a slight recovery, after which the gradual fall continued until the effective life of the lamp was reached.

Taking the tests at the normal voltage, the operative life of the lamps appears to be about 400 hours, the candle-power being 67 c. p. at the start, with a consumption of 1.33 watts per candle-power, and falling to 28.5 c. p. at the expiration of 400 hours, when a consumption of 2.60 watts per c. p. was recorded. The average life of the lamps was about 500 hours, failure being due to the breaking of platinum contact at the positive end of the rod. Overrunning tests showed no advantages whatever, being not only detrimental to the life of the lamp, but also without the gain in efficiency which occurs with the ordinary incandescent lamp. The life is also much shortened by overrunning, so that there is no object whatever in attempting it.

Some very interesting tests were those in which a constant current wase maintained. Under ordinary conditions the current falls off to a large extent, and the burner is then no longer run at its best efficiency, the decrease in candle power being also objectionable and detrimental to the reputation of the lamp. But with constant current, the candle-power, after its first drop, which is characteristic of every case, remains constant until that point is reached where under normal conditions, the candle-power would have fallen off very rapidly, and here, instead of a drop, the candle-power increases for a short time until the lamp burns itself out.

The Nernst lamp will give on the average throughout a life of 400 hours at least .48 c. p. per watt expended, as against not more than .28 c. p. per watt in the case of good glow lamps. The cost of renewals would appear to be not more than three times as much for the Nernst as for the glow lamp, allowing for the shorter life of the former. In a 100-watt Nernst lamp the total energy used is over 35 units during economical life, and at 4d. a unit this costs 11s. 8d. or, say, not more than 15s., when all expenditure due to renewal of the burner is taken into account. Thus the Nernst lamp will furnish 1,000 c. p. hours at a cost of 11d., while 1s. 3d. is the approximate cost of the same amount of illumination from good glow lamps. In this comparative estimate the cost of renewals in each case has been included, the price pei unit assumed to be 8 cents, while the glow lamp has been taken at an average of 3.6 watts per candle-power throughout a life of 700 hours.

The lamps tested by Mr. Hulse were of German make, and it is a matter for regret that he did not give full detailed drawings of their construction, in order that they might be compared with the lamps made under the Nernst patent by the Westinghouse company in the United States. Each maker appears to have made modifications in details, and from the account of the American Nernst lamp, as described by Mr. Wurts, in his paper before the Buffalo meeting of the American Institute of Electrical Engineers, it seems as if some of the causes for disintegration of the connections experienced by Mr. Hulse might be overcome. It would be most interesting to subject the lamps of various makers to simultaneous and identical tests, and in that way only can final information be obtained as to the best methods of working out the details.

The Combustion of Coal.

A RECENT issue of the *Electrical Times* contains a paper on the coal question in generating stations, which treats very clearly of the subject of the economical combustion of coal under steam boilers, and is so refreshingly free from any fog of technicalities as to attract interested attention.

After calling attention to the fact that the calorific values of the more customary coals do not vary over such a wide range as to demand the consideration which is sometimes given to that question, the matter of size is discussed. Here two distinct points are to be considered: the surface of coal exposed to combustion, and the space provided for the passage of air. With large coal there may be an excess of air opening between the pieces, and at the same time insufficient surface to the pieces in proportion to their volume to insure satisfactory combustion. As the size is reduced the relative surface for combustion is increased and the air space is diminished until combustion is retarded. There are thus three elements to be considered; draught, fuel-size, and thickness of fuel-bed. Hence for large coal the fire must be thick or too much air will come through unused, while for small coal the draught must be moderated or it will blow the thinner fire into holes, and air will pass through unused.

The real value of the large coal lies in the ease with which it can be burned, and this, rather than any unusually high calorific value, causes a high price for the coal. In other words, the price of coal is not fixed by its calorific capacity, but by its capacity for being burned. This is an interesting example of the manner in which commercial conditions may altogether confound scientific deductions; the most efficient fuel may not conduce to the highest economy of money. There are undoubtedly many coals of moderate price which are capable of being burned faster than is possible with natural draught, but, with mechanical draught and mechanical stoking, such coals would permit a high fuel efficiency as well as a substantial commercial advantage.

So far as efficient combustion is concerned, this is most difficult to secure in internally-fired boilers, owing to the close proximity of the relatively cold surfaces of the boiler. Externally-fired boilers, especially the water-tube type, have possibilities, which, however, are but infrequently appreciated. In most instances the freshly generated gases from the burning fuel are flung up between the rows of cold tubes, and extinguished before they are half consumed.

The behaviour of a piece of bituminous coal, when heated on a hot plate, will give some instructive information as to what takes place in a furnace. Before the solid carbon becomes consumed, the volatile constituents must be distilled off. This takes place at a low temperature, and until this is completed the temperature does not rise, the analogy being similar to the evaporation of water, in which a constant temperature is maintained until evaporation is completed. This is due to the fact that the conversion of a portion of the solid fuel into gas absorbs heat, which becomes latent; an action which explains the remarkable dulling effect of a small quantity of fresh coal thrown upon a clear fire. Stoking by spreading the fresh coal upon the surface of the fire demands, therefore, a thick fire-bed, to resist this chilling action of the fresh fuel. The solid carbon can be burned all right, if the air supply be sufficient, but the distillation of the volatile matter is another thing.

It is in connection with this latter feature of combustion that the injurious effect of chilling boiler surfaces appears. Ample space must be allowed between the grate and the boiler, as well as a sufficient supply of air properly distributed. By raising the boiler somewhat, a grate of the step form can be used, the movement of the fuel being thus assisted by gravity, and a thick fire being more readily handled. An ordinary water-tube boiler cannot be properly kept smokeless without the use of a refractory lined furnace or combustion chamber in which the combustion may be effected before the gases meet the cooling tubes.

Anthracite needs a strong draught, the principal difficulty being to get enough air for complete combustion, and fires of even thickness are necessary. With bituminous fuels the difficulty is almost entirely that of temperature and suitable air admixture. It is most difficult to secure a high enough temperature to produce smokeless combustion unless, for some distance beyond the grate surface, there is but a small area of heat absorbing material. Hence the steady, though slow recognition of the principle of refractory linings to furnaces and combustion chambers, a principle long since proved correct in the laboratory, and already successfully carried out in practice.

"Between the most bituminous coal and the pure anthracites there exists every grade. Best Welsh coal, so-called smokeless, contains only about 4 per cent. of hydrogen, and burns with a short flame; but one cannot place a coal entirely by its percentage composition. The conditions which determine whether and how far a coal will be bituminous seem to be connected with the internal molecular arrangement of the coal and not with the simple empirical or percentage composition. Many of the long-flaming bituminous coals give off a flame more than 100 feet long, during all of which distance it is exposed to the cooling effect of a boiler. It seems probable that such coals, if burned in better and more favourable surroundings would burn with a shorter flame. To the difficulty in burning bituminous coal and conforming to the law as to smoke must be attributed the higher price paid for Welsh and other more dry coals."

The Standardisation of Pipe Flanges.

Much has been said on both sides as to the advantages and defects of standardisation, and on both sides there is much to be said. Excessive standardisation is undoubtedly a hindrance to improvement, acting as a bar to the use of important modifications, but there are certain branches of work in which standard sizes and proportions undoubtedly tend to advancement. Among such branches may be mentioned screw threads, both for bolts and for pipes, also standard reamers, twist drills, and similar details, the great advantage of uniformity in repair and contract work far outweighing any considerations which can be advanced as to the use of special sizes.

Closely allied to these subjects is the question of standard flanges for pipe joints, and hence the paper of Mr. Robert E. Atkinson, presented before the Institution of Mechanical Engineers is of interest. Withou attempting to pass upon the merits or defects of any existing or proposed system, we may discuss the subject in a general manner, in connection both with the presentation of this paper, and with a consideration of the work which has been done elsewhere.

The importance of the subject is well stated by Mr. Atkinson. Says he:

"The want of interchangeability is keenly realised in any class of work when breakdowns occur. Delays are frequently involved in obtaining renewals of valves or fittings, and in the case of an electrical-power installation this may involve serious loss. When public institutions, such as hospitals are concerned, the delay may prove more disastrous than the financial loss. Users will at once recognise that, without a common standard, their purchasing area is greatly restricted. Owing to the varied requirements as to the sizes of flanges, methods of drilling, etc., manufacturers find inconveniences and difficulty in speedy production, as it is impossible to commit themselves to the large expense necessary to produce high-class patterns, and up-to-date machinery, or to carry goods in stock, ready for delivery."

The subject is not a new one, having been considered by the American Society of Mechanical Engineers and the Master Steam Fitter's Association in the United States, and by the Verein deutscher Ingenieure in Germany, by both of which organisations definite standards have been prepared and recommended. In America, also, the manufacturers of valves and fittings have agreed upon a supplementary set of standards for use with heavy pressures, and in practice the result has been eminently satisfactory, since the user can purchase valves and fittings with every assurance that they will agree with those of other makers which are already in use.

In considering the question of a set of standards for British use Mr. Atkinson has not only examined the standards in use in America and Germany, but he has also gathered data and information from the practice of the principal manufacturers in Great Britain, most of whom agree with him as to the desirability of establishing uniformity.

In the paper, to which the reader is referred for details, the advantages and defects of the American and German systems are examined, and suggestions made as to the improvements which may be made. These may safely be left to the committee of the Institution to which the matter has been referred. For the present we may be permitted to comment on the discussion, which was instructive in that it showed most clearly two points of view, those of the maker and of the user.

So far as the matter was concerned, the question of proportion needs be considered in connection with the satisfactory performance in regular service and with the best economy in manufacture. From the user's standpoint, however, there enters the question of convenience at all times, of interchangeability, of emergency repairs, and of cost in erection, rather than of manufacture.

As Mr. Atkinson well said, a great proportion of the work done in connection with flanged joints is carried on at a distance from the works where they are produced; hence cheapness in first cost is altogether secondary to convenienc and saving of labour in fitting.

Standards must always be a matter of compromise, but when a decision must be made, it should be made in favour of the man who has to use the article rather than of him who makes it and can dismiss it from his thoughts. The great bone of contention lay in the matter of the number of the bolt holes. Theoretically the number and arrangement of bolts should be governed by the strength of the material and the stresses to which it must be subjected. Practically it is greatly influenced by the fact that it is most important in pipe fitting that every connection should be capable of being turned through an angle of 90 degrees, without altering the position of the bolt holes. This latter requirement led the American committee to make the number of bolt holes always a multiple of four.

The jump from four to eight holes seems too much to the theoretical designer, but the flange with six holes in it is an abomination to the steam fitter. So with the diameters of flanges, in which materials of various strengths may have to be connected together.

These are only a few of the matters which must be harmonised before working standards can be attained, but it is by a comparison of the requirements of both maker and user, that sound practical and theoretical results may finally be attained.

REVIEW OF THE CONTINENTAL PRESS

The Düsseldorf Exposition.

INTERNATIONAL expositions will always possess a great attraction for the general public, but it is a question whether the smaller and more specialised local displays do not offer much more for fruitful study by the engineer. This fact is especially emphasised by the exposition at Düsseldorf, which from its location as well as from its character and arrangement is undoubtedly a most interesting display of engineering progress.

At the enormous aggregation of exhibits seen at Paris it was in many respects difficult to arange matters so as to show the connection between the various departments of engineering work in a comprehensive manner, but in a smaller exhibition such an arangement is posible, and at Düsseldorf this important point appears to have been well kept in view. From an excellent account given in a recent issue of *Stahl und Eisen,* we abstract some general description of the exposition as it existed just previous to the opening and in our leading pages this will shortly be followed by a fully illustrated account of its progress, as seen by the special representative of THE ENGINEERING MAGAZINE.

Leaving the detailed description of the grounds and buildings for the forthcoming illustrated account, we may examine in general the arrangement of the engineering features of the exposition, especially with regard to the generation and application of power.

So far as the exposition in general is concerned, it may be mentioned that the covered buildings represent an area of 127.000 square metres, to which may be added 53,000 square metres of outdoor exhibits, or a total of about 180,000 square metres. This is about 20 per cent. more than there was at the Paris exposition of 1867, and is nearly 28 per cent. of that at the Paris exposition of 1900.

The generation of steam is effected by boilers of various types, arranged in two distinct plants, the main installation containing 16 boilers, with a total of 3,550 square metres heating surface, with coal firing, while the secondary plant contains 3 boilers each of 100 square metres surface, arranged to be fired with lignite. This second plant provides the steam for the steam hammers and tor air compressors and rolling-mill engines. The main plant supplies steam for the various engines exhibited, amounting in all to about 12,000 h. p., most of which is used for the generation of electricity. Superheating is very generally applied, thus insuring dry steam, and a central condensing plant, capable of handling 30,000 to 35,000 kilogrammes of steam per hour, enables the engines to operate with an excellent vacuum. Although the location by the banks of the Rhine permits an ample supply of water, the condensing water is used repeatedly, in order to permit the exhibition of the operation of the cooling towers, these handling about 1,200 cubic metres of water per hour. Feed water purifiers, pumps, and varied auxiliary machinery completes this portion of the power plant.

The engines include vertical and horizontal compound types, from 3,000 h. p. down, besides a de Laval steam turbine of 100 h. p. and a number of gas engines. Especially interesting in this latter connection is the presence of one gas-driven blowing engine of 1,000 h. p., and two of 600 h. p., and also a complete gas power plant of 800 h. p. for operation of a rolling mill.

Although much electric driving is installed, an especial display is made of compressed air transmission, and numerous applications are installed, while hydraulic machinery, especially as used in iron and steel works, forms an essential feature.

We have then, at the Düsseldorf exposition an excellent opportunity of studying the latest developments in connection with the generating and applying of power. Large engines, supplied with superheated steam, and exhausting into a main central condenser, supplied with cooling towers are directly connected with high-tension polyphase electric generators, for the distribution of energy in the most effective manner. Side by side with these are found internal combustion motors, fed with lean gas, and by-products, operating on the largest scale with high economy. The presence of compressed air and of hydraulic transmission, make comparisons practicable, while the small amount of belting and rope driving used serves only to emphasise the transformation which has taken place in the transmission and distribution of power.

The location of the exposition necessarily indicates that the principal exhibits of manufactured products fall within the departments of mining and metallurgy for which the district of Rhenish Westphalia is famous. The eminence of Düsseldorf as an art centre, however, gives the department of fine arts a prominence which might otherwise be lacking, and rounds out the whole in a thoroughly acceptable manner. It is too soon to predict the outcome of the exposition, but its influence upon the applications of science which constitute the field of engineering cannot fail to be both interesting and stimulating.

The Sterilisation of Water by Ozone.

We have referred more than once in these columns to the possibility of employing ozone in the sterilisation of water upon the large scale, with especial reference to the methods of MM. Marmier and Abraham, as installed at Lille, in France. We now have, in a recent issue of the *Gesundheits-Ingenieur,* an account of the apparatus of Siemens & Halske, with the results of an examination of its performance made by Dr. Erlwein, of Berlin.

All ozone generating apparatus is based upon the ozone tube of Dr. Werner Siemens, first made in 1857, in which electrical discharges between tinfoil-covered glass tubes, ozonised the air in the annular space between. The present practical devices are of two kinds, one employing flat plates, without water-cooling, and the other using tubular electrodes cooled by internal circulation of water.

The apparatus at Martinikenfeld, upon which the investigations of Dr. Erlwein were made, has a capacity of 10 cubic metres per hour. This apparatus, the details of which are given in the paper, consists essentially of suitable reservoirs, together with a preliminary rapid filter, for the removal of the major portion of the bacteria, of a tower for the treatment of the filtered water by ozone, and of the ozone generating plant. The rapid filters were of the Krohnke type, the water being forced through a body of sand by a head of about 2 metres. The ozone tower was 1 square metre in area and 5 metres high, and contained lumps of broken stone, the water being sprinkled from above and trickling down against the rising current of air charged with ozone. The ozone generator consisted of four pairs of plates, 1 metre square, each plate being of glass covered with a metallic coating, the dry air being delivered between the plates, and a pressure of 10,000 to 15,000 volts being maintained. About 1 horse power is required to maintain each pair of plates in action, and the delivery is about 25 to 30 grammes of ozone per h. p. hour.

The experiments were made upon a mixture of water from the Charlottenburg local supply and raw water from the Spree, and a number of examinations showed it to contain from 40,000 to 200,000 bacteria per cubic centimetre. After passage through the apparatus this water was in many cases absolutely sterilised, and in but a few instances there were found from 2 to 11 bacteria per cubic centimetre. The mean consumption was about 2.5 grammes of ozone per cubic metre of water, the air containing about 3 grammes of ozone per cubic metre.

An interesting feature of the process was the effect of the ozone in removing colour from water. The difficulty in decolourising waters containing iron, or colouring matter from peat beds, is well known, but these experiments showed that such colour is almost entirely removed by the action of the ozone. For such effects it is found desirable to follow the ozonising with a final sand filtration. A convenient arrangement for this purpose is shown, in which the ozonised air first bubbles up through the water, and is then delivered to the bottom of a tower containing broken stone. The water, after the preliminary contact with the ozone, is passed through a rapid sand filter, and then passed down through the tower, meeting the ozone once more, this procedure effectually removing the colour as well as producing complete sterilisation, with a consumption of about 3 to 3.5 grammes of ozone per cubic metre of water.

The principal question, namely, that of cost, may be deduced from the above data, since it is mainly dependent upon the cost of power at the point of installation. Of the effectiveness of ozone in the sterilisation and decolorisation of water, there appears to be no doubt. Probably the practical application of the method will be found in combination with effective filtration plants for the removal of the greater portion of the bacteria, followed by treatment with ozone in times of epidemic or other occasions demanding additional precautions. The presence of colour may also determine the extent to which the ozone plant may need to be used, this forming a sort of auxiliary to the main filtration plant. The cost will in this way be kept within practical limits, while at the same time the administration will be at all times prepared to cope with any emergency which may arise.

Electric Tramways in Germany.

It is the custom of the *Elektrotechnische Zeitschrift* to gather and arrange the statistics of the electric tramways of Germany in a yearly exhibit, presenting the data in a very completely tabulated form, accompanying these facts with such comments as may enable the work of the year to be compared with the results of previous years. We now have the report for the year past, the data being brought down to October 1, 1901. This is a month later than has been the custom, the change being made in order to secure later data, and hence it must be remembered that the present figures are for 13 months. Included in the electrical data are the figures for the Marienfeld-Zossen high-speed military railway, although this is not for public transport, but solely for experimental investigations of the government.

The prevailing business depression in Germany has somewhat affected the construction of electric railways in Germany, at least to the extent of retarding new projects, and although good progress is shown, the remarkable development of the past few years has not been maintained.

As usual, the tabulated information includes the time of construction, character of system, as overhead, underground, accumulator, or special, also the length of track, number and character of vehicles, and data concerning the generating stations, whether the source of current is from a special station or from a general supply works.

It will be necessary to refer to the tabulated matter of the original article for detailed information concerning any particular railway, but a general summary may be given here.

The number of generating centres has increased from 99 on September 1, 1900, to 113 on October 1, 1901, a gain of 14 per cent., or about the same as in the previous year. The increase in track, however, has fallen off very much, the gain in road length having fallen from 40 per cent. in 1899-1900, to 8 per cent. in 1900-1901, and the gain in total track being but 6.9 per cent. as against nearly 50 per cent. in the previous year.

The existing roads, however, have been worked much more extensively, than in the previous year, so much so that the increase in electrical output of the stations has been as great as in 1899-1900, or more than 40 per cent., while there has been a gain of 21 per cent. in motor cars, and 25 per cent. in trailers during the past year.

There has thus been as great an increase in the generation of electricity for traction purposes as in the previous year, but it has been mainly expended in handling increased traffic over existing lines, and not in providing power for new lines. This is what might be expected, apart from any business depression; the most important cities having been provided with tramway systems, and the most urgent demands for interurban communication having been provided. Indeed it is a more healthy condition to find such a growth in the business of existing lines than to have it appear in the rush to develop new enterprises.

A noteworthy advance is found in the increased use of accumulator batteries for the purpose of equalizing the load upon generating stations, this branch showing a gain of 51 per cent. over the previous year. It is also interesting to note that the consumption of electrical energy per car has diminished and the consumption per kilometer has increased, thus showing an increased efficiency as well as a gain in service.

At the present time there are in operation in Germany 3,099 kilometers (about 1,900 miles) of road, or 4,549 kilometers of single track, (about 2,800 miles), operating 7,290 motor cars and 4,967 trailers.

Germany thus remains far ahead of the other countries of Europe in the use of electric traction, although she is far behind the United States.

The principal object of interest in electric traction is undoubtedly the high-speed military road between Marienfeld and Zossen. Although various trials have been made, it yet remains to be demonstrated that higher speed can there be attained than has already been accomplished by steam locomotives. At the same time it is a matter for congratulation to find that such important experiments are undertaken by government, while at the same time it is curious to note that expenditures which would be most difficult to obtain for scientific experiments in the interests of peaceful industries are readily obtained for matters military.

Speaking Photography.

The conversion of various forms of energy into articulate speech appears to be running through a course, which, if not altogether of commercial vale is none the less of great scientific interest. Thus the phonautograph of Léon Scott, which recorded the vibrations of a diaphragm under the influence of spoken words upon a smoked cylinder in translatable characters, was followed in 1877 by the phonograph of Edison, which even in its crude early form, was capable of "answering back" in more or less audible manner. Then came the graphophone of Berliner, the improved Edison phonograph, and the telegraphophone of Poulsen.

In the meantime the development of the telephone and the microphone, as remarkably sensitive receivers and converters of electrical variations into articulate sounds, came to aid in the problem.

In 1880 Professor Alexander Graham Bell, in the course of his investigations into the relations of the vibrations of light and electricity, devised the selenium cell, in which the impinging of a ray of light upon selenium modified its electrical conductivity, this enabling the action of the light to be converted into sound, and heard in a telephone receiver placed in the electric circuit.

More recently some very interesting observations have been made upon the action of vibrations upon electric arcs, and the researches of Professor Simon, of Erlangen, and of Mr. Duddell, in England, have shown that the electric arc may be used as a telephone transmitter. Thus, in the experiments of Professor Simon a transformer was placed in the circuit of an arc lamp, a battery and microphone being placed in the secondary circuit. Sounds delivered into the microphone transmitter were then clearly reproduced in the arc, which emitted musical notes, and responded visibly to the variations in the microphone. When the microphone is replaced by a telephone, the arc becomes a transmitter and the vibrations in the vicinity of the arc are converted into audible sounds in the telephone.

The result of such experiments naturally indicated the possibility of using the ray of light as a means of transmitting messages without the use of a wire, and in the radiophone of Professor Bell, shown at the Chicago exhibition of 1893 messages sent by a ray of light were received upon a selenium cell.

We now have a further application of this conversion of light into electricity and sound in the so-called photographophon, described in a paper presented by Herr Zacharias in a recent issue of *Glasers Annalen*. This apparatus, devised by Herr Ruhmer, consists of a receiver, in which the vibrations of an arc lamp are received and permanently recorded upon a rapidly moving photographic film, in a similar manner to that used in making moving pictures. When such a film is caused to move in front of a strong light, and the images of the marks on the moving surface are focussed upon a selenium cell, the variations in the light are converted into variations in electrical resistance, and thus into audible sounds in telephone receivers placed in the same electrical circuit as the selenium cell. Experiments with this interesting apparatus are still in progress, but thus far it has been found possible to photograph sounds and record them upon films for indefinite reproduction to unlimited audiences.

The utility of such a device is yet to be demonstrated, and indeed the various forms of phonographs have so far proved themselves to be little more than toys. At the same time there are possibilities which may yet be developed which will render these interesting pieces of apparatus valuable. The moving picture has found its principal application thus far in amusing and entertaining various popular assemblies, although examples are not lacking of its use in scientific demonstration. The photography of the sounds accompanying an action upon the same film with the pictures, and their simultaneous reproduction would be an experiment at once interesting and valuable. Again it may be possible to convert light variations, themselves silent, into sounds which may lead to their interpretation in a manner hitherto impossible, and thus widen the scope of scientific research and discovery.

We have thus far been able to convert into sound the vibrations of mechanical, electrical, magnetic, luminous, and chemical forms of energy. It remains to reverse these phenomena, and transmit visible images by means of vibrations, a problem often announced as solved, but as yet undemonstrated, although there is every reason to believe it capable of solution.

The Modern Steam Locomotive.

In the course of an interesting paper upon the modern locomotive, presented before the Société d'Encouragement de l'Industrie Nationale, M. Edouard Sauvage brings out some points which may well be borne in mind when considering any sudden transformation in the character of motive power for main-line railways.

Thus it is estimated that at the close of the nineteenth century there were in operation upon the railways of the world, between 130,000 and 140,000 steam locomotives, not including machines used on tramways or other special service. That is to say, there is about one locomotive for every 10,000 inhabitants of the earth.

Assuming a very moderate estimate of value, M. Sauvage considers that these are worth 4 to 5 milliards of francs (£160,000,000 to £200,000,000—$800,000,000 to $1,000,000,000), while there are constantly employed in operating, tending, and repairing these locomotives about half a million men! Truly an important department of industry, and evidence of the impress which the work of the engineer has made upon the civilisation and industry of the world!

Without attempting to discuss the details of all the varied types of locomotives, M. Sauvage gives some interesting points concerning the development of the locomotive in various parts of the world. Concerning the normal gauge of 1,435 millimetres (4 ft. 8½ in.), this has been considered too narrow, by many, and there is no doubt that wider gauges have their advantages. At the same time M. Sauvage points out that, even with the present gauge, the load upon the rails has increased to such an extent as to demand the greatest stiffness and weight, and this would have been even a more severe requirement had there been wider locomotives and cars to be carried. Thus in Europe, prior to 1875, the usual weight of an express passenger train, not including the locomotive and tender, did not exceed 100 metric tons, and it is but a few years since a train of 200 tons was considered very heavy. To-day we are approaching trains of 300 tons, demanding locomotives capable of hauling them at express speed.

For freight trains, and especially for mineral trains, it is the question of the cost of transport which is the determining element, but for passenger service other conditions predominate, such as speed, convenience and luxury of vehicles, frequency of trains, etc., and these must be provided independently of cost of construction or operation.

The handling of freight, as M. Sauvage well says, not always best done by heavy trains at slow speeds, although this may appear to be the most economical of fuel, and hence of total cost. There are other things besides fuel which enter into the cost of the ton-kilometre. In England freight trains of moderate weight are hauled at fair speeds, usually by engines with three coupled axles. On the Continent the slow, heavy trains prevail, while in the United States very heavy trains, drawn by colossal locomotives with four coupled axles, with weights of 18 to 22 tons per axle, are found.

As already indicated, the elements of total cost are numerous and complicated, and it is a mistake to consider the efficiency of a locomotive as dependent directly upon the fuel consumption. It is comparatively easy to charge each locomotive with the fuel and lubricant consumed and with the repairs which it requires, as well as the wages of its attendants. The proportion of general expense and the charge for its own depreciation may be closely approximated so that in general the debit side of the account may be considered as fairly attainable. On the other hand, it is most difficult to measure the service which is rendered by a locomotive in any manner which can be made comparable with other engines. Sometimes it is taken as proportional to the mileage, but this is a very indefinite element when the weight and speed are not included. The train-mile is also indeterminate, since the weights vary, and the speed and the profile of the line may still exert preponderating influences. The service which a locomotive may render also depends in a very great degree upon the usage which it receives. If powerful engines are used to haul moderate trains and given close attention and care, the fuel-consumption and repair-expenses per kilometre may be kept low. If, on the contrary, the engines are given the heaviest trains which they are capable of hauling at the required speed, the boilers are forced and the steam is not used economically, and the fuel consumption is necessarily high. At the same time the expense of attendance is much better utilised, and especially the capital charges form a far smaller element in the cost per ton-kilometre. It must be remembered that the whole question of freight transport is not one of the locomotives alone, to be considered as regards their economical performance by themselves; they should always be considered in connection with all the expenses of the entire railway management and operation.

M. Sauvage proceeds to examine modern locomotive construction in detail, considering the machine as composed of three distinct elements, the boiler, or steam generator; the engine, in which the steam is used; and the vehicle, by which both are carried. It is impossible here to follow him in the study which he makes of the details of each of these essential portions, the reader must be referred to the original paper, and to the paper of Mr. Charles R. King, commenced elsewhere in this issue. It is sufficient to recall the fact that the subject is treated in the broadest manner, by an engineer, who while French by nationality and practice, is cosmopolitan both in ideas and information, one whose opinions are far above local or national prejudice, and are based upon wide knowledge used with consummate ability.

Industrial Applications of Carbonic Acid.

The practicability of producing liquefied gases in commercial quantities has led to the suggestion of various useful applications in the arts, and in certain directions such applications have already become of material importance. Carbonic acid was one of the earliest of the gases to be reduced to a liquid state, and is still one of the cheapest and hence it has advanced furthest in its industrial applications. For this reason the exhaustive paper of M. E. Mathias, in recent issues of the *Revue Générale des Sciences*, upon the preparation and uses of liquid carbonic acid demands notice, and the record which is given of existing practice may lead to further applications.

Taking up first the production of liquid carbonic acid, M. Mathias divides the methods into two classes: those which produce a gas sufficiently pure to be reduced to the liquid state with but a slight preliminary purification, and those which produce a gaseous mixture containing from 15 to 35 per cent. of carbonic acid, the balance consisting of air or other inert gases, which are not absorbed by an alkaline carbonate. In the first class are grouped the processes using the gas from natural sources, such as are found in volcanic districts, also the gas given off during the fermentation of grain in brewing, and the gas produced by the action of acids upon natural carbonates.

Passing over the first source as of limited use, we consider the utilisation of the gas produced in the operations of brewing. This source of gas is due to the fact that in the transformation of glucose into alcohol, there is liberated, along with small quantities of glycerine and of succinic acid, a quantity f carbonic acid about equal in weight to that of the alcohol formed. This gas is very pure, but it is given off very slowly, and its collection is attended with various difficulties, so that up to the present time most of it has been permitted to escape unutilised.

The production of carbonic acid by the action of dilute sulphuric acid upon limestone or marble dust was at one time the principle method employed, but it has now gone almost entirely out of use. The gas contained entrained sulphuric acid, as well as salts of lead, and these are by no means removed by the purification methods ordinarily employed, and indeed the use of gas made by this process is prohibited in several countries.

The present method, is usually that of the second class, in which a gaseous mixture, rich in carbonic acid, is passed through a solution of an alkaline carbonate, from which the absorbed gas is afterwards separated by heat and collected in a receiver for liquefaction.

The gas for use by this method may be produced in a great variety of ways, the great advantage being that the process may be used in connection with some other branch of manufacture, from which the gases are a by-product of trifling cost. Thus furnace gases, containing a large proportion of carbonic oxide, may be burned completely to carbonic acid, and the resulting mixture passed through a scrubber and then absorbed by carbonate of sodium or potassium. Gas from lime kilns or from coke ovens may be used, or in fact any source of carbonic acid as a by-product which does not render it liable to contain gases which are absorbed by the alkaline carbonate. The absorption of the gas is effected in some apparatus similar to the well-known Glover tower, the principle object being to insure as complete a contact as possible between the liquid and the gases. By then exposing the solution of carbonic acid to heat, usually by means of steam coils, the gas is given off again. It is then practically pure, requiring only filtration through charcoal, and drying with sulphuric acid, or with chloride of calcium, to be ready for compression.

The liquefaction is usually effected in a two-stage compressor, the gas being cooled between the stages, the pressure depending upon the temperature, and ranging from 70 to 80 kilogrammes per square centimetre (995 to 1,138 pounds per square inch.) The liquid gas is pure, with the exception of a small quantity of air, which latter may be removed, when an absolutely pure gas is required, by fractional distillation.

M. Mathias describes the construction and use of the cylinders in which the liquid gas is collected and transported, and then proceeds to discuss some of the commercial applications of the product. Naturally one of the first applications proposed was that of artificial refrigeration. By the use of the liquid gas as a medium in refrigerating machines in a manner similar to ammonia, practically the same efficiency may be obtained with apparatus of much smaller dimensions.

The more general use of the liquid gas, however, is as a portable material for the production of cold. In this way it is employed in hotels, restaurants, and similar service. It is also used in the same connection for the carbonating of waters, for the enlivening of malt liquors, and in the form of the well-known "sparklets" these applications have become familiar in the household.

Attempts to use the liquefied gas as a source of motive power must necessarily be very limited. In all stationary situations the power will always be more economically produced by direct means similar to those employed for compressing the gas. When, however, economy is not the question, as in aeronautics, or in submarine torpedo work, it may be possible to use some such form of stored energy, but up to the present time, no really satisfactory carbonic acid motor has been made, although numerous attempts have been made by eminent engineers.

Among uses as yet of minor importance, but which may develop into commercial value, may be mentioned the application in tanneries, for the removal of the lime used to take the hair off the skins; in processes of sterilisation; for the extinguishing of fires; and especially of its employment, as by Krupp, in steel-working, both for the contraction of hoops on guns, by cooling, and for the compression of steel ingots, by the enormous pressure produced at high temperatures.

In addition to the above applications, liquefied carbonic acid is of use in the laboratory for various experimental purposes, as well as in practical chemical technology, materially increasing the range of temperature available at the lower end of the scale.

The Evaporation of Water.

Among various industrial operations there is probably none more common than that of the conversion of energy by means of the evaporation of water by the application of heat to the exterior of a containing vessel.

Some portions of this subject have been very fully investigated, especially those relating to the steaming capacity of boilers in power plants, but these have mainly been determined on the basis of evaporation per unit of heating surface and of grate surface, as well as per unit of fuel consumed, and observations upon temperatures have necessarily been limited. When lower temperatures are employed, however, as in the case of evaporating pans, and steam coils such as are used in sugar refineries, and in breweries, it becomes possible to make more reliable experiments and to determine data and co-efficients for scientific work. At the same time there is no very reliable information at the quantitative relations between heat applied and water evaporated, although the theoretical questions are very definitely established. Thus the experiments of Mollier showed the coefficient of heat transmission, or the quantity of heat transmitted through 1 square metre in one hour for a difference of 1 degree centigrade, for very thin copper, varied between 2,270 and 6,900 calories. Since the influence of the thin metal might be neglected, these great variations can only be attributed to errors of experiment, and Mollier suggested that they might be due to entrained air.

Taking average conditions into account, he states that a fair value may be considered to be about 3.500 calories.

The whole question has been made the subject of a very thorough series of experiments by Dr. H. Claassen, and from a paper which he has recently contributed to the *Zeitschrift des Vereines deutscher Ingenieure*, some interesting conclusions may be given.

So far as the experimental results are concerned, these are fully tabulated in the paper, to which reference must be made; but an examination of these results shows that the coefficient of transmission depends upon three elements: the temperature of the heating medium, usually steam; the temperature of the evaporated liquid; and the rate of variation in temperature.

Thus for a heating temperature of 100° C. and an evaporative temperature in vacuum pan, of 60.2° C, the transmission coffiecient was 2,816 calories, while with the same heating temperature and with an evaporating temperature of 71° C., the coefficient fell to 2,126 calories. Again when evaporating against atmospheric pressure, or at a temperature of 100° C., with heating temperature of 110.5° C., the coefficient was 1.823 calories, while when the heating temperature was raised to 124.8° C., the coefficient became 2,947 calories, showing the increase with the increase in difference of temperature.

The experiments also included researches upon the influence of the concentration of the solution to be evaporated, in the case of apparatus for the evaporation of saline or saccharine solutions, as well as the influence of the depth of the liquid in the pan, and consequent head of water against which the evaporation was effected. All these results are fully tabulated, thus furnishing valuable data for reference.

In general the conclusions drawn from the experiments were as follows:

The coefficient of heat transmission increases with an increase in the difference of temperature, but within the limits of the investigations the law of this increase could not be determined.

The coefficient of transmission also increases when both the temperatures of heating and of evaporation are increased. The coefficient is diminished when the head of water on the liquid is increased, this naturally being due to the increased pressure.

In the evaporation of water from solutions, the coefficient is much affected by the character of the solution and by the degree of concentration. Under similar conditions saline solutions show slightly higher coefficients than pure water, while for saccharine solutions the coefficient diminishes with the concentration.

The arrangement and character of the heating surface naturally affects the evaporation, and the use of superheated steam for evaporating is followed by a very marked increase in the value of the coefficient of transmission.

The Maximum Loading of Trains.

In the attempts to secure the greatest commercial economy of the transport of merchandise there has been a continual increase in the weight of freight trains, and the advantages of maximum loading have been advocated as conducting the greatest economy. This important question in railroading was discussed at length in a paper recently presented before the New York Railroad Club by Mr. E. E. Russell Tratman, and published in *Engineering News*.

The real question at issue appears to be the determination of what is really maximum train loading, and whether, in the attempt to secure maximum loading it does not sometimes become excessive loading. On this point Mr. Tratman says:

"In certain cases, no doubt, the maximum loading has been carried to an extreme But whatever may be the facts in individual cases, there can, I think, be no doubt that the heavy engine, heavy car load and heavy train load have been proved satisfactory and have come to stay. It is futile for the equipment man to complain that the cars are being damaged by the new conditions, or for the maintenance-of-way man to complain about the effects upon the track, with any idea that the conditions will be modified to suit the cars or track. On the contrary, the cars and tracks must be made to fit the traffic conditions, and rightly so, since it is the traffic which makes the business and earns the revenue. There is not the slightest prospect of any backward step in the present tendency to consolidate freight traffic into heavy trains hauled by heavy engines, and it is the proper way and work of the various departments of the service to facilitate operation of traffic under these conditions to the best of their ability."

In examining this question Mr. Tratman has made extensive inquiries concerning the wear and general injury or disturbance to track on the divisions where the heaviest engines are employed, in order to be able to make a balance account between the advantages and disadvantages of the system. The details of the responses to these inquiries are given in the paper, to which the reader is referred, but the general conclusions may be given here.

The reports show that the heavy traffic has involved much wear and tear upon the roads, and that the work and expense of track maintenance have increased with the use of heavy engines and trains.

Additional wear and failure has also been shown to occur upon the cars and rolling stock in general, but at the same time the losses from all these additional expenses do not offset the gain due to the higher efficiency of the system as a whole and to the greater proportion of productive to general expense. Taking all these points into account, as deduced from authoritative responses from many of the leading railways in the United States. Mr. Tratman draws the following conclusions:

1. The heavy engines, cars and trains for freight service have come to stay, for the reason that the "maximum train" method of handling the traffic has shown an ultimate economy in spite of the large sums expended in improving the road and the rolling equipment.

2. There is undoubtedly an increased wear of the track and cost of maintenance of way due to the heavy equipment and trains and it would be wise economy in very many cases to make liberal expenditures in materially increasing the strength of the track. The engineer has been able to show conclusively the ultimate economy to be obtained by large expenditures in general improvements and it is now time for the e gineer of maintenance of way to show a similar economy, to be obtained by expenditures upon the track itself. If he fails to impress the management with a realization of these economies, the only thing to be done is to make the best of what he has for there is no chance of driving away the heavy en-

gines, cutting down the car loads, or reducing the train loads to conform to the economical capacity of the existing track. Besides the track proper, improvements in passing tracks, double tracking, yard and terminal facilities, etc., offer further opportunities for effecting economy in operation.

3. While the present large engines and cars are generally satisfactory, many improvements remain to be made, especially in reducing the dead weight and strengthening the weak parts which develop under the severe conditions of service. Improvements in draft rigging, in brake equipment and in the proper maintenance of coupler and brake equipment are specially to be noted. It seems unlikely that the capacity of cars will be increased. Such a step is neither necessary nor desirable, for, with the exception of certain class of freight (and these often hauled in one direction only), the large cars are very frequently run with loads far beneath their capacity.

4. It would seem that we had about reached the limit of economical weight of the locomotives. Actual weights may still be exceeded in certain cases, but engines of 90 to 125 tons may fairly be considered to represent the limit in mere power and weight. The future progress will be rather in increasing the number of such engines, in improving their construction to obtain further economy in service and in improving the methods designed to work them to their full capacity.

5. The tonnage rating system for making up trains has by no means reached its full development, either in the facility of its application under varying conditions, or in securing the desired end of uniformly giving the engines a full load. In fact, much greater development may be expected in these directions than in the direction of building heavier locomotives.

6. Improvements are much needed in the work of getting the traffic over the road with as little delay as possible. These may be effected partly by increased track and terminal facilities, additional tracks, modern water and coal stations, the block system, etc., but more especially by greater promptness in handling cars and trains at division and terminal points. Closely related to this matter are the problems of restricting the use of cars for storage and the improper use of foreign cars. An auxiliary fast service of smaller and lighter cars for the economical and prompt handling of small shipments in local freight traffic may come at some future time as an offset to the comparatively slow and enormously heavy trains of large capacity cars.

This discussion of the subject only emphasizes the position taken elsewhere in this issue in discussing the performance of Belgian and American locomotives in Egypt, namely, that no detail in railway management should be considered by itself, but that it is the profitable and advantageous working of the whole which must always be considered.

The Service of the Automobile.

In an interesting paper recently presented before the Engineer's Society of Western Pennsylvania, and published in the *Proceedings* of the society, Mr. Hiram Percy Maxim discusses automobiles from a very practical standpoint.

Leaving on one side the present popularity of automobiles as pleasure vehicles, Mr. Maxim proceeds to discuss the question from the position of the engineer, and to show its relation to existing conditions of transportation.

"Urban or city transportation, or at least that part of it which is to-day having trouble with its motive power is divided into four classes:

1st. The transportation, in a private vehicle, over irregular routes, of usually one but possibly two passengers engaged in such service as the daily visiting of physicians, contractors, collectors, inspectors, and similar business men.

2d. The transportation of one or more passengers over irregular routes in a hired vehicle driven by a hired driver, or, as is better known, cab service.

3d. The transportation of several passengers by regular omnibus lines on city streets which are prohibited to street cars.

4th. The collection transportation and distribution of miscellaneous, city and suburban merchandise.

In every one of these services the horse has gradually become unsatisfactory as a motive power. The reason for his inability to prove satisfactory now, when he has been satisfactory for centuries past, is of course due to the changes that have been made in motive power in all other branches of transportation. If it were not that system railroad and the electric street car had set standards which other forms of transportation must meet, there is no doubt that the horse would have continued to give satisfactory service in the work we are considering.

In order to provide data suitable for an engineering consideration of the subject, Mr. Maxim made mileage tests, showing the proportion of the time which a vehicle rendered available service. He also made investigations into the energy expenditure per ton-mile in various kinds of service, with the result of showing, from plotted curves, that the automobile, even as it exists to-day is better able to do the useful, commercial work of transport, than is the horse.

These investigations, as discussed in the paper, extended over all four of the classes enumerated, and in all of them the superiority of the machine over the animal is shown, although in varying degrees. The most favorable showing appears to be in the transport of merchandise, such as local express service. This service is undoubtedly destined to grow with the rapid extension of local delivery into suburban districts, where the horse is most deficient because of the necessity for higher speeds over continually increasing distances.

Mr. Maxim is of opinion that electric motive power is the best for all such city service, and undoubtedly it is in the city, if anywhere, that electricity can do its best work. At the same time the developments in internal-combustion motors for automobile service have made them the favored power for long-distance service, and it is by no means certain that they will not prove the best for business purposes.

Comparing the two sources of power, Mr. Maxim says:

"I think electricity as a motive power will be used first for express service because we can get the maximum reliability from it. In making the substitution of a mechanical motive power for the horse in express service to-day we have to get something that will work pretty nearly right the first time. As far as reliability goes we might say that electricity is almost foolproof. We are dealing with a revolution here. We have to throw down a lot of strong ideas and prejudices, and it is my conviction that electricity will take the field in express service first because we can make the electric automobile so that it is almost independent of any skill on the part of the driver. The driver need only steer and apply the power and take it off. There is no other form of motive power available yet in which such simple operation is possible. There are two other motive powers in use to-day. The gasoline engine and the steam engine. We probably stand a better chance of getting an absolutely automatic motor with gasoline than we do with steam. We can now produce a horse power hour cheaper with it than with any other motive power suitable for a vehicle. We can probably get the H. P. hour for one-half what we can get it with a steam plant on the same vehicle. It seems very doubtful whether we shall ever get a steam plant entirely automatic—one which it will be safe to make automatic. Therefore, just as soon as we can produce a gasoline motive power equipment which requires no more skill to drive than the electric machine does to-day, where engine power counts for anything, the gasoline machine may be better than the electric. I do not believe that steam has any chance whatever. That is why I say it is probable the electric machine will not always have the lead. In express service, where they cannot afford to have anything unreliable, the gasoline may eventually give the electric automobile a hard rub. But I have been unable to see any chance in that service for steam."

Leaving the question of details of construction out of the question, and considering the matter solely from the point of the demands of existing transport conditions, it cannot be denied that relief may be had from the mechanically propelled vehicle, operating independently of any fixed tracks.

"Our cities have already spread to areas which make the irregular transportation of passengers and merchandise over them most difficult, and the continued development of the prime cause of it all—the electric street car—is daily increasing the difficulties. The automobile comes as a successor to a part of the work of the horse, just as the electric street car came as a successor to part of his work. From the very nature of our civilization it becomes an absolute necessity. The mechanically propelled street vehicle is as inevitable as was the mechanically propelled boat, railroad train and street car, and we might as well include such institutions among our fads as to include the automobile. When it comes to their manufacture, where we will build one for pleasure, sport, or fad, we will build one hundred for serious work."

Compensation of Skilled Labor.

There has been much written of late about the methods of compensating labor, but most of it has related to the general details of different so-called systems, including such forms of incentive as have appeared available to obtain the best results. It is therefore refreshing to have the matter discussed on its broad and fundamental principles by such a man as the veteran, Mr. John Richards, whose experience as an engineer, manufacturer, and employer of labor on both sides of the Atlantic renders him especially qualified to speak on this vital matter.

In a paper presented before the Technical Society of the Pacific coast, and published in the *Journal of the Association of Engineering Societies,* Mr. Richards treats the subject in a manner so logical, and so well adapted to existing and future conditions, that his views demand extended notice.

In the first place he calls attention to the necessity for a logical definition of the word "wages."

"Does it mean the money compensation for workmen's time, or does it mean compensation for work accomplished? These things are essentially different and require different terms to define them. The first is a "rate" of wages, while the second is the "amount" of wages. I beg that you will keep these terms in mind, because out of them and the relation between them must arise much that will be said of compensation.

"The 'amount' of wages, or compensation for work accomplished, is the labor cost that enters into commodities, and constitutes the real economic problem, the one that directly affects our industries and determines their success.

"The 'rate' of wages, or compensation for workmen's time, is a social rather than an economic problem, dealing with the intellect and skill of workmen, their ingenuity and power of producing; consequently it affects directly the workmen themselves.

"The amount of wages is very uniform the world over when measured by product—indeed, must be so, as will appear—but the rate varies with the productive power of workmen.

"It does not much matter to an employer whether it requires one, two or three workmen to produce a given result in a given time. He can as well pay the amount of wages to three men as to one man or two men. The amount of the wages, measured by production, is the matter he is directly interested in; but to the workmen the rate is a serious matter, directly affecting their social and other conditions, because it is a measure of their personal compensation."

Having arrived at this distinction concerning the possible meanings of the term "wages," Mr. Richards proceeds to show the postulates upon which he bases his discussion.

First. The costs of manufactured articles of every kind are made up of four elements or components; namely,—material, wages, expense and profit.

Second. All staple articles of manufacture, such as enter into the world's trade, must have a nearly uniform or international value.

Third. The amount of wages, entering into the cost of manufactured commodities, is also nearly uniform, and must be so, irrespective of the *rate* of wages paid for their production.

Fourth. The rate of wages depends upon what workmen produce, or upon efficiency of their labor and to some extent on artificial values.

Fifth. Fluctuations in the rate of wages are commonly a result of demand and supply.

Sixth. The amount of wages that can be paid to produce a commodity is not an accident, but is the result of fixed commercial laws of general operation, and upon the relation to other components.

This idea of the general or world's value of products is the natural outgrowth of the general exploitation of the surface of the earth and the practicability of easy and rapid communication between various nations. As a result, demand and supply, due originally to the difficulties in distributing the products of labor to various parts of the world, no longer regulate the wages element of value, and the values of articles are measured by the cost of their production, irrespective of the location where they are made.

Considering now the question of employment, Mr. Richards divides the methods into four classes:

First. In the scale of personal service is slavery, where workmen are not responsible.

Second. Time service, in which workmen are partially responsible.

Third. Piece work, where a workman is responsible for his own work alone.

Fourth. Contract work, where a whole working force is collectively responsible.

"Now these four methods or systems of service have the several degrees of responsibility named; that is, from all to nothing. Responsibility is the key to efficient skilled service. It forms the distinction between free and slave labor and the incentive of effort."

Here at once is seen the fundamental principle of the compensation of labor. Men are paid, not only for the actual articles which they produce, but also for the degree of responsibility which they bear. Just so far as the time system resembles slavery, so far it is degrading, tending as it does, to relieve the men from responsibility. Piece work is a step in advance, but only a half-way house; the contract is a still further advance, and in the present constitution of society, it places the men upon precisely the same basis as the employers; they are in business for themselves as much as the firm is for itself.

In the modern developments of industry there is no possibility for the position of labor to stand still. Manual work is being replaced by machinery wherever it is possible for it to be done, and the result is an inevitable sorting out of the men according to their individuality.

It has often been said that great industrial combinations have made it impossible for a man successfully to conduct a manufacturing business on his own account. Under the old conception of things this is probably true, but the old conception of things must be abandoned because it *is* the old conception. As a matter of fact every man who is really competent may go into business for himself more readily than ever before, he can do so without any stock in trade except his head and his hands, and he will find that the work of his head is far more valuable as capital than the efforts of his hands. The great corporations are to him what the great purchasing public was to his predecessor, an unlimited array of customers. If he will use his head he can sell to all the world his judgment, his responsibility, his brains, and the volume of his business will depend upon his product. If he insists upon selling the product of his hands only, he will always find himself a petty shopkeeper.

Herein the labor organizations make their great mistake, lagging, as they must necessarily do, behind the pace of the individuals. In demanding that their members do time work only, in limited working hours, with limited output, and avoidance of responsibility, they really demand that all distinctions of skill be destroyed, and, such a system, if possible, would reduce all to a homogeneous class like common, unskilled laborers.

The Speed Regulation of Prime Movers.

Among the valuable papers presented at the New York meeting of the American Institute of Electrical Engineers were two upon the subject of the regulation of prime movers for operating alternators in parallel, one of these being by Mr. C. P. Steinmetz and the other by Mr. W. L. R. Emmet. These are now published in the *Transactions* of the Institute, together with the valuable discussion, so that the subject may now be reviewed as a whole.

Mr. Emmet discussed the behavior of alternators operated in parallel, and described his investigations to discover the cause of the oscillations which made their appearance when two generators were started in parallel, and after vainly searching for the source of trouble in the electrical portion of the plant, he finally determined it to be in the engines. Here it soon appeared that the trouble lay in the periodic action of the governor, which, while performing its intended function of maintaining a closely uniform mean rotative speed, created angular oscillations in its efforts to respond to the varying impulses upon the piston.

Such oscillations naturally result from the sensitiveness of the governor for the work for which it was originally designed, that is, for the maintenance of a nearly uniform rotative speed, and the remedy is naturally found in the use of a damping device, usually some form of dash pot. This, while preventing excessive oscillations, also reduces the sensitiveness to load variations, but in most instances this is not felt to an objectionable extent. When a strong damping effect is desired, the ingenious time-delay dash pot of Mr. Harte Cooke may be used, this acting to interpose a heavy resistance to the change of governor position for a short period, but permitting it to respond to the least change of speed if persistent beyond the period of oscillation.

An interesting point in this conection is the fact that an increase in the weight of the fly wheel is not necessary, nor is it advisable. Mr. Emmet says:

"It is popularly supposed that it is necessary to use very heavy fly wheels in order that alterators may be successfully operated in parallel; it being the custom of some engineers to consider a guarantee of small angular variation as the equivalent to a guarantee for parallel operation. Experience indicates that generators with light fly wheels are most easy to operate in parallel. The frequency of natural oscillations in such machines is high, and the conditions of engine operation are generally unfavorable to their development. Large fly wheels are desirable on direct-coupled alternators, because a steady frequency is a valuable feature in any system. The requirements of parallel operation, however, are rather unfavorable than otherwise to the use of heavy fly wheels."

This apparently anomalous effect is due to the fact that the lighter the fly wheel the less the intensity of the pendulum effect of the oscillations, and the less the resistance necessary to apply to the governor in the shape of dash-pot resistance.

The discussion is especially interesting in that it shows the inter-relation between the various departments of enginering. Until the question of running alternators in parallel came up, a few years ago, there was probably no one feature in steam engine design which was supposed to be more thoroughly worked out than that of speed regulation and control. The electrical engineer comes forward with new requirements, and immediately the subject is reopened and the new conditions met in a scientific and commercial manner. The whole question shows the transformation in methods from the time when invention was regarded as a sort of lucky accident, to the present practice, in which operative phenomena are examined in a scientific manner, and the requirements met in the regular course of design and construction.

The Purification of Sewage.

The question of the purification of sewage is one which is gradually being taken up of necessity by nearly every municipality since either local conditions demand its consideration, or else the pressure of external influences come into action.

A very interesting paper, dealing broadly with the whole subject was recently presented before the Western Society of Engineers by Mr. John W. Alvord, and published in the *Journal* of the society, from which we make some abstracts.

The subject of purification of sewage has interested not only the sanitary engineer, but also the medical profession, the chemist the bacteriologist and the municipal expert. The result of this has been that the language of this specialty has become replete with technical terms, drawn from these various professions, which cause it to be sometimes rather unintelligible. Moreover, as is the case with every art which is in a rapid state of advancement, new theories are constantly being propounded, so that the observer is often perplexed in his attempt to decide just how much of the art is safely or surely determined, and just how much is still in a theoretical stage.

Mr. Alvord calls attention to the fact that sewage purification plants are not as popular with municipalities as water works, for instance, and hence the operations are often carried on only to such an extent as will satisfy the pressure of necessity. This was especially the case in former years, when the expense was greater than at present, but even with the improved biological methods the necessity for skilled supervision remains.

"The purification of sewage as now practiced most successfully requires that the process be divided into two stages:

"In the first stage there is the necessity of eliminating all of the greater portion of the particles of suspended organic matter contained in the liquid. This is accomplished more or less successfully by screening, sedimentation, chemical purification, roughing filters, bacteria beds and the septic tank. At the present time the septic tank is generally considered to be the most economical and efficient means of accomplishing the first stage of purification.

"The second stage of purification consists of removing the more finely suspended residue and the impurities in solution. There are many ways of accomplishing this, known by different names, but the general principle underlying them all is that the liquid to be purified must be brought into contact by wide diffusion at innumerable points with certain forms of nitrifying bacteria in the presence of a sufficient supply of oxygen and retained under such conditions a proper length of time for complete chemical change to be accomplished; this properly done, the liquid is found to be purified. Most of the methods by which this principle is practically applied involve intermittency of application of the liquid to the filter and its alternating aeration. This second stage involves processes commonly known as broad irrigation, intermittent filtration, bacterial contact beds, filters with forced aeration and continuous filters."

Discussing the successive stages of purification, Mr. Alvord calls attention to the importance of giving proper study to the design and operation of the septic tank. It is in the tank that the first and most important stage of the purification is accomplished, and that, by a species of bacterial fermentation, the solid matter is broken down and either discharged as inoffensive gas, or passed into solution.

The septic tank has passed through the period of doubt and distrust and is now being carried along on the popular wave of enthusiasm. It has come to pass that almost any one thinks he can design such tanks, although he may only have read of them. Accepting the English dictum that the sewage should rest in the tank from 12 to 24 hours, many tanks in this country have been designed on this basis, ignoring the fact that English domestic sewage will often average about four times the strength of American sewage, and that the English climate is quite different from the climate in this country. Mr. Alvord has found that septic tanks are not to be designed on haphazard principles, and has developed a theory from four years' practical experience in the operation of such tanks, that the particles of every sewage require a rest or fermentation period within the tank the length of time of which must be adapted to their temperature, their concentration, their character and the volume of flow. It has been clearly shown that if this fermentation period is unduly prolonged poisons are created which are detrimental to the life and activity of the anerobic bacteria. Such impairment of their vitality reduces their activity and fills the tank with undecomposed suspended matter, which must be necessarily cleaned out quite often and produces an effluent which it is difficult to oxidize. On the other hand too short a fermentation period does not effect that degree of purification of the suspended matter which is possible and allows considerable suspended matter to be carried over onto the filters to their detriment, and also causes the tank to fill with sludge.

The second stage consists of the oxidizing of the organic matter in solution, this naturally involving the effective contact of the liquid with air. Various methods have been adopted to accomplish this result, including broad irrigation and intermittent filtration. The objections to the former have been both the cost of land near large cities, and also the offensive accumulations which followed the method when raw sewage was turned directly upon the ground. Contact beds, however, have been demonstrated to be altogether capable of dealing with the problem, and of such beds Mr. Alvord gives some interesting information.

Comparing a contact bed to a huge lung, in which the filling and emptying of the liquid corresponds to the inhaling and exhaling of the breath, he shows the importance of providing proper, and if possible automatic control of the intermittent action. The early filter beds in England required raking and cleaning, but these were operated with raw sewage, containing solid matter. With the advent of the septic tank, and the consequent preparation of the sewage in liquid form, automatic devices became possible, with a result of increasing the efficiency of the process while at the same time reducing its cost.

It is customary to operate contact beds with two hours resting full, thirty minutes to empty, three hours resting empty to aerate, and thirty minutes or so to fill, thus dividing the day into six-hour cycles and providing for four fillings per day. With strong sewage, eight-hour cycles and three fillings and emptyings per day are sometimes best. All this work may go on continuously with the automatic devices without regard to night or day, noon hour or work hour, fair weather or storm, and this regularity is found to be very desirable and essential to the economical workings of the plant, for by its means the greatest possible effectiveness is obtained from any given contact bed or filter.

Mr. Alvord gives some valuable data concerning cost, but this must necessarily depend greatly upon local conditions. Given, however, the capacity and extent of a plant, it is altogether practicable to determine beforehand the cost of sewage purification for any given locality, and thus render the financial side of the subject a definite matter.

The two great sources of disease are undoubtedly to be found in impure water and in the presence of organic sewage, and these two are very frequently combined. With the purification of sewage before it is discharged into streams, and the filtration of water after it is taken from them, danger from these two sources may be practically eliminated, and a corresponding advance realized in the protection of the health of the community.

Some Resources of the United States.

In an interesting address read at the celebration of the twenty-fourth anniversary of the founding of the Engineers' Club of Philadelphia, Mr. John Birkinbine called attention to the magnitude of the resources of the United States in a manner well designed to impress his listeners with the enormous active and latent wealth of the country, as well as the share which the engineer has contributed to its increasingly rapid exploitation.

The estimated wealth of the United States is approximately one hundred thousand millions of dollars, or an average of $1,300 per capita of population. The output of coal is more than three-quarters of a million long tons per day, while the annual product of pig iron reaches 16,000,000 tons, requiring the mining of more than 29,000,000 tons of ore. The yearly output of gold and silver exceeds $100,000,000 in value, and this is about equalled by the value of the annual production of copper. Lead, zinc, and similar metals are represented by a yearly value of $40,000,000, and as a whole, the mineral products of the United States in 1901 attained a grand total value of $1,000,000,000.

One of the most impressive facts in connection with this vast array of natural resources is the extent to which mechanical appliances have been adapted to their exploitation. Thus, a single mining enterprise produces a million and a half tons of marketable product a year, transports this 100 miles, delivers it into vessels which carry it about 1,000 miles, and these vessels are discharged by mechanical appliances, so that the bulk of the iron ore is never touched by hand from the time it was lying in its bed until it is converted into metal. This is but a single example of the part which the work of the engineer has placed in developing the great natural wealth of the country.

"The farmer looks to the engineer for his agricultural machinery and those in the arid regions for dams and irrigating ditches which make possible the growth of crops on what would otherwise be barren soil. The miner depends on the engineer for the designing of shafts, laying out adits, drifts, and gangways, in equipping mines with ventilating and hoisting machinery, and in transporting the mineral won. All over the country there are evidence of the influence which the work and study of the engineer have exerted upon its development, and the position which he has occupied is one which brings honor to the profession and credit to the nation."

THE ENGINEERING INDEX

"THE ENGINEERING INDEX IS THE KEYSTONE OF APPLIED SCIENCE"

The following pages form a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world,—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,	(4) Its length in words,
(2) The name of its author,	(5) Where published,
(3) A descriptive abstract,	(6) When published.

We supply the articles themselves, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

CIVIL ENGINEERING

BRIDGES.

Arch Girder.

The Graphical Statics of Arched Girders. (Zur Graphischen Statik der Bogenträger) T. Stark. Giving the strain diagrams for a hinged arch in simple and convenient form. 1500 w. Zeitschr d Oesterr Ing a Arch Ver—March 21, 1902. No. 47726 B.

Defective Construction.

Defective Bridge Construction in the Prairie States. Daniel B. Luten. An illustrated article describing a type of steel bridge called the leg bridge, and noting its defects. 1800 w. Eng News—April 17, 1902. No. 47551.

Girders.

A Simple Method of Calculating Continuous and Constrained Beams. Edward Godfrey. Explains rule deduced from the three-moment formula and illustrates its application. 1100 w. Eng News—April 17, 1902. No. 47556.

Parallel Girders. F. H. Hummel. Read before the Civil and Mech. Engrs. Soc. Illustrates and describes parallel girders, giving their history and method of calculating weights in the present article. 3000 w. Prac Engr—April 18, 1902. Serial. 1st part. No. 47699 A.

Iron Bridges.

The Strengthening of Early Iron Bridges. The present article discusses the need of inspection and considers floors, cast-iron girders and suspended bowstring girders. 3300 w. Engr. Lond—April 11, 1902. Serial. 1st part. No. 47601 A.

Painting.

The Painting and Sand-Blast Cleaning of Steel Bridges and Viaducts. George W. Lilly. Read before the Engrs' Club of Columbus, O. Describes a method of plastering the metal with a coating composed of Portland cement, red lead, and linseed oil. 6500 w. Eng News—April 24, 1902. No. 47668.

Piers.

High Concrete Piers for Railway Bridge Across Stone's River; Tennessee Central Ry. Illustrations with brief description of piers 65½ ft. high. 400 w. Eng News—March 27, 1902. No. 47254.

Reinforced Concrete.

Concrete-Steel Arch Y-Bridge at Zanesville, O. Illustrated detailed description of this unusual bridge and its construction. 2500 w. Eng News—March 27, 1902. No. 47258.

See Civil Engineering, Materials.

Specifications.

Notes on Massachusetts Railroad Commissioners' Bridge Specifications. Gives some of the more important details of the specifications drawn by Prof. George F. Swain for bridges carrying electric railways. 2500 w. St Ry Jour—April 5, 1902. No. 47412 D.

Swing Bridges.

The Non-Continuous Swing Bridge; Two Existing Structures of This Type. Illustrates details of two bridges of this type built about ten years ago. 1000 w. Eng News—April 3, 1902. No. 47462.

Trans-Caspian Ry.

The New Bridge Over the Amou Daria River on the Trans Caspian Railway. A. Zdiarski. Describes the temporary wooden bridge and the permanent structure which is 5,250 ft. long, having 25 through spans of 210 ft. Ill. 2500 w. Eng News—April 10, 1902. No. 47509.

Viaducts.

The Chesapeake & Ohio Railroad Bridge at Richmond, Va. Illustrated description of double-track plate-girder viaduct 12,810 ft. long and a truss bridge 4,000 ft. long. The unusual method of erection by means of a steel cantilever traveler with an overhang of 142 ft. is fully explained. 3000 w. Eng Rec—March 29, 1902. No. 47202.

The Riverside Drive Viaduct Over Ninety-sixth Street, New York. Illustrated description of a short skew cantilever highway bridge. 2700 w. Eng Rec—April 12, 1902. No. 47477.

CANALS, RIVERS AND HARBORS.

Breakwaters.

Breakwaters and Plans for Breakwater Extension at Agate Bay, Two Harbors, Minn. S. M. White. Gives briefly the history of early examples, discussing the resistance to be overcome, manner of destruction, modern methods of construction, &c., the conditions at Agate Bay, and the work there. Ill. 9300 w. Jour Assn of Engng Socs—March, 1902. No. 47621 C.

Coast Protection.

The Lighting and Buoying of Coasts. (L'Eclairage et le Balisage des Côtes). M. Ribière. A review of recent progress in lighthouse engineering with especial reference to French practice. 15000 w. Ann d Ponts et Chaussées—4 Trimestre, 1901. No. 47718 E+F.

Dams.

An Estimate for Rebuilding the Austin Dam. Interesting part of a report and estimate submitted on March 24, to the Board of Water & Light Commissioners of Austin, Tex. 1500 w. Eng News—April 3, 1902. No. 47460.

Earthen Dams. Reginald E. Middleton. A letter on the relative merits of masonry and puddle for the cores of high dams. 1600 w. Eng Rec—March 29, 1902. No. 47209.

The Bohio Dam. Discussion of the paper by George S. Morison. Maps. 10,800 w. Pro Am Soc of Civ Engrs—March, 1902. No. 47218 E.

Docks.

Notes Collected in Relation to Docks and Harbors in Great Britain, France and Belgium in the Summer of 1900. Frank W. Hodgdon. A summary of information collected during a trip. Ill. 10000 w. Jour Assn of Engng Socs—March, 1902. No. 47618 C.

Dredges.

Light Draft Hydraulic Dredge. Illustrated detailed description of a dredge designed for special work on the coast of the Gulf of Mexico. Also describes the dredging machinery, propelling machinery and steam plant. 2000 w. Marine Engng—April, 1902. No. 47267 C.

Modern Dredging Machinery. (Neuere Baggerkonstruktionen.) R. Wels. Describing especially the improved suction dredges used in America, Russia, Australia and elsewhere. Two articles, 7500 w. Zeitschr d Ver Deutscher Ing—March 22, 29, 1902. No. 47708 each D.

Erie Canal.

The Improvement of the Erie Canal. An illustrated article explaining the bill now before the legislature, calling for the appropriation of $30,000,000 to be devoted to the reconstru tion of the locks, and the relocation of the canal at certain points. 1800 w. Sci Am—April 26, 1902. No. 47657.

Galveston.

Plans for the Prot ction of Galveston from Floods. Gives the principal features of the plan adopted, and abstract of the engineers' report, with drawings. 2500 w. Eng News—April 24, 1902. No. 47673.

Government Work.

Some Needed Reforms in the Conduct of River and Harbor Work. Extracts from an address by Hon. Theodore E. Burton, setting forth some of the evils attendant upon the present method of providing for and carrying on river and harbor works. 2500 w. Eng News—April 17, 1902. No. 47553.

Harbor Works.

The Seaham Harbor Extension Works. Reviews the history of this coal port and describes the extensions to meet the requirements of trade. 1200 w. Engr, Lond —March 28, 1902. No. 47454 A.

Isthmian Canal.

A Bit of the "Ancient" History of the Isthmian Canal Problem. John Meikle. An account, with map, of a survey made about the middle of the nineteenth century for a canal across the isthmus of Darien. 2300 w. Sci Am Sup—March 29, 1902. No. 47228.

Sandy Coasts.

Grasses as Sand and Soil Binders. Abstract of a paper by Prof. H. Lamson-Scribner, giving the best available data upon the protection of sandy coasts from waves and winds. Ill. 1500 w. Eng News—April 24, 1902. No. 47672.

Tidal Basins.

Tidal Scour in Harbors, or the Function of Tidal Basins with Special Reference to the Harbor of Boston. Joseph P. Frizell. Also discussion. 5300 w. Jour Assn of Engng Socs—Feb., 1902. No. 47213 C.

CONSTRUCTION.

Building Construction.

A Successful Fire Test of Concrete-Steel Factory Construction. Describes the condition of a 200x250 ft. concrete-steel building after a serious fire within it. 1000 w. Eng Rec—April 12, 1902. No. 47474.

Composite Structures. An account of tests made of buildings which did service at the recent Paris Exposition, especially the Pavilion of the Republic of San Marino, a system of reinforced brick work and concrete with interwoven cores. The economy of material combined with resistance to all kinds of demolition could hardly be exceeded. 2800 w. Engng—March 21, 1902. No. 47290 A.

The Construction of the Hanover Bank Building, New York. Illustrates and describes the method of constructing pneumatic foundations and erecting steel-work of a 22-story office building. The details of a large steel derrick are shown. 2000 w. Eng Rec—April 12, 1902. No. 47473.

The Flatiron Building, New York. Illustrated description of the unusual structural steel detai s of a 21-story office building, triangular in plan and exposed to wind on all sides. 4800 w. Eng Rec—March 29, 1902. No. 47206.

The New Jersey Law Regulating Architectural Practice. The test of a law requiring all architects practicing in the State to be licensed by a State Commission. 1800 w. Eng. Rec—April 26, 1902. No. 47650.

Loads and Working Stresses for Austrian Building Work. Gives the unit stresses adopted by the Austrian Society of Engineers and Architects after an investigation covering two years. 600 w. Eng Rec—April 5, 1902. No. 47328.

Bricklaying.

Bricklaying at the British Westinghouse Works. J. C. Stewart, in the London *Times*. Explains the method adopted to double and triple the rate of bricklaying per man in Great Britain. 1700 w. Eng Rec—March 29, 1902. No. 47208.

Chimneys.

Chimney Design. Charles L. Hubbard. Reviews methods of determining the dimensions of chimneys. Ill. 1800 w. Engr, U S A—April 1, 1902. No. 47354.

Fireproofing.

The Conflagration at Paterson, N. J., February 8 and 9, 1902. An illustrated description of this disastrous fire and a discussion of the lessons to be learned from it. 4000 w. Br Build—March, 1902. No. 47260 D.

Foundations.

Lifting and Underpinning a Nine-story Wall. Describes the method of raising a 9-story wall of an office building nearly two inches and underpinning it without injury to the masonry or disturbance to the alignment of the elevators and other machinery. 1200 w. Eng Rec—April 19, 1902. No. 47614.

The Substructure Work for the Mutual Life Building New York. Illustrated description of the method of sinking small pneumatic cylinders and of underpinning heavy walls with girders on cylinder piers. 4300 w. Eng Rec—April 19, 1902. Serial. 1st part. No. 47611.

Grain Elevator.

A Concrete Grain Elevator. Illustrated description of a storage house embodying the concrete and wire mesh system with steel tie rods as an additional strengthening. It is also unique in shape and size. 1600 w. Ir Age—April 3, 1902. No. 47318.

The Operation of the Modern Grain Elevator. D. A. Willey. An illustrated account of the construction and operation of the modern "tank" elevators for storing and handling grain. 3000 w. Engineering Magazine—May, 1902. No. 47775 B.

Jetties.

Single Curved vs. Double Straight Jetties. Lewis M. Haupt. An application of natural laws to the removal of bars. 1700 w. Jour Fr Inst—April, 1902. No. 47396 D.

Retaining Wall.

A New Design of Concrete-Steel Retaining Wall. Illustrated description of a construction patented by Frank A. Bone. 700 w. Eng News—March 27, 1902. No. 47252.

Sliding Embankments. (Fliessende Hänge) Max Singer. A description of the yielding of the sides of a railway cutting in the Eger valley, in Austria; with the methods employed for retaining the embankment. 4500 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—March 14, 1902. No. 47725 B.

Road Rollers.

Oil Engine Road Rollers. Illustrated description of a successful application of oil engines to road rollers. Two of these engines have been used in France for two years. 800 w. Engr, Lond—March 21, 1902. No. 47304 A.

Roads.

Economical Methods of Road Improvement in the South. Charles H. Scott. Describes treatment given roads in North Carolina which proved both satisfactory and economical. 1800 w. Eng News—March 27, 1902. No. 47256.

Improvements in Tests of Macadam Materials. Describes experiments to standardize tests of the resistance to abrasion and of the cementing power of different stones. 2300 w. Eng Rec—April 19, 1902. No. 47608.

Methods of Reducing the Cost of Contractors' Work on Road Construction. Halbert Powers Gillette. Concerning certain economies that will reduce the cost of macadam road construction. 1800 w. Eng News—March 27, 1902. No. 47257.

Recent State Road Construction in Massachusetts. Describes mainly the methods adopted in preparing sub grades for broken stone and gravel roads. 1600 w. Eng Rec—April 5, 1902. No. 47325.

Steel-Work.

The Murray Iron Works Company's Boiler Shop Illustrated description of the structural steel-work in a 425x190-ft. boiler shop. 3000 w. Eng Rec—April 5, 1902. No. 47324.

Subways.

The Pennsylvania Avenue Subway and Tunnel, Philadelphia, Pa. George S. Webster and Samuel Tobias Wagner. An illustrated article presenting features of interest in connection with this work. 21000 w. Pro Am Soc of Civ Engrs—March, 1902. No. 47215 E.

Tunneling.

A Rock Slide on the New York Rapid Transist Railway. Describes the recent accident in constructing a tunnel 60 ft. below the surface. which resulted in the collapse of several house fronts. 1500 w. Eng Rec—March 29, 1902. No. 47203.

Cave-In at the Park Avenue Rapid Transit Tunnel. Brief illustrated account of the accident which wrecked valuable property between 37th and 38th streets on Park avenue, New York City. 700 w. Sci Am—March 29, 1902. No. 47226.

The Aspen Tunnel. A. W. Clapp. Interesting features in the construction work of this tunnel of the Union Pacific R. R. in Wyoming are described and illustrated. 1400 w. Eng & Min Jour—April 12, 1902. No. 47503.

The Extension of the Orleans Railroad in Paris. Illustrated description of the method of driving a double-track railway tunnel with a roof shield. 1600 w. Eng Rec—April 5, 1902. No. 47323.

The Park Avenue Tunnel Cave-In. Illustrated description of the cause of the accident and the method decided upon to repair the trouble. 1100 w. Sci Am—April 5, 1902. No. 47382.

The Progress on the East Boston Tunnel. Describes the method of driving a tunnel by means of two advance drifts for the side walls and a roof shield for the arch. 1300 w. Eng Rec—April 19, 1902. No. 47610.

MATERIALS.

Basalt.

Basalt and Its Uses in Engineering Construction. An illustrated article describing this material and the uses to which it has been successfully applied. 2800 w. Quarry—April 1, 1902. No. 47529 A.

Cements.

The Addition of Puzzolana to Portland Cement (Addition de Pouzzolanes aux Cimente Portland). R. Feret. An examination of experiments showing the advantages of the addition of puzzolana to cement used in maritime work. 3000 w. 1 plate. Ann des Ponts et Chaussées—4 Trimestre, 1901. No. 47720 E+F.

The Classification of Crystalline Cements. Edwin C. Eckel. Formulates a classification believed to be rational and practical. It is based primarily upon the amount of chemical change caused by the processes of manufacture and use; and secondarily upon the chemical composition after setting. 2400 w. Am Geol—March, 1902. No. 47430 D.

The Structure of Cementing Materials. W. Carrick Anderson. Read before the Sci. Soc. of the Glasgow & W. of Scotland Tech. Col. Presents much information on the chemistry of these materials, reporting valuable investigations. 8000 w. Quarry—April 1, 1902. No. 47530 A.

Reinforced Concrete.

The Computation of Monier Beams. (Beitrag zur Berechnung der Monierplatten). Max R. v. Thullie. A review of the methods of Barkhausen and Considère, with application of computations of actual examples of concrete steel construction. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—March 28, 1902. No. 47727 B.

See Civil Engineering, Bridges.

Steel Protection.

The Chemistry of the Protection of Steel Against Rust and Fire by Concrete. Extracts from an article by Prof. Spencer B. Newberry, read before the Assn. of Expanded Metal Cos.' at Chicago, summarizing the chemical and physical laws supporting the belief that concrete is an efficient covering. 1000 w. Eng News—April 24, 1902. No. 47670.

Tests.

Weight Tests of Concrete Arches. Report of some recently conducted weight tests on various types of arches designed by Jacob Schratwieser which show remarkable results. Ill. 2200 w. Ins Engng—March, 1902. No. 47273 C.

Wood Preservation.

Preservative Processes for Woodwork. H. C. Standage. Gives various processes covering almost every case of wood requiring preservatives from exceptional decaying influences. 4200 w. Builder—April 12, 1902. No. 47579 A.

MEASUREMENT.

Measuring Distances.

Measuring Cloud Distances from a Railway Train. A brief description of the conditions that are involved, with the method of determination. 1300 w. Eng News—March 27, 1902. No. 47253.

Metre.

The Metric Convention (La Convention du Mètre). C. E. Guillaume. Discussing the influence of variations in gravitation upon the establishment of standards, also the use of light wave-lengths as invariable references. 10,000 w. Bull Soc d'Encour—March, 1902. No. 47723 G.

Photography.

Photography as Applied to Architectural Measurement and Surveying. J. Bridges Lee. Indicates the great possibilities of accurate photography and the lines along which the development should progress. Ill. 6000 w. Jour Soc of Arts—April 18, 1902. No. 47698 A.

Road Survey.

Preliminary Road Surveys in Maryland. Describes the nature and cost of the work of the Maryland Geological Survey. 900 w. Eng Rec—April 12, 1902. No. 47476.

Surveying.

Some Devices for Increasing the Accuracy or Rapidity of Surveying Operations. Discussion of the paper by Walter Loring Webb. Ill. 13600 w. Pro Am Soc of Civ Engrs—March, 1902. No. 47217 E.

Surveying Instruments.

Remarks upon Surveying Instruments, with Special Reference to the Paper of Mr. Dunbar D. Scott on the Evolution of Mine-Engineering Instruments, and to its Discussions. H. D. Hoskold. Ill. 8400 w. Trans Am Inst of Min Engrs—Nov, 1901. No. 47538 D.

Theodolite.

The Hammer-Fennel Tachymeter-Theodolite (Der Hammer-Fennel 'sche Tachymeter-Theodolit). J. Stambach. Description of an improved stadia theodolite for topographical surveying. 2000 w. Schweizerische Bauzeitung—March 29, 1902. No. 47743 B.

Tide Gage.

Indicating and Recording the Tides. Day Allen Willey. Illustrates and describes the instruments used by the United States government for predicting, recording and indicating the fluctuations of the tide. 1700 w. Sci Am—April 12, 1902. No. 47470.

MUNICIPAL.

Destructors.

A British Refuse Lighting Plant. Illustrates and describes the plant to supply the Burgh of Partick, near Glasgow, in which the destructor plant furnishes the principal source of heat for raising steam. 2000 w. Elec Wld & Engr—April 26, 1902. No. 47676.

Partick Municipal Electricity and Destructor Works. Illustrated description of buildings and plant costing about £6,500. 2300 w. Elect'n, Lond—March 28, 1902. No. 47439 A.

Great Britain.

Sanitary Betterment in Great Britain. From the address of Dr. John C. Thresh, before the Inst. of San. Engrs, Great Britain. A review of the history of the sanitary movement in England. 4000 w. Dom Engng—April 15, 1902. No. 47630 C.

Municipal Population.

Methods of Estimating Population. Abstract of a paper by Walter F. Wilcox. Discusses the relative accuracy of different methods of estimating population of cities in the United States, as demonstrated by comparisons of the methods with the results of Federal censuses. 3700 w. Eng Rec—March 22, 1902. No. 47040.

Pavements.

Robbia Pavement. Allan Marquand. An illustrated article giving information in regard to the Robbia work, both in relation to pavements and sculptural monuments, showing simila designs. 1600 w. Br. Build—March, 1902. Serial. 1st part. No. 47259 D.

Public Works.

Public Works Administration. John A. Fairlie. Gives the leading features of public works administration in some of the leading cities of the United States. 3000 w. Munic Engng—April, 1902. No. 47272 C.

Refuse C emation.

A House-Refuse Incinerator for New York City. Illustrated description of a crematory constructed on a timber pier for burning wood, paper and similar refuse. 1400 w. Eng Rec—April 19, 1902. No. 47612.

Proposed Light Refuse Crematory for New York City. Illustrated detailed description of a proposed plant to be built on the dumping pier for New York City by the Department of Street Cleaning. 1600 w. Eng News—April 17, 1902. No. 47555.

Sewage.

Bacterial Purification of Sewage. B. H. Buxton. Outlines the changes which take place in sewage when treated by bacterial methods. 3300 w. Eng Rec—April 26, 1902. No. 47646.

Sewage Purification and Water Pollution in the United States. Gives a list of 95 cities and towns where some means of treating the sewage is practiced, with remarks on methods in use. 2000 w. Eng News—April 3, 1902. No. 47461.

Sewage Disposal.

German Experiments with Sewage Treatment by Septic Tanks and Contact Filter Beds. Reports results of experiments extending over 3½ years. 900 w. Eng News—April 10, 1902. No. 47510.

Management of the Septic Tank. Extracts from a paper read before the Royal Inst. of Public Health. Discusses the objects of careful management of septic tanks and contact beds. 3300 w. Dom Engng—April 15, 1902. No. 47631 C.

The New Sewage Disposal Works at Gardner, Mass. Illustrated description of coke strainers and intermittent filters, with automatic apparatus for discharging sewage over them, operating at 150,000 gallons per acre daily on the filters. 2300 w. Eng Rec—April 12, 1902. No. 47472.

The New Sewage Disposal Works at Pittsfield, Mass. An illustrated description of the new plant to take the place of the temporary outlets into the Housatonic River. 1800 w. Eng News—April 24, 1902. No. 47671.

The Present Status of the Sewage Problem in England. Report of a lecture by L. P. Kinnicutt on current British opini n concerning septic tanks, contact beds and intermittent continuous filters. 1600 w. Eng Rec—March 29, 1902. No. 47205.

Sewers.

A Reinforced Concrete Sewer. Illustrated description of an 8x14-ft. sewer wholly of concrete, the roof being strengthened by concrete-steel beams. 300 w. Eng Rec—April 12, 1902. No. 47475.

Washington, D. C.

Beautifying the Nation's Capital. An illustrated article discussing new bridges to be built to replace what is called the "Long bridge." 4200 w. In Archt—March, 1902. No. 47239 D.

WATER SUPPLY.

Dams.

The Construction of the Wachusett Dam. Illustrated description of the plant and methods employed in constructing a masonry dam 850 ft. long and 207 ft. high. 4300 w. Eng Rec—April 5, 1902. No. 47322.

The Proportions of Reservoir Dams. (Beitrag zur Dimensionierung der Thalsperrenmanern). G. Ramisch. Developing formulas for the stability of masonry dams, tabulating the values for various dimensions. 1800 w. Zeitschr d Oesterr Ing u Arch Ver—April 4, 1902. No. 47728 B.

Purification.

Water Purification for Domestic Use. F. Rigaud. Discusses methods of sterilization of water, and other considerations that must be taken into account. Especially favoring the ozone process. 3000 w. Min & Sci R—April 5, 1902. No. 47484.

Water-Works.

A Kindergarten Lesson in Water Supply. An account of Jersey City's experience in buying water-works and water rights from a contractor without itself preparing plans. 1200 w. Eng Rec—April 12, 1902. No. 47471.

The Fire Protection Obligation of Water Companies. Reviews a decision of the Kentucky Court of Appeals, holding that a water company can be sued by the owners of property destroyed through inadequate water supplies for fire protection. 900 w. Eng Rec—March 29, 1902. No. 47201.

COMMUNICATION.

Cable Testing.

A Modified Mance Test. J. H. Strong. Explanatory of the method of eliminating the error due to earth current in localizing faults in submarine cables. 200 w. Elect'n Lond—March 28, 1902. No. 47440 A.

Exchanges.

Exchange Construction. W. H. Crumb. Read before the Interstate Independent Tel. Assn. Considers points of importance in good construction. 2200 w. Telephony —April, 1902. No. 47496.

Space Telegraphy.

An Induction Cost for X-Light Tubes and Wireless Telegraphy. William Rollins. An illustrated article giving directions which will enable anyone possessing mechanical skill to construct a seventy-centimetre induction coil suitable for the powerful currents needed in wireless telegraphy and in X-light work. 3500 w. Elec Rev, N Y—March 29, 1902. No. 47235.

Long-Distance Telegraphy and Marconi's Latest Experiments. Fernand Poucelet. An examination of Marconi's experiment in sending a signal between the Lizard and Newfoundland, with the aim of judging what will be the future of wireless telegraphy over the ocean. Ill. 3500 w. Elec Engr, Lond—April 18, 1902. Serial. 1st part. No. 47805 A.

Tesla's Work and Marconi's. From the *New York Sun.* Quotes from a lecture by Tesla delivered in 1893. and notes, the acknowledgement by Prof. A. Slaby that Tesla is the inventor of the process of wireless telegraphy. 2500 w. Elec, N Y—April 9, 1902. No. 47463.

The Marconi Wireless Telegraph System in Canada. Wilfrid Blaydes. An account of the agreement considering the fourteen clauses *seriatim.* 2000 w. Elec Wld & Engr—March 29, 1902. No. 47248.

The Telephone in Wireless Telegraphy. Emile Guarini. Part first gives illustrated descriptions of various methods of wireless signaling. 1200 w. Elec Wld & Engr —April 5, 1902. Serial. 1st part. No. 47417.

Wireless Telephony. A. Frederick Collins. Explains five distinct methods for transmitting speech without wires at varying distances. 1200 w. Elec Wld & Engr —April 5, 1902. No. 47418.

Wireless Telegraphy and Submarine Cables. E. Guarini. An illustrated article discussing Mr. Mervyn O'Gorman's idea. that the coherer might render valuable service to submarine cables. 1200 w. Elec Rev, Lond—March 21, 1902. Serial. 1st part. No. 47288 A.

Wireless Telegraphy in Spain. E. Guarini. An account of the experimental work of Señor Julis Cervera Baviera, with description of the instruments used, tests, &c. Ill. 2300 w. Elect'n, Lond—April 18, 1902. No. 47810 A

Wireless Telegraphy: Mr. Marconi's Short-Distance Work in Europe and America. Wilfrid Blaydes. A brief account of the extent to which this part of the work has been developed. Ill. 2400 w. Elec Wld & Engr—April 5, 1902. No. 47421.

Telephony.

A Modern Central Energy Bell Telephone Exchange. Illustrated description of the new common battery exchange at Mt. Vernon, N. Y. 1200 w. Am Elect'n —April, 1902. No. 47374.

An Independent Central Energy Exchange and Toll Line Office. An illustrated description of the exchange at Alton, Ill., which is a part of a scheme to give long-distance service to the cities of Missouri and Southern Illinois. 1400 w. Am Elect'n—April, 1902. No. 47378.

The Evolution of the Message Rate Telephone Service. Herbert Laws Webb. Reviews the progress before and since the adoption of the message rates. 2200 w. Elec Wld & Engr—April 5, 1902. Serial. 1st part. No. 47420.

The Technical Development of Telephony. Kempster B. Miller. A rapid review of the development. 3500 w. Telephony—April, 1902. No. 47495.

Underground.

Underground Conductors for the Municipal Telephone System of the German Post Office. (Unterirdische Führung von Anschlussleitungen in Stadfernsprechnetzen der Deutschen Reischpost). H. Zappe. A fully illustrated description of the underground system recently installed in Berlin. 5000 w. Elektrotech Zeitschr—April 10, 1902. No. 47755 B.

DISTRIBUTION.

Conductors.

A Rapid Method of Computing the Regulating Resistance for Electric Lighting Conductors (Praktische und Schnelle Berechnung der Widerstands regulatoren für Licht leitungen). P. Gesing. Deducing a simple formula and providing full tables for practical use. 2000 w. Elektrotech Zeitschr—April 3. 1902. No. 47750 B.

We supply copies of these articles. See page 487.

The Cost of Electrical Conductors. (Beitrag zur Kostenberechnung Elektrischer Leitungen). L. W. Cohn. Discussing the use of a formula in which the unit cost and character of the conductor are given, and the cost for any required service may be determined. 1000 w. Elektrotech Zeitschr—March 27, 1902. No. 47748 B.

Grounding.

Grounding of High Potential Systems. J. D. Nies. The aim of the paper is to determine what are the causes to which the existence of danger may be ascribed, with special reference to the occasional practice of grounding the point of zero e. m. f. in such systems. Also editorial. 3300 w. Elec Wld & Engr—April 12, 1902. No. 47505.

Insulation.

A Study of Insulating Compounds. This first article deals with shellac. 1200 w. Cent Sta—April, 1902. Serial. 1st part. No. 47371.

Mains.

The Mains Department of a Direct-Current Electricity Supply Station. J. F. Moore. Sketches the different characteristics of the several classes of cable, discusses localization of faults, meters, &c. 3800 w. Elec Engr, Lond—April 11, 1902. No. 47585 A.

Paris.

The Sections of Electrical Distribution in Paris (Les Secteurs de Distribution d'Electricité à Paris). C. Marquet. The first of a series describing the character and extent of electrical distribution under the various concessions in Paris. Serial. 1st part. 2500 w. Génie Civil—March 22, 1902. No. 47701 D.

Wiring.

Electric Wiring Methods of To-day. Fred. Bathurst. Discusses this subject with especial reference to conduit systems. 3800 w. Elec Rev, Lond—April 11, 1902. No. 47588 A.

The Wastes of Wiring. J. Whitcher. Means of reducing waste are discussed. 2000 w. Elec Engr Lond—April 4, 1902. No. 47425 A.

ELECTRO-CHEMISTRY.

Accumulators.

The Max Accumulator. From *La Locomotion*. Illustrated detailed description of this new system. The electrodes have a cylindrical form. 1000 w. Sci Am Sup —April 19, 1902. Non. 47562.

Acker Process.

The Acker Electrolytic Alkali Process. Clinton Paul Townsend. Reviews the work of prior investigators, and compares this process with the Castner-Kellner mercury cathode process. Ill. 2300 w. Elec Wld & Engr—April 5, 1902. No. 47419.

Electro-Metallurgy.

Recent Developments in the Electro-Metallurgy of Iron and Steel. Marcus Ruthenberg. Considers the magnetic concentration of low-grade ores in the electric furnace; describes the Conley electric steel-smelting process for the production of steel direct from the ore; and the Harmet process for the production of steel direct from the ore. Ill. 3000 w. Electro-Chem & Met—March, 1902. No. 47563 A.

Germany.

The Electrochemical Metal Industries of Germany. (Von der Elektrochemischen Metall-Industrie Deutschlands). H. Danneel. A review of the present conditions of the electrochemical production of metals, with data as to export quantities, and methods of operation. 3000 w. Zeitschr f Electrochemie—March 6, 1902. No. 47-757 D.

Graphite.

Artificial Graphite and Platino-Iridium as Materials for Anodes (Ueber Künstlichen Graphit und über Platiniridium als Anodenmaterialen). F. Foerster. Data and results of experiments to determine the durability of anodes of artificial graphite under various conditions. 2500 w. Zeitschr Elektrochemie—March 6, 1902. No. 47758 D.

Hargreaves-Bird.

Hargreaves-Bird Process for the Electrolytic Production of Soda and Bleach. Edward Walker. Illustrated detailed description of the works and plant, with account of the principles of the process. 1500 w. Eng & Min Jour—April 5, 1902. No. 47402.

Ionisation.

Ionisation of Gases by Ionic Shock. J. Stark. Abstracted from *Ann. der Physik*. Explains the ionic theory and the work in this field. The object of the paper is to find theoretical guides for experimental work. 3800 w. Elect'n, Lond—March 21, 1902. No. 47289 A.

Manganese.

The Determination of the Melting Point of Manganese (Schmelzpunktsbestimmung von Mangan). W. C. Heraeus. A description of the use of electric fusion methods by which the melting point of manganese is found to be 1245 degrees centigrade. 1200 w. Zeitschr f Elektrochemie—April 3, 1902. No. 47759 D.

Niagara Falls.

The Electro-Chemical Industries at Niagara Falls. Abstract of a lecture by Prof. Joseph W. Richards before the N. Y. Elec. Soc. describing the manufacture of aluminum, the Acheson carborundum and graphite, the Castner sodium process and caustic soda process, the manufacture of carbide, and the Salom lead reduction process. 2800 w. Ir Age—April 3, 1902. No. 47319.

Polarization.

Electrochemical Polarization. C. J. Reed. Concludes that polarization is a progressive change in the composition and electromotive force of an electrochemical system necessitated by the progressive exhaustion of one or more of the electrochemical reagents. 3500 w. Jour Fr Inst —April, 1902. No. 47395 D.

ELECTRO-PHYSICS.

Alternating Currents.

Apparatus for the Demonstration of Alternating Currents (Apparat zur Demonstration von Wechselströmen). Dr. R. Heilbrun. Describing the construction of a lecture room model, with revolving arms and disc, enabling the sine-curve phenomena to be mechanically produced before an audience. 1000 w. Elektrotech Zeitschr—March 20, 1902. No. 47745 B.

Electromagnets.

The Distribution of Magnetic Flux in Large Electromagnets. W. M. Thornton. Read before the Newcastle Soc. of the Inst. of Elec. Engrs. Describes a method giving precise knowledge of the flux at any desired point of the circuit and of its variation with magnetizing current or with time. It has been the aim to do for magnetic observations what the indicator diagram does for engine testing. 5000 w. Elec Engr, Lond—April 11, 1902. Serial. 1st part. No. 47586 A.

Electronic Theory.

The Electronic Theory of Electricity. Dr. J. A. Fleming. A sketch of this theory showing the evolution of the idea that electricity is atomic in structure, and thus these atoms of electricity called electrons attach themselves to material atoms and are separable from them. 9800 w. Pop Sci M—May, 1902. No. 47651 C.

Electrons.

Note on the size and Inertia of Electrons. Oliver Heaviside. A review of the work that has been done in determining the physical constants of the electron. 700 w. Elect'n, Lond—April 4, 1902. No. 47427 A.

Lightning.

Lightning Above and Below Water. Prof. John Trowbridge. An illustrated account of experiments believed to show that lightning never strikes the surface of the sea. 1100 w. Sci Am—April 5, 1902. No. 47384.

Photographone.

Speaking Photography (Sprechende Photographien). H. Zacharias. Describing the apparatus by which the variations in an electric arc due to articulate sounds may be photographed on a moving film, and subsequently re-produced by means of a selenium cell and telephone. 2000 w. Glasers Annalen—March 15, 1902. No. 47731 D.

Radio-Conductors.

Single-Contact Radioconductors (Radioconducteurs à Contact Unique). E. Branly. A resumé of experiments with single contacts through a film of oxide. 1000 w. Comptes Rendus—Feb. 10, 1902. No. 47724 D.

Rotating Disks.

Condenser Effects with Rotating Disks. A. G. Dill. An account of experiments with description of apparatus used. 1000 w. Elec Wld & Engr—March 29, 1902. No. 47250.

Static Effects.

Static Strains in High Tension Circuits and the Protection of Apparatus. Percy H. Thomas. Discusses the "static effects" in high tension circuits, especial attention being given to the disturbances produced by lightning, switching, grounding, and the like. Ill. 19000 w. Trans Am Inst of Elec Engrs—March, 1902. No. 47568 D.

Thermo-Electricity.

Electricity and Power Direct from Heat. James Asher. Reviews some of the methods, the thermo-electric batteries, pyromagnetic generators, &c. 1500 w. Sci Am—March 29, 1902. No. 47224.

Waves.

Electric Waves in Wires (Elektrische Drahtwellen). G. Seibt. An examination of the action of electric waves in metallic wires, with reference to the utilization of electric waves in wireless telegraphy. Serial. Part 1, 4000 w. Electrotech Zeitschr—April 10, 1902. No. 47754 B.

GENERATING STATIONS.

Alternators.

Parallel Operation of Alternators. Paul M. Lincoln. Discusses this subject and describes a new synchronism indicator invented by the writer, and the principles upon which it rests. Ill. 5300 w. Jour Fr Inst—April, 1902. No. 47394 D.

The Phase Displacement of Alternators and Parallel Running. H. C. Leake. Deals with the effect of periodic fluctuation of the turning moment of the prime mover. 1500 w. Elec Rev, Lond—April 4, 1902. Serial. 1st part. No. 47524 A.

Armatures.

The Phenomena in Double-Current Armatures (Ueber die Vorgänge in Wechselstromdurchflossenen Gleichstromankern). L. Fleischman & A. Orgler. An examination of the occurrences in ring armatures from which both continuous and alternating currents are taken. 2000 w. Elektrotech Zeitschr—March 27, 1902. No. 47747 B.

Coal Question.

The Coal Question in Generating Stations. Discusses the cause of such wide variation in prices, and gives a brief study of the varieties in use. 3800 w. Elec Times—April 3, 1902. No. 47532 A.

Commutator.

How Many Commutator Sections Should Be Used in a Continuous-Current Dynamo? (Wieviel Kollektorlamellen Soll eine Gleichstrommaschine Haben?) A. Rothert. An examination of the construction of the commutators of continuous-current dynamos, showing the method of computing the proper number of sections. 6000 w. Elektrotech Zeitschr—April 10, 1902. No. 47752 B.

Cornwall.

A Novel Central Station at Cornwall. An illustrated article describing this recently completed station in Canada, of special interest because of illuminating the locks and their approaches on the Cornwall Canal, thus permitting the passage of ships day and night. 800 w. Cent Sta—April, 1902. No. 47370.

Dynamos.

The Operation of Two or More Dynamos Together. B. T. McCormick. Discusses the cases of dynamos in parallel, the three-wire system, and dynamos in series explaining the reasons. Mathematical. 900 w. Elec Rev, N Y—April 5, 1902. No. 47401.

Generators.

Running Direct-Current Generators in Parallel. John H. Ryan, Jr. An illustrated article discussing economical running at all loads. 3000 w. Engr, U S A—April 1, 1902. Serial. 1st part. No. 47356.

Synchronous Reactance. F. G. Baum. Presents a method showing the probable error due to using the synchronous reactance in computing the effect of regulation. 800 w. Elec Wld & Engr—April 26, 1902. No. 47675.

Hydro-Electric.

A Small Water Power Electric Transmission Plant for Local Lighting Service, Utah County, Utah. W. P. Hardesty. Illustrated description of a plant as an example of what can be done in the way of utilizing the natural fall of many mountain streams for the benefit of neighboring settlements. 1800 w. Eng News—April 17, 1902. No. 47549.

Notes on Irish Water-Power and Its Electrical Development. W. Tatlow. Abstract of a paper read before the Dublin Local Section of the Inst. of Elec. Engrs. A general survey of water-power that can commercially be made available, with descriptions of a few places. 3000 w. Elect'n, Lond—April 4, 1902. No. 47528 A.

Isolated Plant.

A Central Station Isolated Plant. Illustrated detailed description of the plant of the Peruna Drug Mfg. Co., of Columbus, O. Interesting because of the high-class of the installation, diversity of service, and special devices and their applications. 3500 w. Elec Wld & Engr—April 26, 1902. No. 47674.

Municipal Works.

Middleton Electric Lighting and Tramways. Illustrated description of small supply works recently opened in England. 1600 w. Elect'n, Lond—April 11, 1902. No. 47583 A.

Parallel Operation.

Parallel Operation of Engine-Driven Alternators. W. L. R. Emmet. Explains a method of overcoming the difficulties of surging which has been in successful use for three years. 2500 w. Trans Am Inst of Elec Engrs—March, 1902. No. 47575D.

Polyphase.

Some Notes on Polyphase Machinery. A C. Eborall. Read before the Manchester Sec. of the Inst. of Elec. Engrs. Considers the construction and operation of standard types, discussing the latest development. Ill. 3000 w. Elec Rev, Lond —April 18, 1902. Serial. 1st part. No. 47808 A.

Power Supply.

Electric Power Supply on the Northeast Coast. C. S. Vesey Brown. Read before the Newcastle Section of the Inst. of Elec. Engrs. A brief retrospect of the history of electric power supply in England, with views on the equipment of power stations, and the possibilities which will probably follow their instalment. 4500 w. Elec. Engr, Lond—March 21, 1901. No. 47286 A.

Regulation.

The Regulation of Prime Movers and Parallel Operation of Alternators. Charles P. Steinmetz. Considers features regarding the effect of speed regulation of prime movers, and difficulties with parallel operation of alternators driven from separate prime movers. 1200 w. Trans Am Inst of Elec Engrs—March, 1902. No. 47574 D.

Rhyl Works.

The Rhyl Electricity Works. An illustrated description of dynamos, engines, boilers, steam-pipes, switchboard, cables and arc lamps used. 2000 w. Elec Engr, Lond—March 28, 1902. No. 47437 A.

Sparking.

Sparking—It's Cause and Cure. Arthur L. Rice. A study of injurious sparking considering its cause, effects, and location of the trouble. Ill. 2500 w. Engr, U S A—April 1, 1902. No. 47353.

Swiss Plant.

Electrical Works of the Maschinenfabrik Oerlikon. Frank C. Perkins. Illustrates and describes details of this great Swiss plant. 2500 w. Mach, N Y—April, 1902. No. 47423.

Tariffs.

The Influence of Tariffs on Electricity Supply. C. Ashmore Baker. Commences an examination of undertakings to ascertain the influence the various methods of charging for electrical energy may exert on the load factors and financial results. 800 w. Elec Rev, Lond—March 21, 1902. Serial. 1st part. No. 47287 A.

HEATING AND WELDING.

Electric Furnaces.

A Modification of the Moissan Furnace (Uebereinen Modifizierten Moissanschen Schmelzofen). L. Liebmann. A detailed illustrated description of an improved electric furnace especially adapted for laboratory use. 1800 w. Zeitschr f Elektrochemie—Feb. 27, 1902. No. 47756 D.

Some Recent Electric Furnace Products. Clinton Paul Townsend. Concerning the methods for the pulverization of metals in the electric furnace and the nature of the products obtained. 900 w. Elec Wld & Engr—April 5, 1902. No. 47422.

LIGHTING.

Boulevard Lighting.

The Lighting of Diversey Boulevard, Chicago. J. R. Cravath. Illustrates and describes one of the best recent examples of boulevard lighting in the United States. The lamps are series direct-current enclosed arcs, taking 6.2 amperes at 72 volts. 1200 w. Am Elect'n—April, 1902. No. 47377.

Illumination.

The Art of Design for Electric Illumination; Domestic and Public. Fred T. Cash. Comments on the great improvement made in fixtures for interior lighting, and criticises the designs for public lighting. 2000 w. Elec Rev, Lond—April 11, 1902. No. 47587 A.

Nernst Lamp.

Development of the Nernst Lamp in America. Alexander Jay Wurts. Discussion at Buffalo, Aug. 23, 1901. 6800 w. Trans Am Inst of Elec Engrs—March, 1902. No. 47570 D.

Tests on the Nernst Lamp, R. P. Hulse. Read before the Birmingham Sec. of the Inst. of Elec. Engrs. Reports tests made of the 1902 model. 2800 w. Mech Engr—April 5, 1902. No. 47531 A.

MEASUREMENT.

Conductivity.

The Commercial Measurement of Electrical Conductivity. Lawrence Addicks. A review of the methods and apparatus for the measurement of conductivity and a brief discussion of their respective merits. 3300 w. Elec Rev, N Y—April 12, 1902. No. 47504.

Photometry.

An Improved Apparatus for Arc Light Photometry. Discussion of a paper by Dr. Matthews at New York, Sept. 27, 1901. 3000 w. Trans Am Inst of Elec Engrs—March, 1902. No. 47573 D.

Transformation.

Ratio of Transformation in Three-Phase Circuits. William A. DelMar. Calls attention to the changes in ratio of transformation that can attend the various methods of connecting sectional transformers with three-phase circuits. Mathematical. 600 w. Elec Wld & Engr—April 19, 1902. No. 47645.

Voltmeters.

An Apparatus for the Rapid Comparison of Voltmeters. F. A. Laws and W. D. Coolidge. Describes apparatus used at the Mass. Inst. of Tech. for comparing direct current voltmeters with a standard instrument. Ill. 1300 w. Tech Qr— March, 1902. No. 47816 E.

Zero Method.

Zero Method for Magnetic Measurements (Nullmethode für magnetische Messungen). R. Goldschmidt. Discussing applications of the method of determining the magnetic force of given windings by the use of auxiliary windings producing induced currents in opposite directions. 1200 w. Elektrotech Zeitschr—April 10, 1902. No. 47753 B.

POWER APPLICATIONS.

Cranes.

Electric Locomotive Crane (Ein Elektrisch Betriebener Locomotivguss Krahn). C. Machacek. An illustrated description of a traveling locomotive crane operated by electric power taken from an overhead trolley. 2500 w. 2 plates. Oesterr Zeitschr f Berg u Hüttenwesen—March 15, 1902. No. 47767 B.

Electric Power for Forge Cranes (Elektrische Drehvorrichtung für Schmiedekrähne). A. Willaredt. A description of a new electric crane for use in connection with forging presses at the Cockerill Works at Seraing. 1200 w. Stahl u Eisen —April 1, 1902. No. 47738 D.

Magnetic Brakes. Gerald E. Flanagan. An illustrated explanation of the action of magnetically operated brakes as used on cranes and hoisting machinery. 700 w. Am Mach—April 10, 1902. No. 47488.

Modern Electric Hoists and Cranes for Steel Works. Dr. A. Krebs. Illustrated description of an installation in a new Belgian foundry. 700 w. Elec Wld & Engr —March 29, 1902. No. 47251.

Haulage.

Electric Haulage in Coal Mines. W. B. Clarke. Brief illustrated description of plant, with general remarks. 1400 w. Elec Wld & Engr—March 29, 1902. No. 47247.

Machine Driving.

Influence of Electricity in Shops. Cloyd Marshall. An illustrated article reviewing the advantages and showing machines operated by electricity. 2000 w. Engr, U S A—April 1, 1902. No. 47355.

Mining Plant.

A Polyphase Electric Power Plant, and a Direct-current Power Plant. Illustrates and describes two recently installed plants at English collieries, comparing the two. 4000 w. Col Guard—April 11, 1902. No. 47593 A.

Mexican Electric Power Distribution to the Santa-Rosalia Copper Mining near the Gulf of California. Frank C. Perkins. Illustrations with description of the plant. 2000 w. Min Rept—April 10, 1902. No. 47508.

Sparkless Electrical Plant for Use in Mines and Ironworks. Abstract of a paper by J. H. Whittaker read at meeting of the South Staffordshire and East Worcestershire Inst. of Min. Engrs. 2700 w. Col Guard—April 18, 1902. No. 47692 A.

The Electro-Mechanical Plant at the Tunnel of the Raibl Mine (Der Elektro-Maschinelle Betrieb des Neues Hilfstolleng für den Ararischen Erzbergbau in Raibl). A. Edlen von Posch. Describing the electric drills and other machinery used in running the auxiliary tunnel of the Raibl mines in Carinthia, Austria. Four articles. 7500 w. Oesterr Zeitschr f Berg u Hüttenwesen—March 8, 15, 22, 29, 1902. No. 47766 each B.

Motors.

Characteristic Performance of the Induction Motor. A. S. McAllister. Discusses the ordinary polyphase induction motor, its characteristic behavior as built at present, starting devices, etc 2200 w. Am Elect'n—April, 1902. No. 47375.

Continuous Current Motors with Variable Speed (Ueber Gleichstrommotoren mit Veränderlich Umdrehungszahl). A. Hundt. The variation in speed is effected by varying the air gap between the poles and the armature. 1200 w. Elektrotech Zeitschr—March 20, 1902. No. 47744 B.

Synchronous Motor Stability and Overload Capacity Curves. F. G. Baum. Considers some important factors influencing the stability and overload capacity of motors, giving method of determining curves. 1800 w. Elec Wld & Engr—March 29, 1902. No. 47249.

Motor Tests.

Tests of Polyphase Motor (Untersuchung eines Drehstrommotors). E. Ziehl. Data and results of tests of a polyphase motor built by the Berlin Maschinenbau A. G., with curves showing efficiency and capacity under various conditions. 3500 w. Elektrotech Zeitschr—March 20, 1902. No. 47744 B.

United States.

The Position of the United States in the Production of Electric Power. Sidney Graves Koon. Tables and diagrams with facts showing the enormous preponderance of the United States in every department of this field. 1300 w. Sib Jour of Engng—March, 1902. No. 47057 C.

TRANSMISSION.

Cables.

Air-Spaced Cables: Their Treatment and Use. G. E. Fletcher. Read before the Manchester Sec. of the Inst. of Elec. Engrs. Considers the conditions and precautions necessary for the production of air-spaced paper insulated cables and the question of protecting them from the destructive effect of lightning, recommending their use. 2000 w. Mech Engr—April 19, 1902. No. 47801 A.

High Potential.

Discussion of President Steinmetz's Paper on "Oscillations of Extremely High Potentials in Alternating High Potential Transmissions." Communicated after adjournment by Percy H. Thomas. 900 w. Trans Am Inst of Elec Engrs—March, 1902. No. 47572 D.

Legislation.

Electric Legislation and Finance. H. W. Handcock. Read before the Newcastle Section of the Inst. of Elec. Engrs. Discussion of these subjects as related to the practical application of electricity in England. 5000 w. Elec Engr. Lond—Feb. 28, 1902. No. 46714 A.

New Zealand.

Electric-Power Transmission Plant at Rotorua. Oswald Haes. An illustrated description of a recently installed long-distance plant in New Zealand. 6300 w. N Z Mines Rec—March 18, 1902. No. 47811 B.

Niagara Falls.

The Electric Transmission of Power from Niagara Falls. Lewis B. Stillwell. Discussion at Buffalo, Aug. 23. 1901. 5000 w. Trans Am Inst of Elec Engrs—March 1902. No. 47569 D.

Acetylene Lamps.

Experiments with Acetylene Lamps for Pit Work. Abstract of a paper by G. Franke, of Berlin, showing that at present these lamps require more careful usage than is given by the average miner. Reports of tests are given. Ill. 1200 w. Col Guard—March 21, 1902. No. 47306 A.

Benches.

I. Is There Any Economy in Full Depth Benches Over Half-Depth; and Why? D. R. Russell. II. Isolated Generator Firing of Benches. W. E. Steinwedell. Two papers, discussed together, presented at meeting of the Ohio Gas Lgt. Assn. 3500 w. Am Gas Lgt Jour—April 28, 1902. No. 47686.

Candle-Power.

Notes on Candle-Power Determinations. Charles W. Hinman. Read before the New England Association of Gas Engrs. A report of tests and of a novel method of taking candle power. 2700 w. Am Gas Lgt Jour—March 31, 1902. No. 47243.

China.

Natural Gases and Observations Concerning Gas Lights in the Chinese Empire. Sketches of work in progress in the natural gas section of China, with descriptive notes. 1700 w. Am Gas Lgt Jour—April 7, 1902. No. 47413.

Conveyors.

More About the "De Brouwer" Conveyor. Extracts from an article by P. Bolsius describing improvements made in this apparatus. Ill. 1500 w. Jour Gas Lgt—March 25, 1902. No. 47425 A.

Enrichment.

The Use of Oil in Water Gas, Coal Gas and Air Gas Production. Vivian B. Lewes. A sketch of the history of water gas and air gas manufacture, showing the importance of oil in the generation of these gases. 7000 w. Jour Gas Lgt—April 1, 1902. No. 47468 A.

Explosive Mixtures.

Explosive Gas Mixtures. A review of paper by Dr. H. Bunte, read before the German Soc. of Gas and Water Engrs. and containing much information regarding the theoretical facts involved in the construction of atmospheric gas burners and of gas engines. 1500 w. Engr, Lond —March 28, 1902. No. 47451 A.

Mixtures of Combustible Gases and Air. Gives results of experiments, published recently in German technical papers, to determine the range of proportions in which gases and air can be mixed so as to remain explosive. 800 w. Eng Rec—April 19, 1902. No. 47613.

Fuel Gas.

Fuel Gas for Domestic Use and Small Trade Purposes. Thomas Fletcher. The first of a series of articles on the application of gaseous fuel to heating purposes, with editorial. 5800 w. Jour Gas Lgt—April 15, 1902. Serial. 1st part. No. 47655 A.

Producer Gas and Its Use in Engineering and Shipbuilding. F. J. Rowan. Read before the Inst. of Engrs. & Shipbuilders in Scotland. Explains the advantages of this method of treating fuel, giving illustrated descriptions of modern types of producers. 2800 w. Mech Engr—March 22, 1902. Serial. 1st part. No. 47282 A.

The Economy of Gas-Fired Furnaces. F. J. Rowan. Abstract of paper read before the Inst. of Engrs. and Shipbuilders in Scotland. Considers the furnaces found especially useful in engineering and shipbuilding. Ill. 2000 w. Ir & Coal Trds Rev—March 21, 1902. No. 47297 A.

High Pressure.

Distributing Artificial Gas at High Pressure in a Suburban Locality. George F. Goodnow. Read before the Boston meeting of the New England Assn. of Gas Engrs. Describes the methods used by the North Shore Gas Co. in the suburban district near Chicago. Ill. 3300 w. Pro Age—April 1, 1902. No. 47271.

Distribution of Gas Under High Pressure. F. H. Shelton. Paper and discussion presented at meeting of the Ohio Gas Lgt. Assn. Ways in which it enables saving in expenses, or improvement in service, or extension. 5500 w. Am Gas Lgt Jour—April 28, 1902. No. 47684.

The Distribution of Artificial Gas Under High Pressure. Describes the methods adopted in Chicago suburbs to save the expense of large pipe lines. 1800 w. Eng Rec—April 12, 1902. No. 47478.

History.

A Brief History of Street Gas. Reviews the early history of gas as an illuminant. 900 w. Sci Am—April 5, 1902. No. 47381.

Illuminations.

Artistic Electrical Illumination. Edwin O. Sachs. Read before the Soc. for the Encour. of the Fine Arts. Reviews briefly illumination appliances used in the past, discussing gas illumination and electric lighting boards. 4800 w. Elec Rev, Lond—April 11, 1902. No. 47589 A.

Incandescence.

The Chemistry of Thorium. Summary of a paper by Dr. G. P. Drossbach. pub-

We supply copies of these articles. See page 487.

lished in the *Zeitschrift für Angewandte Chemie.* Methods of determining the value of the rare earths now so much used. 1200 w. Jour of Gas Lgt—April 1, 1902. No. 47649 A.

Lamps.

High-Power Gas Lamps and Their Cost. Reviews what has recently been accomplished by the "high pressure" system, discussing the cost. 1300 w. Builder—March 22, 1902. No. 47277 A.

Meters.

The "Positive" Meter. John Greenall, before the Eastern Counties Gas Mgrs. Assn. An illustrated article explaining the fundamental principles and working. and giving report of tests. 3600 w. Gas Wld—April 19, 1902. No. 47-804 A.

Mond Gas.

The Mond Gas Process (Mond-Gas). A description of the Mond gas process, in which the cost of power gas is reduced by the saving of the by-products. 3000 w. Glückauf—March 15, 1902. No. 47763 B.

Natural Gas.

Natural Gas in Colorado. Arthur Lakes. An illustrated description of some of its occurrences and the conditions which point to the probability of its existence. 2200 w. Mines & Min—April, 1902. No. 47337 C.

Oil Gas.

Oil Gas and Incandescent Lighting. Third lecture by Prof. Vivian B. Lewes at the Petroleum Inst. Abstract. Discusses commercial results. processes, costs, etc. 3600 w. Gas Wld—April 19, 1902. No. 47802 A.

Radiation.

The Laws of Radiation of Heat and Light. Summary giving the leading points of a series of papers by Rudolph Mewes, in the *Zeitschrift für Beleuchtungswesen.* 1200 w. Gas Wld—March 22, 1902. No. 47279 A.

Residuals.

Some Notes on the Working Up of Gas Works Residuals. The present paper deals with tar distillation. 1700 w. Gas Wld—March 29, 1902. Serial. 1st part. No. 47432 A.

Supply.

Boston and Its Gas Supply. J. S. Dongall, before the Eastern Counties Gas Mgrs. Assn. Details and early history of the supply to this English seaport. 1200 w. Gas Wld—April 19, 1902. No. 47-803 A.

Water Gas.

Carburetted Water Gas. How it affects the distributing plant, burners, cookers, etc., and the remedies, 1500 w. Gas Engrs' Mag—March 10, 1902. No. 47278 A.

The Loomis Gas Plant. Illustrated description of the water gas plant designed by the Loomis Pettibone Company of New York, which has been much improved over the first designs. 1800 w. Ir & Coal Trds Rev—March 21, 1902. No. 47299 A.

INDUSTRIAL ECONOMY

Coal Supplies.

Some Problems in Relation to Our Coal Supplies. Remarks of Prof. Archibald Elliott, contributed to the discussion of a paper by J. Stephen Jeans. The subject of Great Britain's supply is considered from a mathematical point of view. 3800 w. Ir & Coal Trds Rev—April 11, 1902. No. 47590 A.

The Misuse of Coal. W. Hibbert. Remarks on suggestions of Prof. Perry, with review of a work on "Primary Batteries." 2200 w. Elec Rev, Lond—April 18, 1902. No. 47809 A.

Exhibition.

The Düsseldorf Exhibition. Brief illustrated description of the iron, steel, and engineering industries. 1500 w. Engng—March 21, 1902. No. 47291 A.

The Rhenish-Westphalia Exposition of 1902 at Düsseldorf (Rheinisch-Westfälische Industrie Gewerbe-und Kunstausstellung, Düsseldorf, 1902). A fully illustrated description of the Düsseldorf exposition just prior to the opening, with map. 3500 w. Stahl u Eisen—April 1, 1902. No. 47736 D.

Factory Office.

The Factory Office Considered as a Productive Department. Kenneth Falconer. Mr. Falconer's second paper shows the true relation of the factory office to the stores department and the shops. 3500 w. Engineering Magazine—May, 1902. No. 47778 B.

Labor.

Compensation of Skilled Labor. J. Richards. Discussion of this subject by one who is himself a practical workman and who has had large experience in directing work and arranging compensation, etc. 6500 w. Jour Assn of Engng Socs—March, 1902. No. 47617 C.

Steel Trust.

Steel Trust Expansion. Comment on the earnings of the past year production in Sweden, and the purchase of the control of the Gellivara mines by an American combine. 1500 w. Engr, Lond—April 11, 1902. No. 47603 A.

Trusts.

The Trusts and Their Effect on the Business World. Charles Kirchoff. Read before the Philadelphia Foundrymen's Assn. Considers the effect of consolidation upon the manufacturing industries; how they are to deal with the growing competition, etc. 3500 w. Ir Age—April 17, 1902. No. 47344.

Works Management.

Money Making Management for Workshop and Factory. C. V. Carpenter. Mr. Carpenter's fourth paper discusses in detail the systematic arrangement and operation of the stock department of a factory. 5000 w. Engineering Magazine—May, 1902. No. 47773 B.

MARINE AND NAVAL ENGINEERING

Battleship.

The French Coast Defence Battleship Requin. An illustrated description of this reconstructed battleship which has been brought well up to date in construction and equipment. 800 w. Engr, Lond—March 21, 1902. No. 47303A.

The French Reconstructed battleship Courbet. Illustrated description of the modifications introduced in the vessel and armament. 350 w. Engr, Lond—April 11, 1902. No. 47602 A.

Combination.

A Great Steamship Combination. Information obtained from Clement A. Griscom concerning the recent combination of six lines by J. Pierpont Morgan, and what they propose to accomplish. 2200 w. Marine Rev—April 24, 1902. No. 47683.

Corrosion.

Corrosion of Condenser Tubes and Sea-Water Conductors. Prof. Ernst Cohen. Read before the Inst. of Naval Archts. An acount of researches and the remedies recommended. Ill. 2000 w. Mech Engr—April 19, 1902. No. 47800 A.

Crank-Shafts.

Strains on Crank-Shafts. Prof. S. Dunkerley. Read before the Inst. of Naval Archts. Considers the straining action on the different parts of a crank-shaft, illustrating by an actual case of a four-cranked marine shaft. Ill. 3700 w. Engng—March 28, 1902. Serial. 1st part. No. 47450 A.

Cruisers.

Repairs and alterations to the U. S. S. Olympia. William P. Robert. An illustrated article describing the extensive repairs made to bring the vessel thoroughly up to its fighting efficiency, and to refit and adorn it in memory of the prominent part it took at Manila. 5000 w. Marine Engng—April, 1902. No. 47624 C.

Destroyer.

The Repair of the Torpedo-Boat Destroyer "Salmon." Illustrated description of interesting reconstruction of a vessel almost cut in two transversely by a collision. 2500 w. Engng—March 21, 1902. No. 47292 A.

Torpedo-Boat Destroyer S. W. Barnaby. Read before the Inst. of Naval Archts. A discussion of this type of vessel as used in the British Navy, as to seaworthiness, strength, &c. 3400 w. Engng—March 21, 1902. No. 47295 A.

Economy.

The Growth of Economy in Marine Engineering. W. M. McFarland. Mr. McFarland's third paper deals with the multiple expansion engine and the great advances in economy which followed its introduction. 4000 w. Engineering Magazine—May, 1902. No. 47774 B.

Ferryboat.

New Screw Ferryboat. An illustrated description of the "Edgewater," the latest to be built for New York waters. 1800 w. Naut Gaz—April 24, 1902. No. 47661.

Floating Dock.

The New Bermuda Floating Dock. H. J. Stepstone. Illustration with description of this latest equipment to the British Navy. 1200 w. Sci Am—April 5, 1902. No. 47383.

Fortresses.

Ceuta and Gibraltar. Major-Gen. John F. Crease. Discusses the value of these strongholds, especially considering the impregnability of Gibraltar. Maps. 1400 w. Jour Soc of Arts—April 11, 1902. No. 47577 A.

Freighters.

Types of Ocean Freighters for the Foreign Trade. Theodore Lucas. An illustrated review of types of ships used principally for the carrying trade between the United States and foreign countries. 1800 w. Naut Gaz—April 17, 1902. No. 47628.

Liquid Fuel.

On Liquid Fuel for Ships. Sir Fortesque Flannery, with discussion before the Inst. of Naval Archts. Considers the supply, and the comparative advantages and disadvantages for war vessels and for the mercantile ships. Ill. 6600 w. Engng —March 28, 1902. No. 47449 A.

Merchant Marine.

Manning the Merchant Marine. Theodore Lucas. Discusses steps taken by different nations to foster the interest for the sea in young men and inspire them with a healthy ambition in the work. 1500 w. Naut Gaz—March 27, 1902. No. 47229.

Naval Engineers.

The Status of the Naval Engineer. Charles M. Johnson. A strong presentation of the dangers of the existing status of the engineering branch in the British Navy, showing the urgent necessity of reform. 5000 w. Engng Mag—May, 1902. No. 47776 B.

Naval Warfare.

Recent Scientific Developments and the Future of Naval Warfare. William Laird Clowes. Read before the Inst. of Naval Archts. An appeal for greater official interest in recent inventions, and education for those who are to use the tools. 2600 w. Engr, Lond—March 28, 1902. No. 47453 A.

Navipendulum.

The Navipendular Method of Experiments, as applied to Some Warships of Different Classes. G. Russo. Read before the Inst. of Naval Archts. Gives results of experiments and comparative tests of the rolling of certain battle ships. 6400 w. Engng—April 18, 1902. Serial. 1st part. No. 47691 A.

Primitive Vessels.

From Raft to Steamship. Randolph I. Geare. The present article illustrates and describes the earliest forms of vessels. 1300 w. Sci Am Sup—April 5, 1902. No. 47386.

Rudders.

Rudders. J. Foster King. Read at Glasgow Meeting of Inst. of Engrs. & Shipbuilders in Scotland. Discusses types of rudders in use in normal vessels of the merchant service. Ill. 6400 w. Naut Gaz—April 3, 1902. No. 47358.

Schooner.

Modern Five-Masted Schooner. James A. Hargan. Illustrates and describes the large steel sailing vessels being built at Bath, Me. 1700 w. Marine Engng—April, 1902. No. 47266 C.

Shaft Bearings.

Improvements in Propeller Shaft Bearings. A. Scott Younger. Read before the Inst. of Naval Archts. The objects of the paper are to record some results of experiments, and present some improvements in propeller shaft bearings, and other improvements. Ill. 3300 w. Engr, Lond—March 28, 1902. No. 47456 A.

Shipping.

Shipping Portents. Editorial discussion of the commercial requirements and the attitude of the various countries. 2600 w. Engng—March 14, 1902. No. 47084 A.

Ship Subsidy.

How Various Countries Subsidize Their Mercantile Marine. Editorial on the various means adopted by European nations to encourage their mercantile marine. 1000 w. Sci Am—March 8, 1902. No. 46690.

Ships' Plates.

Stresses on Ships' Plates. Ivan G. Boobnoff. Read before the Inst. of Naval Archts. An illustrated study of the stresses in a ship's bottom plating due to water pressure, giving a system of construction that the writer recommends. 4600 w. Engng—March 21, 1902. No. 47296 A.

Shipyards.

Recent Operations in the Shipyards on the Great Lakes. Waldon Fawcett. An illustrated article reviewing the work since the opening of the year 1901. 2200 w. Marine Engng—April, 1902. No. 47265 C.

The Electrical Equipment of a Modern Shipyard. Illustrated detailed description of the fine plant of the Fore River Ship and Engine Co., at Quincy, Mass. 3000 w. Elec Rev, N Y—April 26, 1902. No. 47667.

Signal Apparatus.

The New Signal Apparatus of the Union Electrical Company (Die Neuen Signalapparate der Union Elektricitäts Gesellschaft). E. Henbach. An illustrated description of an improved electrical apparatus for signalling from the bridge of a vessel to the engine room. 5000 w. Elektrotech Zeitschr—April 3, 1902. No. 47751 B.

Steamships.

Steamship Lines of the World. An enumeration of the leading steamship lines of the most important countries, with illustrations of four representative American steamships. 5400 w. Naut Gaz—April 17, 1902. No. 47629.

The Screw Steamship "Sithonia" (Der Schraubendampfer "Sithonia.") An illustrated description of the new steamer of 13,500 tons, built by the Flensburg Works for the Hamburg-America China trade. 2500 w. 1 plate. Zeitschr d Ver Deutscher Ing—April 12, 1902. No. 47716 D.

Turbine Engines.

Turbine Engines for Passenger Ships. Notes on the "King Edward." An illustrated article discussing the performance of the turbine engines, and concluding that they are destined to play an important part in the propulsion of steamships. 1500

w. Sci Am Sup—April 5, 1902. No. 47388.

Vibrations.

Torsional Vibrations of Shafts. L. Gumbel. Read before the Inst. of Naval Archts. A study of the torsional vibrations of the shafts of marine engines by the aid of Fourier's Theorem. 4600 w. Engng—April 11, 1902. No. 47595 A.

Yachts.

German Emperor's Yacht Meteor III. An illustrated account of the launching and brief description of the vessel. 1000 w. Marine Engng—April, 1902. No. 47268 C.

The Arrow, Fastest Steam Vessel in the World. Jefferson S. Briggs. An illustrated detailed description of this recently built twin-screw yacht, intended to attain the highest possible speed. The design and construction of the hull and machinery are of particular interest. 3800 w. Sta Engr—April 15, 1902. No. 47626.

MECHANICAL ENGINEERING

AUTOMOBILES.

Alcohol.

Alcohol for Automobiles. R. F. Collins. Discusses the headway made in France and Germany in the use of alcohol as a fuel for motor vehicles. 1200 w. Auto Mag—April, 1902. 47274 C.

The Spirit-Locomotive Wagon in Germany. Concerning competitive prizes offered for these vehicles, giving synopsis of specifications and points to be considered in the competition. 900 w. U S Cons Repts. No. 1322—April 22, 1902. No. 47606 D.

Automobiles.

Automobiles. Hiram Percy Maxim. Discusses the real field of the automobile, especially in urban or city transportation. 2200 w. Am Mfr—April 3, 1902. No. 47360.

Cleaning.

The Automobilist's Spring Cleaning. Albert L. Clough. Suggestions relating to the preparation of motor vehicles which have been out of use, for their period of activity. 2500 w. Horseless Age—March 5, 1902. No. 46666.

Construction.

Some French Novelties. L. Berger. Illustrated review of automobiles shown at the recent exhibition in Paris. 900 w. Horseless Age—Feb. 26, 1902. No. 46508.

Endurance Contest.

Rules and Regulations of the 100-Mile Endurance Contest of the A. C. A. A statement of eighteen rules governing the contests. 2300 w. Horseless Age—March 12, 1902. No. 46894.

Exhibits.

The Leipsic Automobile Show. Illustrations and descriptions of various types exhibited with general remarks. 1500 w. Sci Am Sup—April 26, 1902. No. 47659.

Flash Boilers.

Flash Steam Generation. Charles F. Ruby. Considers points in the design of a successful flash boiler, materials to be used, construction, &c. 1400 w. Horseless Age—April 2, 1902. Serial. 1st part. No. 47320.

Fuel Tests.

Fuel Tests of Automobile Vehicles (Epreuves de Consommation pour Voitures Automobiles). Data and results of various trials, with especial reference to internal combustion motors using alcohol and essence. 1200 w. Génie Civil—March 22, 1902. No. 47702 D.

Heavy Hauling.

Requirements for Heavy Hauling Gives the requirements specified in the competition instituted by the German Government. 2000 w. Auto Topics—April 12, 1902. No. 47464.

Land Yacht.

A Boat on Wheels. John L. von Blon. Illustrates and describes a novel sail propelled vehicle which has been in service on the western desert for eight months. 900 w. Sci Am—April 19, 1902. No. 47560.

Mors Car.

The 15 H. P. Mors. An illustrated description of the mechanism. 1200 w. Autocar—March 15, 1902. No. 47125 A.

Motor Bicycle.

Holden's Motor Bicycle. Illustrates and describes an ingenious invention exhibited at the Crystal Palace Motor Car Show. 1000 w. Engr, Lond—April 4, 1902. No. 47516 A.

Motor Trucks.

Motor Delivery and Trucking in New York City. Harry E. Day. Reports of various users in Greater New York, not very favorable to their efficiency. 5000 w. Horseless Age—April 16, 1902. No. 47545.

Nice.

The Automobile Meeting at Nice. An account of the meeting and illustrated descriptions of the new cars, and their trials and other matters of interest. 5500 w. Autocar—April 19, 1902. No. 47697 A.

Omnibuses.

Steam Omnibuses. Illustrates and describes types of the Thornycroft omnibuses. 900 w. Tram & Ry Wld—March 13, 1902. No. 47315 B.

Panhard-Levassor.

The New Light Panhard-Levassor Automobile. L. Baudryde Sannier, in *La Locomotion*. An illustrated detailed description. 3000 w. Sci Am Sup—March 1, 1902. No. 46557.

Petrol Car.

The New Twelve Horse-Power Humber Car. Illustrates and describes the engine and transmission. 1800 w. Autocar —April 12, 1902. No. 47580 A.

Serpollet.

Motor Vehicles with Serpollet Boilers. (Motorwagen mit Serpollet-Kesseln). H. Hempel. An account of the performance of the Serpollet steam motor vehicles in local tramway service. 1200 w. Zeitschr d Ver Deutscher Ing—March 29, 1902. No. 47712 D.

Steam Carriage.

Some Features of the Toledo Steam Carriage. Illustrates and describes features of interest. 2000 w. Horseless Age —April 16, 1902. Serial. 1st part. No. 47546.

Storage Batteries.

The Storage Battery in the Commercial Operation of Electric Automobiles. W. H. Palmer, Jr. Describes briefly the progress that has been made and the means employed to obtain economy and reliability in operation. Ill. 5200 w. Elec Wld & Engr—April 12, 1902. No. 47506.

Testing.

Automobile Testing as Thesis Work. Albert L. Clough. Indicates work which the laboratories of educational institutions might take up. 1200 w. Horseless Age—March 12, 1902. No. 46891.

Tires.

Tires and Automobile Design. F. A. Oatman. States the principal reasons for the unsatisfactory results obtained from tires, and expresses belief in the future of the solid rubber tire. 1900 w. Horseless Age—April 2, 1902. No. 47321.

Touring Car.

What a Light Touring Car Should Be. H. Ward Leonard. Lecture before the Long Is. Automobile Club. Considers nine important points that should be carefully investigated. 3400 w. Horseless Age—March 12, 1902. No. 47433.

Touring Outfit.

A Practical Automobile Touring Outfit. Hrolf Wisby. An article suggesting what should be, and should not be included. 2300 w. Sci Am—March 1, 1902. No. 46543.

War Car.

The Simms Motor War Car. Illustrated description of a car designed for coast and road defense. 1200 w. Autocar—April 12, 1902. No. 47581 A.

HYDRAULICS.

Back Water.

The Estimation of Damages to Power Plants from Back-Water. A decision of the Maine Supreme Court outlining the methods of ascertaining the damages caused by flashboards. 3500 w. Eng Rec —April 26, 1902. No. 47648.

Cranes.

Hydraulic Movable Warehouse Cranes. Illustrates and describes types made in Liverpool. 600 w. Engng—April 4, 1902. No. 47518 A.

Flow.

On the Measurement of Water by a Small Venturi Meter. E. G. Coker and T. P. Strickland. An account of experiments with illustrated description of apparatus used. 3800 w. Canadian Soc of Civ Engrs. Adv Proof—April, 1902. No. 47616 D.

Gate Valve.

An 8-inch Hydraulic Gate Valve on a Detroit Water Main Supplying River Rouge, Mich. George H. Fenkell. Illustrated description of an automatic hydraulic gate which has been in operation since 1900. 600 w. Eng News—April 17, 1902. No. 47552.

Lost Head.

Notes on Lost-Head in Water Supply Systems. A. Prescott Folwell. A mathematical discussion with conclusions. 2000 w. Eng News—April 17, 1902. No. 47550.

Plumbing.

Plumbing at the Sailors' Snug Harbor, Staten Island. Illustrated description of special work in hospital wards, a laundry, and a power house. 2600 w. Eng Rec—April 5, 1902. No. 47327.

Water Power.

The Elgin Water Power Decision. An opinion by the Illinois Supreme Court that a company managing the dam and raceways of several power users is without legal right to sue for damages caused by a diversion of water above the dam by other parties. 3000 w. Eng Rec—March 29, 1902. No. 47204.

The Joliet Water Power Plant on the Chicago Drainage Canal. Illustrated description of a 7000 H. P. plant operating under an unusually low pressure, which makes it necessary to have six turbines coupled to the shaft of each main generator. 3000 w. Eng Rec—April 19, 1902. No. 47607.

Turbines and the Effective Utilization of Water-Power. Alex. Rea. Abstract of a paper read before the Salford Science Students' Assn. Illustrated descriptions of various types of turbines, discussing their construction. 2200 w. Mech Engr—March 22, 1902. Serial. 1st part. No. 47281 A.

MACHINE WORKS AND FOUNDRIES.

Bolt Cutter.

The Acme Automatic Unit Tapping and Bolt Cutting Machines. Illustrated descriptions of two interesting and valuable machines and their operation. 1600 w. Ir Age—April 3, 1902. No. 47317.

Boring Machine.

A Large Boring Machine. Illustrated description of a fine large machine for boring large engine beds, Corliss engine cylinders, frames for large pumping engines, and similar work. 5000 w. Engr, Lond—April 18, 1902. No. 47695 A.

Cost Keeping.

Analyzing Cost of Machinery Making. Oberlin Smith. Considering cost keeping in the manufacture of machinery. 2800 w. Ir Trd Rev—April 3, 1902. No. 47399.

Cranes.

See Electrical Engineering, Power Applications.

Dies.

Dies for Punching Leather Shoe Tips. Joseph V. Woodworth. Illustrates and describes means employed for punching elaborate designs in leather. 900 w. Am Mach—April 3, 1902. No. 47350.

Forges.

Fans and Piping for Forges. William Sangster. Suggestions as to the approximate cost of blowers and piping with hints on arranging. Ill. 1300 w. Am. Mach—April 24, 1902. No. 47666.

Foundry.

The Foundry of John Lang & Sons, Johnstone, Scotland. C. C. Macmillan. Illustrated detailed description of a fine modern foundry. 2500 w. Foundry—April, 1902. No. 47275.

Foundry Cupola.

The Foundry Cupola and How to Manage It. Robert Buchanan. Read before the Staffordshire Iron & Steel Inst. Describes the various forms, and discusses their management; also considers blast pressure, scaffolding and how to avoid it, scrap iron, charging, &c., &c. Discussion follows. 13000 w. Foundry—April, 1902. No. 47276.

Lathe.

The Patternmaker's Lathe. John M. Richardson. Illustrates and describes tools for the lathe. 1800 w. Am. Mach—April 3, 1902. No. 47349.

Machine Driving.

See Electrical Engineering Power Applications.

Machinery Protection.

Fencing or Guarding Machinery Used in Textile Factories, with Special Reference to Machinery Used by Cotton Spinners and Manufacturers. Samuel R. Platt. Illustrated descriptions of guards for textile machinery. 6 plates. 3000 w. Inst. of Mech Engrs—March 21, 1902. No. 47308 D.

Fencing of Steam and Gas Engines. Henry D. Marshall. Reviews the usual modern practice of furnishing protection to diminish risk of accidents to attendants, and offers suggestions for additional safeguards. Ill. 2000 w. Inst of Mech Engrs—March 21, 1902. No. 47307 D.

Guarding Machine Tools. W. H. Johnson. Considers the conditions fulfilled by a perfect guard, the materials used, and the ways of applying them. 3 plates. 1500 w. Inst of Mech Engrs—March 21, 1902. No. 47310 D.

Protection of Lift Shafts, and Safety Devices in Connection with Lift-Doors and Controlling Gear. Henry C. Walker. States conditions and describes a lift with ideal entrance doors, locks, and controlling apparatus. 3400 w. 3 plates. Inst of Mech Engrs—March 21, 1902. No. 47-309 D.

Mechanical Device.

A Good Machinist With Only One Hand. C. W. Putnam. An illustrated article describing a device that enabled a good workman who had lost his left hand, to resume his place. 600 w. Am Mach—April 3, 1902. No. 47348.

Ordnance.

United Stat s Ordnance Factories. Waldon Fawcett. Brief illustrated descriptions of some of the government plants for the manufacture of naval and coast defense ordnance. 1500 w. Mod Mach—April, 1902. No. 47361.

Pipe Flanges.

Standardization of Pipe Flanges and Flanged Fittings. Robert E. Atkinson. An illustrated paper giving statements of sizes of pipe flanges, with number of bolts in use by several manufacturers in England, with similar particulars about general practice in Germany and America. Particulars and scale drawings of special joints, &c. 5400 w. Inst of Mech Engrs —April 18, 1902. No. 47687 D.

Planer.

The Bilgram Bevel-Gear Planer. Illustrations and descriptions of its construction and method of working. 3600 w. Engng—March 21, 1902. No. 47293 A.

Shops.

The Plant of the Bullock Electric Manufacturing Company and Its Work and Cost System. Illustrated detailed description of one of the finest modern plants, located near Cincinnati, and its methods. 5000 w. Ir Trd Rev—April 3, 1902. No. 47398.

The Works of the British Westinghouse Electric and Manufacturing Company. The present article describes the buildings of this large plant. The equipment will be dealt with in subsequent articles. Plans and illustrations are given. 2300 w. Engng—March 28, 1902. Serial. 1st part. No. 47448 A.

Surfacing.

The Surfacing Machine. Illustrated description of a new machine for facing tees, crosses and elbows. 900 w. Am Mach—April 24, 1902. No. 47665.

MATERIALS OF CONSTRUCTION.

Buckling.

The Buckling of Multiple Supported Rods (Die Knicklast Mehrfach Befestigter Stäbe). F. Wittenbauer. A mathematical investigation of the resistance to buckling of rods supported at several points, and subjected to endlong pressure. 2000 w. Zeitschr d Ver Deutscher Ing—April 5, 1902. No. 47715 D.

Corrosion.

The Corrosion of Copper Water-Pipes (Ueber Anfressungen Kupferner Wasserleitungen). H .Hüllmann. A discussion of the behavior of copper water conductors in vessels of the German Navy. 2000 w. Zeitschr d Ver Deutscher Ing—April 12, 1902. No. 47717 D.

Elasticity.

The Elastic Deformation of Solids (La Déformation Elastique des Solides). A. Mesnager. A comparison of the theoretical principles with the results obtained in the study of glass by polarized light. 12000 w. Ann des Ponts et Chaussées—4 Trimestre, 1901. No. 47719 E+F.

Gutta Percha.

Seeking Gutta-Percha. George E. Walsh. On the sources of supply, the prospect of forests of the trees in the Philippines, the advisability of cultivating the trees in suitable climates, &c. 1300 w. Elec Rev, N. Y—March 1, 1902. No. 46561.

Oil Extraction.

Extraction of Oil by Chemical Process. Information concerning the mechanical arrangements and the process used so successfully in France. 1200 w. U S Cons Repts, No. 1311—April 9, 1902. No. 47397 D.

Penetration.

The Resistance of Elastic and Non-Elastic Materials to Penetration (Résistance à la Penetration de Matiéres Elastiques on Non). E. Simon. A report upon the Persoz system of testing metallic and textile materials by penetration. 4000 w. Bull Soc d 'Encour—March, 1902. No. 47721 G.

Resistance.

The Dynamics of the Resistance of Materials (Beitrage zum Dynamischen Ausbau der Festigkeitslehre). H. Summerfeld. A discussion of the action of vibration in engineering structures, and its influence upon the resistance of materials of construction. 4000 w. Zeitschr d Ver Deutscher Ing—March 15, 1902. No. 47707 D.

Rope.

Rope. J. W. Walton. From a book issued by a Cleveland firm, giving interesting information concerning the processes of manufacturing, and the origin of wire rope. 4500 w. Marine Rev—March 13, 1902. No. 46876.

Stresses.

Stresses in Columns Subject to Combined Axial and Transverse Loading. Charles Worthington. Considers the conditions which generally exist in the designing of columns of this class, deducing formulas, &c. Ill. 2500 w. Pro Am Soc of Civ Engrs—March, 1902. No. 47216 E.

Test Bars.

The False Witness of the Test Bar. Robert Buchanan. Emphasizing the importance of obtaining correctly representative bars for testing the strength of cast iron, and showing the unsoundness of present accepted methods. 3000 w. Engineering Magazine—May, 1902. No. 47-777 B.

Testing.

The Testing of Iron and Steel on Nicked Bars (Prufung von Eisen und Stahl an Eingekerbten Stucken). M. Rudeloff. A discussion of the value of the drop test of nicked bars for the determination of the resistance of iron and steel. Two articles. 7000 w. Stahl u Eisen—April 1, 15, 1902. No. 47737 each D.

Tool Steels.

Comparative Use of American and English Tool Steels in the Machine Shops of the United States. A symposium of opinions of a number of firms called out by a statement made concerning the use of English steel in American shops. 5500 w. Ir Trd Rev—March 6, 1902. No. 46760.

Wire.

Modern Practice and Its Result in the Drawing of Wire Rods into Wire. William Garrett. Describes the modern practice of drawing rods, with brief reference to earlier effort, mostly confined to American practice. 4400 w. Ir & Coal Trds Rev—April 11, 1902. No. 47591 A.

MEASUREMENT.

Omnimeter.

The Omnimeter Annex. W. A. Warman. Illustration and suggestions showing a few of the possibilities of this device as a time saver. 350 w .Am Mach—April 10, 1902. No. 47487.

Planimeters.

Description and Theory of Coradi's Rolling Ball Planimeter. J. W. Beardsley. Illustrated description of a labor-saving instrument of great usefulness. 3500 w. Jour Assn of Engng Soc—Feb., 1902. No. 47212 C.

Verniers.

The Reading of Verniers. An explanatory article. Ill. 1300 w. Am Mach—April 3, 1902. No. 47351.

POWER AND TRANSMISSION.

Bearings.

Roller Bearings. Paper read by Prof. Hele-Shaw before the Automobile Club of Great Britain and Ireland on this subject. Ill. 3500 w. Horseless Age—April 9, 1902. No. 47465.

The Lubrication and Formation of Surfaces for Bearings. John Dewrance. An illustrated article dealing with lubrication, reciprocating bearings, bearing surfaces, &c. 3000 w. Mech Engr—March 22, 1902. No. 47280 A.

Cableway.

The Cableway of the Hydro-Electric Plant at Vouvry (Transporteur Aérien sur Cables de l'Usine Hydro- Electrique de Vouvry). A. Boudon. A description of the method used in handling the material for a hydraulic pipe line in Switzerland, in steep and difficult country. 2000 w. Génie Civil—March 29, 1902. No. 47703 D.

Compressed Air.

The Freezing of Moisture Deposited from Compressed Air. Robert Peele. Considers the conditions that cause freezing, and devices to remedy the trouble. 1600 w. Mines & Min—April, 1902. No. 47336 C.

The Use of Compressed Air in Mining. T. W. Barber. States its special advantages and applications, discussing methods, the installation and improvements needed. 2600 w. Ir & Coal Trds Rev—April 4, 1902. No. 47521 A.

Yield of Air Compressors. J. Walter Pearse. Table and descriptive matter showing a general comparison of several of the prominent makes of compressors. Also editorial. 1400 w. Compressed Air—April, 1902. No. 47480.

Conveyors.

Coal and Ash Conveying Gear. R. A. Chattock. Describes conveying apparatus most in use, pointing out their advantages and defects. 3000 w. Ir & Coal Trds Rev—March 28, 1902. No. 47443 A.

Gears.

Spiral Gear Designing Relieved of Uncertainty and Tedium. W. H. Croker. Aiming to show that a little geometrical construction is all that is needed to secure a reliable solution of any case. 1500 w. Am Mach—April 10, 1902. No. 47485.

Wheel Gearing. W. H. Thornbery. Read before the South Staffordshire Iron & Steel Inst. Begins an illustrated discussion of toothed wheels, the general principles governing the shapes and proportions of the various parts, &c. 3000 w. Ir & Coal Trds Rev—April 18, 1902. Serial. 1st part. No. 47696 A.

High Speeds.

High Speed for Shafting and Belting. Charles A. Hague. Describes a large system of transmission, where unusually high belt speeds are employed. 2400 w. Eng Rec—April 19, 1902. No. 47609.

Power Economy.

Power and Its Economical Transmission. Henry Souther. Lecture before the Canadian Mfrs Assn. Considers sources of power, distribution, transmission, losses belts and ropes, shafting and hangers in this issue. 4000 w. Brick—April, 1902. Serial. 1st part. No. 47373.

Shaft Couplings.

Universal or Flexible Joint Couplings. An illustrated article considering the principles, construction and limitations. 3000 w. Mach N Y—April, 1902. No. 47424.

Variable Speed.

A New Variable Speed Transmission. From *La Nature*. Illustrates and describes a device invented by Roger de Montais.

1500 w. Sci Am—April 19, 1902. No. 47558.

Wire Ropes.

Wire Ropes. Abstract of a paper by W. D. L. Hardie. Describes the construction of wire ropes for mine use, and its various grades, giving required tests. 1700 w. Can Engr—April, 1902. No. 47372.

SPECIAL MOTORS.

Gas Engine.

Engine for Blast Furnace Gases (Hochofengasmotor). Illustrated description of the improved double-cylinder gas engine of 350 h. p. made by Soest, of Reisholz, near Düsseldorf, for use with furnace gas. 1800 w. 1 plate. Stahl u Eisen—April 15, 1902. No. 47741 D.

Gas Engines. George F. Macmun, Jr. Read before the New England Assn. of Gas Engrs. A narration of experiences and observations, difficulties encountered and methods of overcoming them. 2500 w. Am Gas Lgt Jour—March 31, 1902. No. 47244.

Horse Power in Gas Engines. Albert Stritmatter. Discusses the things that affect the power of an engine. 1700 w. Am Mfr—April 10, 1902. No. 47467.

Large Gas Engines for Driving Electric Generators. A. R. Bellamy. Abstract of a paper read before the Manchester section of the Inst. of Elec. Engrs. Summarizes the complaints that have been brought against the gas engine, explaining what has been done to obviate them. 3800 w. Mech Engr—April 12, 1902. No. 47582 A.

The Cockerill Variable Cut Off Gear for Gas Engines. Illustrated detailed description. 1200 w. Ir Age—April 24, 1902. No. 47640.

The Niel Gas Engine (Nouveau Moteur à Explosion de la Campagnie des Moteurs Niel). The improved Niel engine has the regulation effected by the use of a variable compression. A thermal efficiency of 25 per cent, is attained. 1200 w. 1 plate. Génie Civil—March 29, 1902. No. 47704 D.

The Reid Gas Engine. Illustrations and particulars of an engine used for pumping at the oil wells in Pennsylvania. 1700 w. Am Mach—April 17, 1902. No. 47548.

STEAM ENGINEERING.

Angular Velocity.

The Angular Speed Variations of Crank Engines (Ungleichformig-keitsgrad und Winkelabweichung bei Kurbel Kraftmaschinen). F. Klönne. A mathematical investigation of the angular variations of steam and gas engines, when used for driving electric generators. 5000 w. Elektrotech Zeitschr—April 3, 1902. No. 47749 B.

Boilers.

A Water-Tube Locomotive Boiler. Illustrated description of a type used on the London & Southwestern Railway, England. 500 w. Ry Age—March 28, 1902. No. 47242.

Boiler Corrosion. H. C. Lincoln. Discusses the causes, the feed water supply, incrustation and its prevention, &c. 2200 w. Am Elect'n—April, 1902. No. 47380.

Boiler Repairs. W. J. Ranton. Considers the different types of boilers and the repairs generally needed. Ill. 2000 w. Power—April, 1902. No. 47492 C.

Boiler Testing. Charles L. Hubbard. A brief description of how to carry on a test and make the necessary computations. 2600 w. Am Elect'n—April, 1902. No. 47379.

Circulation in Water-Tube Boilers. A. C. Elliott. Investigations of the Belleville boiler, with explanation of method. 4000 w. Engng—April 18, 1902. No. 47688 A.

Circulation in Water-Tube Boilers. William H. Booth. A practical explanation of the principles and action. 3800 w. Elec Rev, Lond—April 4, 1902. No. 47523 A.

Distortion in Boilers Due to Overheating. C. E. Stromeyer. Paper read before the Inst. of Naval Archts., with discussion. Considers the nature and difficulties of the problem and suggests possible cause. 9800 w. Engng—April 4, 1902. No. 47519 A.

The Oil-Burning Water-Tube Locomotive Boiler. Brief illustrated description of a design used on the Northern Pacific Railroad. 600 w. Sci Am—March 29, 1902. No. 47225.

Chimneys.

See Civil Engineering, Construction.

Condensers.

Condensing Engine Practice. Alex. Dow. An illustrated description of the Edwards pump, and reference to other points in condenser practice. 3300 w. Jour Assn of Engng Socs—March, 1902. No. 47620 C.

Experience with Central Condensers in Mine Power Plants (Versuche und Beobachtungen an Central-Kondensationen auf Steinkohlenzechen). E. Stach. A very complete series of trials, showing the advantages of condensation, and the conditions under which the best results may be attained. 5000 w. 3 plates. Glückauf—March 29, 1902. No. 47764 B.

Separation of Oil from Condensed Steam. J. R. Bibbins. A detailed account of experimental work to evolve a method of freeing engine condensation of entrained oil. Ill. 6200 w. Jour Assn of Engng Socs—March, 1902. No. 47619 C.

Engines.

High-Speed Engines. Discusses the merits and advantages of high rotary speeds, and the troubles. 1500 w. Engr, Lond—April 4, 1902. No. 47515 A.

The Ferranti Vertical Compound Engine. Abstract of paper by Mr. Charles Day, presented to the Manchester (England) Assn. of Engrs. Illustrates and describes the type of engine which the firm is building for use with large direct-connected electrical units. 4200 w. Power—April, 1902. No. 47489 C.

Vertical High-Speed Engines Abroad. Frank C. Perkins. Illustrated descriptions of power plants containing installations of some of the leading foreign builders. 2500 w. Steam Engng—April, 1902. No. 47624.

Evaporation.

The Transmission of Heat in the Evaporation of Water (Die Wärmeübertragung bei der Verdampfung von Wasser). Dr. H. Claassen. Giving data and results of experiments for the determination of the rate of heat transmission, with especial reference to evaporating kettles and vacuum pans. 7000 w. Zeitschr d ver Deutscher Ing—March 22, 1902. No. 47709 D.

Explosion

The Investigation of the Penberthy Boiler Explosion. Prof. R. C. Carpenter. Report of the explosion in Detroit which killed 30 people and seriously injured many more. Ill. 4400 w. Power—April, 1902. No. 47494 C.

Furnace Equipment.

The Scott-Elliot Furnace Equipment for Steam Boilers. Illustrates and describes a simple apparatus with which, it is claimed, that a considerable saving in fuel has been obtained. Gives report of trials. 2000 w. Engng—April 11, 1902. No. 47600 A.

Governors.

The Regulating of High-Speed Engines by Shaft Governors (Beitrag zur Frage der Regelung Schnellaufender Dampfmaschinen durch Achsenregler). J. Finkel. Showing the application of the shaft governor to valves of the Corliss and the piston types, with details of recent German governors. 2500 w. Zeitschr d ver Deutscher Ing—March 15, 1902. No. 47706 D.

Mechanical Plant.

The Mechanical Plant of the Broad Exchange Building. Illustrated description of the plant for operating 18 passenger elevators and a steam and electric plant of proportionate capacity in a building having over 11 acres of floor space. 2300 w. Eng Rec—April 19, 1902. No. 47615.

The Mechanical Plant of the Collingwood Apartment Hotel, New York. Illustrated description of the plant in a 12-story apartment hotel for electric lighting, refrigerating, heating and ventilating services. 2100 w. Eng Rec—April 5, 1902. No. 47326.

The Mechanical and Heating Apparatus in the New Century Apartment House, New York. Illustrated description of the mechanical plant for an electric lighting, refrigerating, elevator service, laundry and heating system in a 9-story apartment house 96-ft. square. 1500 w. Eng Rec—April 12, 1902. No. 47479.

Metallic Packings.

Metallic Packings for Piston and Valve Rods. C. G. Robbins. Describes and illustrates a number of the prominent packings, pointing out the special features and showing the application. 7800 w. Power—April, 1902. No. 47493 C.

Pipes.

Thickness of Pipes. William Burlingham. Gives diagrams embodying the formulæ for the thickness of steam and feed pipes for marine work. The method shown is of general application and saves much time. 1800 w. Marine Engng—April, 1902. No. 47269 C.

Piping.

Feed Water Piping. C. G. Robbins. Illustrates and describes many of the arrangements. 1500 w. Power—April, 1902. No. 47490 C.

Safety Valves.

Safety Valves (Soupapes de Sureté). F. Sinigaglia. An exhaustive discussion of the design and proportions of safety valves for steam boilers, with data as to discharge, and an examination of the various formulas. Serial, Part I. 5000 w. Revue de Mécanique—March 31, 1902. No. 47729 E + F.

Scale.

Boiler Scale Solvents. D. B. Dixon. On the best means to prevent incrustations and other points relating to the care of boilers. 2000 w. Am Mfr—April 10, 1902. No. 47466.

Slide Valve.

A New High Pressure Balanced Slide Valve. Illustrates and describes a valve designed to work easily under pressures as great as 250 lbs. 1000 w. Am Engr & R R Jour—April, 1902. No. 47346 C.

Speed Regulation.

Discussion on Speed Regulation of Prime Movers. Discussion at New York, Oct. 25, 1901, of papers on this subject read before the Society. 10600 w. Trans Am Inst of Elec Engrs—March, 1902. No. 47576 D.

Steam Economy.

Effect of Cylinder Clearance Upon Steam Economy. Ira C. Hubbell. Discusses some interesting practical experiments made during the last two years. 1800 w. St. Louis Ry Club—March 14, 1902. No. 47232.

Valves.

Piston, Corliss and Double-Beat Valves. A comparison with discussion of the merits of these types, and illustrated description of the Van den Kerchove gear. 900 w. Am Elect'n—April, 1902. No. 47376.

MISCELLANY.

Aeronautics.

A New Air Ship. Illustrated description of the Barton air ship now being built, and of the principles on which it is based. 1500 w. Engr, Lond—April 18, 1902. No. 47694 A.

The Crossing of the Sahara (A Propos de la Traversée du Sahara). Leo Dex. An examination of the practicability of crossing the desert of Sahara by a balloon controlled by a guide rope and propelled by wind only. 2000 w. Revue Technique—March 25, 1902. No. 47705 D.

The Severo Airship. Illustrated description of an interesting airship being constructed in Paris, which is quite novel in design. 1100 w. Sci Am—March 29, 1902. No. 47227.

Alcohol.

Lighting and Heating by Alcohol (L'Eclairage et le Chauffage par l'Alcool) L. Lindel. A discussion of the conference of the Société d'Encouragement, with tabulated results of the consumption of alcohol in lighting and heating. 3000 w. Rev Gen des Sciences—March 30, 1902. No. 47761 D.

Basket-Making.

The Mergenthaler-Horton Basket-Making Machinery. Illustrates and describes a machine for making fruit baskets which accomplishes in an hour more than is possible for 12 skilled basket makers, and at a cost less than the wages of a single workman. A description of the three types of machines now in use. 1700 w. Sci Am—March 15, 1902. No. 46810.

British Patents.

The Government Patent Bill. Editorial discussion of proposed patent law reform in England. 2800 w. Engng—Feb. 28, 1902. No. 46727 A.

Calculating Machine.

The Mechanical Work of the Twelfth Census. Edward M. Byrn. Illustrates and describes the Hollerith system of mechanical punching and tabulation in its latest development. 1900 w. Sci Am—April 19, 1902. No. 47559.

Calorimetry.

On the Calorimetric Properties of the Ferro-Magnetic Substances. Bruce V. Hill. A report of experimental investigations. 2000 w. Elec Rev, N. Y—March 29, 1902. No. 47234.

Carbonic Acid.

The Preparation and Applications of Liquid Carbonic Acid (La Preparation Industrielle et les Applications de l'Acide Carbonique Liquide). E. Mathias. Describing the modern methods of preparing the liquefied gas, and its numerous uses in the arts. Two articles. 7500 w. Rev Gen des Sciences—Feb. 28, March 15, 1902. No. 47760 each D.

Graphics.

Graphic Integration—Area, Center of Gravity, Moment of Inertia, &c. Karl G. Holst. Gives an approximate method of drawing an integral curve. 1400 w. Am Mach—April 10, 1902. No. 47486.

Heating.

Modern Furnace Heating. A combination of hot air and hot water heating and ventilating system is illustrated and described. 3000 w. Met Work—April 5, 1902. No. 47357.

Physical Laboratory.

The National Physical Laboratory. An illustrated article describing this recently opened laboratory in England, and its equipment. 5000 w. Elec Engr, Lond—March 21, 1902. No. 47284 A.

Refrigeration.

Improved Refrigerating Appliances in Breweries (Neuere Kühlanlagen in Brauerlien). R. Schöttler. Illustrating and describing the installations of the Linde refrigerating apparatus in a number of German breweries. 2500 w. 2 plates. Zeitschr d Ver Deutscher Ing—April 5, 1902. No. 47713 D.

Thermal Properties.

Some Thermal Properties of Naphthas and Kerosenes. A. H. Gill and H. R. Healey. Experimental work to determine the heating value is described. 2000 w. Tech Qr—March, 1902. No. 47817 E.

Ventilation.

Ventilating and Heating St. Bartholomew's Clinic, New York City. Illustrated description of an installation with ventilating apparatus independent of the heating system and supplying 6000 cu. ft. of air per hour per capita in many rooms; heating by direct radiators supported on hangers to facilitate cleaning the floors; and fitted with special cleaning apparatus for the air filters. 2500 w. Eng Rec—March 29, 1902. No. 47207.

Ventilating and Heating the Eastern High School, Detroit, Mich. Illustrated description of a 224 x 220-ft. building having an independent electric plant and a forced circulation of heated air for warming the main rooms. 1500 w. Eng Rec—April 26, 1902. No. 47649.

COAL AND COKE.

Arsenic.

Arsenic in Coal and Coke. Alfred C. Chapman, in *The Analyst*. Describes the method adopted by the writer for the detection and estimation of arsenic. The method consists in the gentle ignition of the fuel with a mixture of magnesia and carbonate of soda. 1500 w. Ir & Coal Trds Rev—April 4, 1902. No. 47522 A.

British Columbia.

The Crow's Nest Pass Coal-Fields. William M. Brewer. Gives the history and geology, with description of these deposits in the southeast part of British Columbia. 4000 w. Eng & Min Jour—April 19, 1902. No. 47634.

By-Products.

The Production of Sulphate of Ammonia from Coke Oven Wastes (Zur Herstellung von Schwefelswirem Ammoniak auf den Destillations-Kokereien). A discussion of the value of coke oven wastes, and the manner in which they can be utilized. 2000 w. Glückauf—March 15, 1902. No. 47762 B.

Coal Fields.

The Rocky Mountain Coal Fields. Concerning the extent, location, quality, and production of the fields now worked. 2400 w. Sci Am Sup—April 5, 1902. No. 47-387.

Coal Supplies.

See Industrial Economy.

Coke Ovens.

Recent Developments in By-Product Coke Ovens. Communications from Dr. F. Schniewind, Thomas Littlehales, and C. W. Andrews, to the Ohio Gas Lgt. Assn., with discussion. 9500 w. Am Gas Lgt Jour—April 28, 1902. No. 47685.

Floods.

Some Lessons from the Recent Floods in the Anthracite Mines of Pennsylvania. W. S. Ayres. Discusses the serious results and great expense caused by the floods of this past winter, and the means of guarding against such loss. 1700 w. Eng & Min Jour—March 15, 1902. No. 46823.

Germany.

The Government Acquisition of Westphalian Coal Mines. Discusses the recent purchase of this coal-mining property by the German government, comparing the present situation with that prevailing two or three months ago. 2000 w. Col Guard —Feb. 28, 1902. No. 46725 A.

Pacific Coast.

The Coal Resources of the Pacific. Harrington Emerson. A fully illustrated description of the various available sources of coal supply on the Pacific ocean, emphasising especially the central position and splendid quality of the Alaskan coals. 4000 w. Engineering Magazine—May, 1902. No. 47771 B.

Peat.

Peat Fuel in Scandinavia. Alfred Bache. Summary of recent articles on peat fuel published in leading Scandinavian periodicals. Deals with the Swedish, Norwegian and Danish countries separately. 2800 w. Col Guard—April 4, 1902. Serial, 1st part. No. 47520 A.

Russia.

The Coal-Mining Industry of Russia. Particulars, prepared by A. Loransky, extracted from a recently published work issued by order of the State Secretary. 2400 w. Col Guard—March 27, 1902. Serial, 1st part. No. 47446 A.

Safety Appliances.

Preventing Shock to the Cage on Reaching the Pit Bottom. From *Glückauf*. Illustrates and describes a device recently invented by J. Römer, explaining its action. 600 w. Col Guard—March 27, 1902. No. 47445 A.

COPPER.

Australia.

Australian Copper Production. Concerning the production and development of the copper mines. 1500 w. Engng—April 11, 1902. No. 47509 A.

Boundary District.

Metallurgical Progress in the Boundary District. W. A. Harkin. Describes the Granby Works, the largest copper smelting works in Canada. 2500 w. B C Min Rec—April, 1902. No. 47481 B.

Concentration.

Electro-Magnetic Concentration. V. F. Stanley Low. Its employment in the treatment of copper ores is discussed. 1000 w. Aust Min Stand—Feb. 27. 1902. No. 47-436 B.

Reduction.

The Reduction of Copper by Solutions of Ferrous Salts. H. C. Biddle. Abstracted from *American Chemical Journal*. Describes the method of reduction. 1500 w. Min Rept—April 17, 1902. No. 47625.

Sampling.

An Automatic System of Sampling. Paul Johnson. Detailed descriptions with illustrations, of the practice at the British Columbia Copper Companies Smelting Works. 2500 w. Eng & Min Jour—April 12, 1902. No. 47502.

South America.

South American Copper. Information concerning the production of the various countries, and the undeveloped properties, with report of fuel conditions. 1800 w. Am Mfr—March 27, 1902. No. 47263.

Wolverine Mine.

The Wolverine Copper Mine. F. J. Nicholas. Brief account of this mine, opened in 1882, but not really worked until 1889. 1000 w. Eng & Min Jour—April 26, 1902. No. 47663.

GOLD AND SILVER.

Alaska.

Investigation of the Mineral Resources of Alaska. Map with brief account of work being done by the Geological Survey. 700 w. Eng & Min Jour—April 26, 1902. No. 47664.

Arizona.

The Geology of the Galiuro Mountains, Arizona, and of the Gold-Bearing Ledge known as Gold Mountain. William P. Blake. An illustrated description of the ledge and deposits. 2400 w. Eng & Min Jour—April 19, 1902. No. 47633.

Brazil.

Historical Sketch of Gold Mining in Minas Geraes, Brazil. Alcides Medrado. Brief account of this rich gold field, and its production. 1100 w. Eng & Min Jour —March 29, 1902. No. 47238.

Bromo- Cyanogen.

Experiments with Bromo-Cyanogen on Southern Gold Ores. S. H. Brockunier. Results of experiments made to find a more economical method of extraction than chlorination. 1500 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 47542 C.

Cyanide.

Cyaniding in the Telluride District. J. Ralston Bell. An illustrated description of the plant and practice at the Liberty Bell mine. 1800 w. Mines & Min—April, 1902. No. 47330 C.

Notes on the Cyanide Process. J. P. Empson. Abstracts from a paper read before the Black Hills Mining Men's Assn. Reviews the early history of this process, describing the practice in New Zealand and Australia. 1600 w. Min Rept—March 27, 1902. No. 47261.

The Manufacture of Cyanides. Editorial discussing the preparation of cyanides, with remarks on the present position and greatly-extended application. 1500 w. Engng—March 21, 1902. No. 47294 A.

East Indies

Mining in the Dutch East Indies. S. J. Truscott. The gold mining in Sumatra and Borneo is reported in this first article, with related matter of interest. 3200 w. Aust Min Stand—Feb. 20, 1902. Serial, 1st part. No. 47434 B.

Placers.

Placer Mining Kinks. Charles P. Richardson. Illustrates and describes simple devices made where materials were scarce and hard to obtain. 2300 w. Min & Sci Pr —March 29, 1902. Serial, 1st part. No. 47363.

Queensland.

The Saddle Reefs of Bendigo. T. A. Rickard. An illustrated historical account of this rich gold field which has produced a yield valued at $342,000,000, describing various types of the saddle reefs. 5000 w. Eng & Min Jour—March 29, 1902. No. 47236.

Rand.

The Easterly Extension of the Rand Goldfields. From the London *Mining Journal.* An account of prospecting and the difficulties met. 4000 w. N Z Mines Rec—Feb. 17, 1902. No. 47428 B.

Tailings.

The Tailings Cyanide Plant of the Homestake Mine, South Dakota. Charles H. Fulton. Abstract from Bulletin No. 5, South Dakota School of Mines. Describes a plant which satisfactorily treats the tailings pulp of three mills. The company does not print the disclosure of information concerning the technical working of their plant. Ill. 1200 w. Min Rept—March 13, 1902. No. 46877.

West Australia.

The West Australia Gold Fields. Arthur Howell. Discusses their progress and prospects, Coolgardie and Kalgoorlie, and the activity on the "Northern Fields." 3800 w. Mines & Min—April, 1902. No. 47333 C.

IRON AND STEEL.

Analysis.

An Accurate Estimation of Sulphur in Iron by the Evolution Method. Harry E. Walters and Robert Miller. An explanation of methods, with report of results. 1000 w. Pro Engrs Soc of W Penna—March, 1902. No. 47312 D.

Blast Furnaces.

An Improved Method of Supplying Water to Blast Furnace Tuyeres and Coolers. W. J. Foster. Illustrates and describes a method that has been in use more than twelve months with very satisfactory results. 2200 w. Ir & Coal Trds Rev—April 11, 1902. No. 47592 A.

Blast Furnace with Electric Power Plant at Audun-le-Tiche, Lorraine. Frank

C. Perkins. Illustrated detailed description. 1000 w. Am Mach—April 17, 1902. No. 47547.

Electric Lifts for Furnace Bell-Tops. F. Janssen, in *Stahl und Eisen*. Illustrates and describes a bell-top lift that has been in operation for about a year, and considers the advantages derived from the use of electricity for working the bell-top. 2000 w. Am Mfr—April 3, 1902. No. 47359.

The Elimination of Blast Furnace Variables. F. L. Grammer. Some conclusions in regard to the management of blast furnaces. 3000 w. Ir Trd Rev—April 10, 1902. No. 47483.

The Rader Blast Furnace. Illustrates the construction of a recently patented furnace. 900 w. Am Mfr—April 17, 1902. No. 47622.

Cast Iron.

The Testing and Classification of Pig Iron and Castings (Zur Frage der Prufung, Beurtheilung und Ein theilung von Giessereiroheisen und Gusseisen). B. Osann. A review of the standard specifications of the American Foundrymens Association, with comments. 3000 w. Stahl und Eisen—March 15, 1902. No. 47733 D.

Crucibles.

Clays and Clay Crucibles. Percy Longmuir. Concerning the composition of crucibles, the apparatus required for making them, their life, &c. 2000 w. Ir Trd Rev —April 3, 1902. No. 47400.

Hematite.

Geological History of the Hematite Iron Ores of the Antwerp and Fowler Belt in New York. W. O. Crosby. 2800 w. Am Geol—April, 1902. No. 47442 D.

Hot Blast.

Hot Blast Stoves (Ueber Winderhitzer). G. Teichgräber. A discussion of recent designs for stoves for heating the wind for blast furnaces, with especial reference to the improvement in the combustion of the gases. 1800 w. Stahl u Eisen —March 15, 1902. No. 47734 D.

Iron Industry.

A Bird's-Eye View of Conditions in the Iron and Steel Industry. Editorial review of the present situation as presented in the recently issued "Directory of the Iron and Steel Works of the United States," and a comparison with the situation four years ago. 1800 w. Eng News—March 27, 1902. No. 47255.

The Recent Development of the American Iron Industry (Die Neuere Entwicklung der Nordamerikanischen Eisenindustrie). E. Schrödter. A comparison of the iron industries of Great Britain, Germany, France, Austria, and Russia, with the United States, showing the rapid growth of the latter. 3000 w. Stahl u Eisen—March 15, 1902. No. 47732 D.

Iron Works.

The Iron Mountain, and the Plant of the Mexican National Iron and Steel Company, Durango, Mexico. F. F. Witherbee. Gives view of mountain and works, with description of ore, method of working, &c. 1800 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 47543 C.

Krupp Works.

Some Interesting Features of the Krupp Works at Essen. Henry L. Geissel. An illustrated article giving particulars of interest and showing the immense extent of the works. 1500 w. Sci Am—April 19, 1902. No. 47561.

Minnesota.

Sketch of the Iron Ores of Minnesota. N. H. Winchell. An account of explorations, production, geological relations, origin of the ores, &c. 2200 w. Am Geol—March, 1902. No. 47431 D.

Mixers.

A 325-Ton Hot-Metal Mixer. Arthur C. Johnston. Illustrates and describes the chief features of a very successful vessel of this capacity. 900 w. Eng News—April 3, 1902. No. 47457.

Modern Pig Iron Mixers (Neuere Roheisenmischer). J. Nockher. Illustrating and describing various forms of mixers used in Luxembourg and Westphalia. 1800 w. Zeitschr d Ver Deutscher Ing—March 22, 1902. No. 47710 D.

Rails.

Microscopic Observations in Deterioration in Steel Rails. Thomas Andrews. Observations on the micro-crystalline structure, chemical and physical properties, of a Bessemer steel rail, unbroken after fifteen years' main line service. 2500 w. Engng—April 18, 1902. No. 47689 A.

Rolling Mill.

Rolling Mill for Billets (Blockwalzwerk). W. Schnell. Illustrated description of rolling mill and double reversing tandem reversing engines at the Röchling iron works at Völklingen on the Saar. 1000 w. 3 plates. Stahl u Eisen—April 15, 1902. No. 47740 D.

Slags.

A Study of Slags (Zur Kenntniss der Schlacken). H. v. Jüptner. A chemical study of the furnace slags and their relation to the metallic products. Two articles. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—March 29, April 5, 1902. No. 47768 each B.

Steel.

New Methods in Steel Manufacture. Briefly outlines methods for the production of compound ingots, to shorten time in open-hearth process, and hydrogen treatment of Bessemer and open-hearth steel. 3000 w. Ir Trd Rev—March 27, 1902. No. 47210.

Steel Plant.

Plant of the Dominion Iron and Steel Company. Waldon Fawcett. Description of a new Canadian plant at Sydney, Cape Breton. 2000 w. Am Mfr—March 13, 1902. No. 46817.

Some of the New and Enlarged Bridge and Structural Mills. Brief report of proposed extensions and new plants. 1700 w. R R Gaz—March 14, 1902. No. 46828.

Steel Treatment.

The Correct Treatment of Steel. Read before the Glasgow Congress. The object of the paper is to help those who handle steel by describing in simple, practical terms such fixed principles as are known, and in what direction they may be applied in practice, and to obtain discussion on important points. 1300 w. Jour Am Soc of Naval Engrs—Feb., 1902. No. 47051H.

Steel Rails.

The Manufacture of Steel Rails. Brief illustrated description of the Edgar Thomson Works, near Pittsburg. 1600 w. Sci Am—April 26, 1902. No. 47658.

Sulphur.

The Sulphur Content of Slag and Other Furnace Products (Der Schwefelgehalt von Schlacken und Hüttenproducten). H. von Jüptner. An examination of the distribution of sulphur in slag and metal in connection with the solution theory. Two articles, 4000 w. Stahl u Eisen—April 1, 15, 1902. No. 47739 each D.

Texas.

The Iron Resources of Texas. Dr. William B. Phillips. Considers the iron resources in a general way and states conclusions. 6500 w. Pro Engrs' Soc of W Penna—March, 1902. No. 47311 D.

MINING.

Auditing.

The Auditing of a Mining Company's Accounts. Charles V. Jenkins. On the value of an audit, inspection of accounts by mining engineers, the conduct of an audit, redemption of capital, etc. 5700 w. Trans Am Inst of Min Engrs—Feb., 1902. No. 47540 D.

China.

Mining in China. Information in regard to the working methods, labor and wages, etc. 1200 w. U S Cons Repts, No. 1319—April 18, 1902. No. 47564 D.

Colorado.

Geology Along the Animas River, with Description of Coal and Metal Mines Along Its Course, Including a Sketch of the Silver Lake Mine. Arthur Lakes. Ill. 2200 w. Mines & Min—April, 1902. No. 47334 C.

Deposits.

Ore Deposits. F. Danvers-Power. Read at meeting of the N. S. W. Chamber of Mines. A general talk on the world's debt to the mineral kingdom and geology, followed by a review of accepted opinions on the origin of ores, their deposition, etc. 6500 w. N Z Mines Rec—Feb. 17, 1902. No. 47429 B.

Firedamp.

Determination of Fire Damp by the Limits of Inflammability. J. Potier, in *Revue Universelle des Mines.* Describes a modification of the Lebreton and Rateau methods, giving drawing of apparatus. 800 w. Col Guard—March 27, 1902. No. 47447 A.

Geology.

Why Employ a Geologist? Arthur Lakes. Gives cases in which a knowledge of geology is necessary to successfully prospect for oil or ores. 1000 w. Mines & Min—April, 1902. No. 47335 C.

Haulage.

See Electrical Engineering, Power Applications.

Hole-Contract.

The Operation of the "Hole-Contract" System in the Center Star and War Eagle Mines. Contribution to the discussion of paper by Carl H. Davis. 900 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 47541.

Importance.

The National Importance of Mining. John E. Hardman. An address introducing topic for discussion at the annual meetings of the Canadian Mining Institute. 5000 w. Can Min Rev—March 31, 1902. No. 47270 B.

Mexico.

A Synopsis of the Mining Laws of Mexico. Richard E. Chism. A digest of the more important laws. 19300 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 47537 D.

Mine Fires.

Mine Fires in Pittsburg Region. James Blick. Read before the Cent. Min. Inst. of W. Penn. Gives their history and causes and methods used to subdue them, as gleaned from observation. 4600 w. Mines & Min—April, 1902. No. 47332 C.

Mine Pump.

Underground Mine Pump of 1000 Horse Power (Unterirdische Wasserhaltungsmaschine von 1000 PS.) S. Steuer. Description of powerful mining pump installed in the Czeladz mine at Sosnowice, in Russian Poland. 1000 w. 1 plate. Zeitschr d ver Deutscher Ing—March 29, 1902. No. 47711 D.

Mining Law.

The Colorado Central Lode, a Paradox

of the Mining Law. Ernest Le Neve Foster. Read before the Colorado Sci. Soc. Begins an account of the litigation over this mine. 1200 w. Min Rept—April 24, 1902. Serial. 1st part. No. 47813.

Mining Plant.

See Electrical Engineering, Power Applications.

Mining Tunnel.

Driving the Newhouse Tunnel. H. Foster Bain. An illustrated description of one of the most interesting mining tunnels in existence, now being driven at Idaho Springs, Colorado. 2200 w. Eng & Min Jour—April 19, 1902. No. 47635.

The Newhouse Tunnel. A. W. Warwick. An illustrated account of one of the greatest tunnel schemes ever undertaken, now being carried out at Idaho Springs, Colorado. 2800 w. Min Rept—April 24, 1902. No. 47812.

Oil Field.

The Western Oil Field of Mesa and Rio Blanco Counties, Colorado. Arthur Lakes. Illustrates and describes a region geologically favorable for oil. 2200 w. Mines & Min—April, 1902. No. 47331 C.

Plumb Lines.

The Divergence of Long Plumb Lines at the Tamarack Mine. Prof. F. W. McNair. An account of experiments made in the shafts of this mine, and a discussion of the cause of divergence. Ill. 3000 w. Eng & Min Jour—April 26, 1902. No. 47662.

Shaft Sinking.

Improvements in Apparatus for Shaft-Sinking. A. Gobert. From *Annales des Travaux Publics de Belgique.* Drawings and description of improvements to remedy the inconveniences arising from defective circulation. 800 w. Col Guard—March 21, 1902. No. 47305 A.

Sinking and Installing a Shaft, 1,010 Metres in Depth, at the Ronchamp Collieries. From *L'Ingénieur Français.* Illustrates and describes the ventilation, sinking, winding engine, central engine house, air compressors and boilers. 2500 w. Col Guard—March 27, 1902. No. 47444 A.

Small Ores.

The Utilization of Small Ores. H. Bumby. Read before the West of Scotland Iron & Steel Inst. Concerning the briquetting of such ores and the processes. 4000 w. Ir & Coal Trds Rev—March 21, 1902. No. 47300 A.

Smelting.

Smelting Arsenical Ores in Blast Furnaces. Herbert Lang. Outlines the method of treatment and reports the success. 2300 w. Min & Sci Pr—March 29, 1902. No. 47362.

Training.

The Training of Mining Engineers. H. C. Jenkins. Read before the Australian Assn. for the Adv. of Science. Discusses what the engineer manager should be if fully equipped for his work. 3200 w. Aust Min Stand—Feb. 27, 1902. No. 47435 B.

Tributing.

Tributing in Mining. Jas. Grant. The present article consists of introductory remarks on the general subject of tributing. 2300 w. Aust Min Stand—March 6, 13, 1902. Serial. 2 parts. No. 47643 each B.

Winding Engine.

Non-Condensing Double-Drum Winding Engine. Illustration and brief description of engine made for the Associated Gold Mines of Western Australia, Limited. 600 w. Engng—April 18, 1902. No. 47690A.

Wire Ropes.

Some Notes on Wire Ropes. G. W. N. Hopper. Discusses points relating to the use of wire ropes in colliery practice. 1700 w. Ir & Coal Trds Rev—March 21, 1902. No. 47298 A.

MISCELLANY.

Alloys.

Metallic Alloys. J. E. Stead. Considers the constituents of alloys, the methods employed for studying the constitution and properties of alloys, classification of binary alloys, and alloy charts for representing the structural, constitutional and physical properties of alloys. Ill. 9000 w. Metallographist—April, 1902. No. 47566 E.

The Freezing-Point Curve of Binary Alloys of Limited Reciprocal Solubility When Molten. H. M. Howe. Tests of curves showing that the very convenience of these graphical illustrations may cause them to mislead. 2000 w. Metallographist—April, 1902. No. 47567 E.

Aluminum.

Aluminum Properties and Reactions. From the French of M. J. Cavalier. A review of recent researches and their interesting results. 2500 w. Am Mfr—April 17, 1902. No. 47623.

Furnace.

An Adobe Reverberatory Furnace. John Gross. Describes briefly the construction of a furnace which is giving good results and can be quickly erected. Ill. 900 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 47544 C.

Lead.

The Disseminated Lead Ores of South East Missouri. Frank L, Nason. Facts in regard to the occurrences of lead ores in this section, their origin and peculiarities. 3000 w. Eng & Min Jour—April 5, 1902. No. 47405.

Metals.

The Crystalline Structure of Metals. J. A. Ewing and Walter Rosenhain. Describes investigations dealing principally with the phenomena of annealing. Ill. 9000 w. Metallographist—April, 1902. No. 47565 E.

Ozark Region.

Lead and Zinc Deposits of the Ozark Region. Information of the ore-bearing formations and mining districts of this region, giving theories of ore deposition, their origin, conditions, etc. 2700 w. Eng & Min Jour—April 5, 1902. No. 47403.

Petroleum.

The Boulder Oil Fields. Information concerning this field in Colorado, which is at present causing much excitement 1000 w. Eng & Min Jour—March 29, 1902. No. 47237.

The Russian Petroleum Trade. Information concerning the production of crude oil of the Baku fields, causes of depression, refining, residuum, transportation, etc. Map. 11900 w. U S Cons Repts, No. 1312—April 10, 1902. No. 47441D.

The Petroleum District of Northwestern Germany (Das Erdösvorkommen in Nordwestlichen Deutschland). P. H. Sachse. An account of the wells and product, showing the growing importance of the district. 2000 w. Glückauf—April 5, 1902. No. 47765 B.

Platinum.

Notes on Platinum and Its Associated Metals. James F. Kemp. Describes its occurrence, where found, its association with other minerals, etc. 2000 w. Eng & Min Jour—April 12, 1902. No. 47501.

Platinum and the Platinum Metals. Dr. J. Ohly. Discusses the commercial importance of platinum and begins a review of its history in the present article. 1200 w. Min Rept—March 27, 1902. Serial. 1st part. No. 47262.

Sulphur Deposits.

The Sulphur Deposits of Calcadieu Parish. Frank M. Kerr. Concerning these deposits in Louisiana and their development; methods, and their results, etc. 2800 w. Jour Assn of Engng Socs—Feb., 1902. No. 47214 C.

Titanium.

Titanium Iron (Ueber Titaneisen). E. Bahlsen. An examination of the influence of titanium upon iron and the use of ferro-titanium in the manufacture of special steels. 1800 w. Stahl u Eisen—March 15 1902. No. 47735 D.

Zinc.

American Zinc Production. Waldon Fawcett. Deals principally with the Joplin district, giving information concerning the gains in production, methods, etc. Ill. 1600 w. Am Mfr—April 24, 1902. No. 47-656.

Palmerton Plant of the New Jersey Zinc Company (of Pennsylvania). George C. Stone. Description of these works and their location. 2500 w. Eng & Min Jour—April 5, 1902. No. 47406.

The Production of Zinc Ore in the United States. Walter Renton Ingalls. Reports the production of the various districts, giving information of interest relating to them. Ill. 3300 w. Eng & Min Jour—April 5, 1902. No. 47404.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in February. Condensed record of the principal train accidents, with remarks on the most serious. 3600 w. R R Gaz—March 28, 1902. No. 47222.

Curve Resistance.

Curve Resistance Tests at West Alton, Mo. Max H. Wickhorst. Describes tests made with dynamometer car on 7½ degree curve to determine the relative resistance of a train on straight track and curves at this point. 1200 w. Am Engr & R R Jour—April, 1902. No. 47341 C.

Fast Run.

The Fastest Timed Railway Run in Europe. Charles Rous-Marten. Reports a new departure on the Northern Railway of France which gives it the fastest-timed railway run ever yet seen in European time-tables, including the British Isles. 700 w. Engr, Lond—April 18, 1902. No. 47693 A.

Graphic Statistics.

Graphic Statistics of Railways, Showing how the "Revenue Statistics" can be analyzed to exhibit the results of the working clearly and correctly. Deals only with the number of passengers as compared with train mileage but other results can be obtained by the same method. 1500 w. Engr, Lond—March 28, 1902. No. 47452A.

Train.

Train for H. R. H. Prince Henry of Prussia. Illustrated description of the train used during the short tour through the United States. 900 w. Loc Engng—April, 1902. No. 47365 C.

Train Control.

Instruction of Queen and Crescent Train

Men. A. J. Love, with editorial. The "train staff" system of train control is explained. It makes operating on a single track absolutely free from danger of c l-lisions. 2900 w. Loc Engng—April, 1902. No. 47367 C.

MOTIVE POWER AND EQUIPMENT.

Cars.

A 60,000 Lbs. Capacity Produce Car—New York Central. Illustrations and description showing the design of a 35 ft. produce car, 300 of which are being built for the hauling of fruit and vegetables. 1100 w. R R Gaz—March 28, 1902. No. 47223.

80,000 Lbs. Box Car, Illinois Central R. R. Illustrated description of the latest design of high-capacity box car adopted by this road. 1000 w. Ry & Engng Rev—March 29, 1902. No. 47245.

80,000 Lbs. Capacity Box Car, Norfolk & Western Ry. Illustrated description of the latest type of all-wood box car. 1200 w. Ry & Engng Rev—April 5, 1902. No. 47427.

Forty-ton Steel Frame Box Car, Norfolk & Western Railway. Drawings and description. 1800 w. R R Gaz—April 18, 1902. No. 47654.

Special Milk Cars for the Delaware & Hudson. Illustrates and describes cars used in this service. 600 w. Ry Age—April 11, 1902. No. 47500.

Test of an Ingoldsby 100,000 Lbs. Capacity Wooden Dump Car. Illustration with report of test. 500 w. R R Gaz—April 4, 1902. No. 47392.

36-Ft. Flat Car, Minneapolis, St. Paul S. Ste. Marie Ry. Illustrated description of flat cars of 60,000 lbs. capacity. 800 w. Ry & Engng Rev—April 12, 1902. No. 47507.

Standard 60,000 Lbs. Capacity Box Cars for the Central of New Jersey. Illustrated description. 500 w. R R Gaz—April 11, 1902. No. 47511.

Vanderbilt 50-Ton Hopper Coal Car. Drawings and description of steel hopper cars, designed by Cornelius Vanderbilt, 800 of which are now being built for the West Virginia Central & Pittsburg Ry. 700 w. Am Engr & R R Jour—April, 1902. No. 47338 C.

Car Wheels.

Chilled Cast Iron Car Wheels. C. H. Vannier. Read before the students of Purdue Univ. Describes the method of manufacture in detail. 5000 w. Ir Trd Rev—April 24, 1902. No. 47660.

Draft Gear.

Elasticity in Draft Gear. Extracts from a paper by R. A. Parke, presented at meeting of the Ry. Club of Pittsburg. Discusses the influence of draft gear upon train operation. Gives diagrams taken from the recording apparatus of a dynamometer car arranged to record the compression and recoil strains transmitted through the draft gear. 2300 w. R R Gaz—April 4, 1902. No. 47390.

Elasticity in Draft Gear. R. A. Parke. Presented at meeting of the Ry. Club of Pittsburg. Suggestions presented with a view of considering some of the various demands upon a satisfactory draft-gear and the character of the service rendered. 2200 w. Ry & Engng Rev—April 26, 1902. Serial. 1st part. No. 47815.

Electric Traction.

Electric Traction on Main Lines. Editorial review of paper by E. Huber before the Zurich Assn. of Engrs. & Archts. 1800 w. Engng—April 11, 1902. No. 47-598 A.

High Speed.

High Speed Transport with Steam Locomotives (Dampflokomotive und Schnellverkehr). H. Fränkel. A comparison of the performance of express locomotives with the results on the Berlin-Zossen high-speed electric railway. 4000 w. Glasers Annalen—March 15, 1902. No. 47730 D.

Locomotives.

A Discussion of Locomotives (Note sur les Locomotives). E. Sauvage. A general discussion of modern locomotive construction comparing the practice of different countries. Serial. Part 1. 7500 w. Bull Soc d'Encour—March, 1902. No. 47722 G.

A Four-Cylinder Compound for Fast Trains. Illustrates and describes an engine of somewhat peculiar design built for the Southern Railroad of Italy. 1100 w. R R Gaz—April 18, 1902. No. 47653.

American, British and Belgian Locomotives. On the report of Lord Cromer concerning the consumption of fuel on locomotives used on the Egyptian lines. 4500 w. Ir Age—April 24, 1902. No. 47641.

American Locomotive Construction. The first of a series of articles setting forth erroneous assumptions in regard to American locomotives, and discussing their construction and design. Ill. 3000 w. Engr, Lond—April 11, 1902. Serial. 1st part. No. 47604 A.

Atlantic Type Passenger Engine for the Illinois Central. Illustrated detailed description of engine built to be tested with a sample engine of the Prairie type. 800 w. Ry Age—April 18, 1902. No. 47642.

Baldwin Consolidation and 10-Wheel Locomotives, Southern Ry. Photographs and general dimensions of each type are given; the consolidation locomotives are for freight service and the 10-wheel engines for passenger service.

1200 w. Ry & Engng Rev—March 29, 1902. No. 47246.

British and Foreign Built Locomotives. Editorial on the recent conference of Indian Railway Engineers, and the subjects discussed. 800 w. Engng—April 11, 1902. No. 47597 A.

British, Belgian and American Locomotives in Egypt. Abstract of a parliamentary paper containing correspondence respecting the comparative merits of British and American locomotives in Egypt. Also editorial. 5600 w. Engr, Lond—April 4, 1902. Serial. 1st part. No. 47517 A.

Comparative Tests of Oil Burning Locomotives, Southern Pacific Railway. A report of interesting service tests. 600 w. Am Engr & R R Jour—April, 1902. No. 47340 C.

Compound Atlantic Type Passenger Locomotive. Illustrated description of the first of a number of heavy Atlantic type, Vauclain compounds with wide fire boxes for the C. B. & Q. Ry. 400 w. Am Engr & R R Jour—April, 1902. No. 47343 C.

Consolidation Freight Locomotive—Norfolk & Western Railway. Illustrated description of interesting engines known as the Class W. 900 w. R R Gaz—April 25, 1902. No. 47679.

Consolidation Switching Locomotives for the Chicago Union Transfer Railway. Engraving and brief description. 500 w. R R Gaz—April 25, 1902. No. 47681.

Double-Bogie Tank Locomotive, Northern Railway of France. Illustration with brief description. 300 w. Engr, Lond—March 21, 1902. No. 47302 A.

European Railway Jottings. Charles Rous-Marten. Describes the new British outside cylinder engines and the new valve gear designed by J. T. Marshall, now in course of experimental trial on the Great Northern Ry. 2000 w. Loc Engng—April, 1902. No. 47366 C.

Heavy 6-Coupled Suburban Locomotive. Illustrates and describes a locomotive in use on the New York Central & Hudson River Railroad. 700 w. Am Engr & R R Jour—April, 1902. No. 47342 C.

Heavy Double-End Suburban Locomotive for the New York Central. Illustrated detailed description of a type from which 16 have been ordered, and 6 are in service. 900 w. R R Gaz—March 28, 1902. No. 47220.

"Lake Shore" Type Tandem Compound Locomotive. Illustrated description of engines built for freight service on the Chicago Great Western Railway. 900 w. Am Engr & R R Jour—April, 1902. No. 47345 C.

Locomotive Improvement. A letter from David Joy giving a sketch of a novel locomotive design for a large engine for heavy work. 1300 w. Engr, Lond—April 11, 1902. No. 47605 A.

New Types of Freight Locomotives on the Atchison, Topeka & Santa Fe and Northern Pacific Rys. An illustrated article describing the present development in freight motive power equipment and new types of locomotives, and a traction-increasing device. 3900 w. Eng News—April 24, 1902. No. 47669.

Prairie Type Compound Freight Locomotives for the Atchison, Topeka & Santa Fe. Illustrated description of engines to use bituminous coal. 900 w. Ry Age—April 4, 1902. No. 47415.

Switching Engine for the Kansas City Belt. Illustrated description of a heavy switching locomotive especially designed for transfer work and pushing service. 700 w. Ry Age—March 28, 1902. No. 47240.

Tandem Compound Locomotive for Chicago Great Western. Illustrated description of heavy engines to be used in freight service. 900 w. Ry Age—April 11, 1902. No. 47499.

Test of Bismarck, Washburn & Great Falls Lignite-Burning Locomotive, No. 3. A report of test which proved conclusively that as a lignite-burning locomotive the machine is a success. 900 w. R R Gaz—March 28, 1902. No. 47219.

The Class H-6-a Consolidation Locomotive of the Pennsylvania. Illustrations showing the principal changes made in the H-6 consolidation freight locomotive and interesting details of this new type. 700 w. R R Gaz—April 4, 1902. No. 47391.

The Four-Cylinder Compound Express Locomotive for the I. R. State Railways of Austria. Iaroslav Iirdra. Illustrated description of an engine of the American (Atlantic) type. 600 w. Loc Engng—April 1902. No. 47364 C.

Wide Fire Box Consolidation Locomotive, Norfolk & Western Ry. General view, side elevation and sectional views with description. 900 w. Ry & Engng Rev—April 5, 1902. No. 47426.

Spreader Car.

The McCann Spreader Car. Illustrates and describes improvements that have been made in this car, and the character of some of the work handled. 1500 w. Ry & Engng Rev—April 19, 1902. No. 47644.

Tools.

The Value of Up-to-date Tools for Railroad Work. M. K. Barnum. Shows the saving made by installing new machinery, with comments on recent types and what they accomplish. Followed by general discussion. 4500 w. W Ry Club—March 18, 1902. No. 47535 C.

Valve Gear.

The Valve Motion That Promises to Save Forty Per Cent. Particulars in regard to the new gear being tried on the Great Northern Ry. of England. 1200 w. Loc Engng—April, 1902. No. 47368 C.

Water.

Railroad Water Supply. William Archer. An illustrated article describing the methods used on the A. T. & S. F. Ry. to supply water for locomotive purposes and for improving the quality. 3500 w. Ry Age—April 25, 1902. No. 47682.

The Water Question. The first of a series of articles prepared by a well-known chemist and engineer who has made a special study of the subject. Describes methods of overcoming objectionable conditions in water for locomotive boilers. 700 w. Am Engr & R R Jour—April, 1902. Serial. 1st part. No. 47347 C.

Wheels.

Chilled Cast Iron Car Wheels. C. H. Vannier. Extracts from an address delivered before the engineering students of Purdue University. Concerning the history of cast iron wheels and their improvements, tests, etc. 1500 w. R R Gaz—March 28, 1902. No. 47221.

The Cost of Car Wheels. Gives actual cost and car miles run on a large number of different lines. 1200 w. St Ry Jour—April 5, 1902. No. 47408.

NEW PROJECTS.

British Columbia.

The Railway Situation in British Columbia. S. J. McLean. An account of railways and proposed lines, with map. 2000 w. Ry Age—April 11, 1902. No. 47-497.

Cuba.

The Cuban Railroad Law. Condensed abstract of the main features of the new code of laws for the government and regulation of the railroads recently issued by the military governor. 1500 w. R R Gaz—April 11, 1902. No. 47512.

Greece.

Railway Project in Greece. Information concerning the organization of the Piraeus-Larissa R. R. Co. Gives particulars of this important project. 800 w. U S Cons Repts, No. 1318—April 17, 1902. No. 47557 D.

PERMANENT WAY AND FIXTURES.

Austria.

New Railways in the Austrian Alps (Oesterreichs Neue Alpenbahnen). K. Imhof. A description of the new government railway in Bohemia, Galicia and Styria, including difficult grades and tunnels in the Austrian Alps. 2500 w. Schweizerische Bauzeitung—March 22, 1902. No. 47742 B.

Block Signalling.

Railway Stocks and Telegraphs—Recent Practice. A. T. Kinsey. Read before the Dublin Loc. Sec. of the Inst. of Elec. Engrs. Discusses the extension of block signal working on the Irish railways, where double lines of rails exist, and the introduction of the train staff block instrument where there is only a single line of rails. 5400 w. Elec Engr, Lond—April 18, 1902. No. 47806 A.

Construction.

The Morenci Southern Ry.—A Line With Five Loops. Brief illustrated description of an example of curious railway construction. 800 w. Ry & Engng Rev—April 26, 1902. No. 47814.

Improvements.

The Atlantic Avenue Improvements of the Long Island Railroad. The improvements will consist of an alternate subway and elevated road for 26,700 ft. east of the Flatbush Avenue terminal, removing these tracks from the street grade. Ill. 2500 w. R R Gaz—April 25, 1902. No. 47678.

Panama.

The Panama Railroad. E. W. Gregory. An illustrated article describing this railroad. 1000 w. Loc Engng—April, 1902. No. 47369 C.

Power.

The Power Question in Locomotive Repair Shops. R. W. Stovel. Abstract of a paper read before the Ry. Club of Pittsburg. The paper aims to give arguments and facts helpful in governing the selection of a power system. 1200 w. Ry Age—April 4, 1902. No. 47416.

Reconstruction.

Reconstruction of the Union Pacific Railroad. Illustrates and describes costly reconstruction work between Cheyenne and Evanston in Wyoming. 1000 w. Sci Am—April 5, 1902. No. 47385.

Shallow Tunnels.

Shallow Tunnels for Railways. The important part of the report of Lieut.-Col. A. H. Yorke on the Chemin de Fer Metropolitain de Paris. 3800 w. Arch't, Lond—April 11, 1902. No. 47578 A.

Shops.

New Shops at Du Bois, Pennsylvania. Illustrated description of shops for the Buffalo, Rochester & Pittsburg Railway, having a capacity of 200 locomotives per year. 1300 w. Am Engr & R R Jour—April, 1902. No. 47339 C.

Oregon Short Line Shops at Pocatello, Idaho. Illustrated description of these new shops and their equipment. 1200 w. Ry Age—March 28, 1902. No. 47241.

The Collinwood Shops of the Lake Shore. An illustrated description of new shops at Cleveland, which will be among the most complete in the country. 2000 w. Ry Age—April 11, 1902. No. 47498.

Spiral Curves.

Suggestion for a More Uniform Practice in Fixing the Lengths of Spiral Curves. W. D. Taylor. A discussion of the principles controlling these curves, with the writer's suggestion giving tables proposed for connecting the degree of curve, the superelevation, the maximum velocity and lengths of spiral. 2000 w. Eng News—April 17. 1902. No. 47554.

Station.

The Bordeaux New Railway Station. Illustrates and describes a fine central railway station in France. 800 w. Engng—April 11, 1902. Serial. 1st part. No. 47-594 A.

Ties.

Combination Concrete and Steel Railway Ties. Illustrates and explains the construction of a tie designed by G. H. Kimball now being tried on the Pere Marquette R. R. 1100 w. Eng News—April 3, 1902. No. 47458.

Tracks.

Track Elevation in Newark, N. J. Clarence H. Baily. A report of the work of changing and elevating the tracks through the city, being done by the Lackawanna, the Pennsylvania and the Central of New Jersey roads. 2000 w. R R Gaz—April 25, 1902. No. 47677.

Tunnelling.

See Civil Engineering, Construction.

TRAFFIC.

Interchange.

Report of the Committee on Revision of the Rules of Interchange. Report, discussion and recommended changes. 6000 w. W Ry Club—March 18, 1902. No. 47536C.

Per Diem.

Errors in Calculating an Average Per Diem Rate. Two letters discussing the recent letter of Mr. Midgley. 1700 w. R. R Gaz—April 4, 1902. No. 47389.

Mileage vs. Per Diem. W. M. Prall. Discusses the present conditions and what may be expected under per diem; and how the cars shall be cleared at terminals so that the car owner may be protected, if per diem is adopted. 3300 w. St. Louis Ry Club—March 14, 1902. No. 47230.

Per Diem from a Terminal Standpoint. Jno. J. Baulch. Briefly notes some features of car service from the terminal point of view. 2300 w. St. Louis Ry Club—March 14, 1902. No. 47231.

The Per Diem Reform. Editorial discussion of this question. 1800 w. R R Gaz —April 11, 1902. No. 47514.

Rates.

Competition and Railway Rates. Charles A. Prouty. An address before the Illinois Mfrs. Assn. at Chicago. A discussion of present conditions and the danger of railroad monopoly. 5500 w. Ry Age—April 4, 1902. No. 47414.

South Africa.

Railway Development in Federated South Africa. A. Cooper Key. A discussion of the conditions involved in the reorganization of the South African railways, with especial reference to the needs of the Transvaal and Orange river colonies. 4000 w. Engineering Magazine—May, 1902. No. 47772 B.

Tonnage Indicator.

Daly's Train-Resistance Computer. Illustrated detailed description of a mechanical arrangement for quickly computing the resistance of a train of cars. 1600 w. R R Gaz—April 25, 1902. No. 47680.

Tonnage Rating.

Tonage Rating of Locomotives. W. M. Ray. Concerning the methods of making the rating, with information received in answer to questions addressed to different roads, tests, diagrams, etc. 4000 w. Jour Assn of Engng Socs—Feb., 1902. No. 47211 C.

MISCELLANY.

Europe.

European Railway Jottings. Charles Rous-Marten. Reviews the principal features of the past year's progress in locomotive engineering in Great Britain, and the Continent. 1500 w. Loc Engng—March, 1902. Serial. 1st part. No. 46646 C.

Some Observations on European Railways. Tipton S. Blish. Descriptive of rolling stock, and customs. 2000 w. St Louis Ry Club—Feb. 14, 1902. No. 46628.

Mexico.

The Mexican Railroad System. Victor M. Braschi. Gives a historical summary of the railroads, their present condition, and a description of a railroad journey on lines of the Mexican railways. 6400 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 47539 D.

Organization.

Railroad Organization. Arthur Hale. A paper read at New York University. Discusses the organization of the entire service. 4000 w. R R Gaz—April 11, 1902. No. 47513.

Regulation.

Some Principles of Railway Regulation. H. T. Newcomb. A discussion of rates, legislation, etc., followed by general discussion. 10500 w. N Y R R Club—March 20, 1902. No. 47534.

Turkey.

Railways in Turkey. A brief summary of the conditions of the railways in the Ottoman Empire, showing their extent, amount of traffic, etc. 1700 w. U S Cons Repts, No. 1315—April 14, 1902. No. 47533 D.

STREET AND ELECTRIC RAILWAYS

Accidents.

Liverpool Overhead Electric Railway. Abstract of the report on the accident at the Dingle station. 1200 w. Engr, Lond—March 28, 1902. No. 47455 A.

Berlin.

The Berlin Elevated and Underground Railway. Illustrated description of the 13-mile rapid transit electric railway in Berlin, explaining mainly the superstructure and power station. 3000 w. Eng Rec—April 26, 1902. No. 47647.

The Berlin Overhead and Underground Electric Railway. Illustrated detailed description with brief resumé of the history of the undertaking. 2700 w. Elec Rev, Lond—April 18, 1902. Serial. 1st part. No. 47807 A.

The New Electric Railroad at Berlin. A descriptive account of the elevated and underground electric railroad recently opened. 1100 w. R R Gaz—April 4, 1902. No. 47393.

The New Electric Underground and Elevated Railway at Berlin. An account of this recently completed enterprise, showing the novel features and German municipal methods. Ill. 2200 w. U S Cons Repts, No. 1302—March 29, 1902. No. 47-200 D.

The Metropolitan Railways of Berlin (Les Chemins de Fer Métropolitains de Berlin). R. Philippe. Fully illustrated description of the system of railways of Berlin, including the earlier steam roads and the latest electric system. Two articles. 8000 w. Two plates. Genie Civil—March 15, 22, 1902. No. 47700 each D.

Brooklyn Bridge.

The Brooklyn Bridge Railroads. Julius Meyer. Discusses the connection desirable between the Manhattan ends of the Brooklyn, Williamsburg and Navy Yard bridges, trolley terminals, etc. Ill. 1800 w. R R Gaz—April 18, 1902. No. 47652.

Car Driving.

The Raw Material for Electric Car Driving. F. T. Stewart. Remarks on the changed employment of men connected with tramways, by the change to electricity and some of the disadvantages of the service. 1800 w. Elec Engr, Lond—March 21, 1902. No. 47285 A.

Cars.

Some Points in the Equipment of Electric Tram Cars. W. G. Rhodes. Abstract of a paper read before the Manchester section of the Inst. of Elec. Engrs. Discusses points of equipment that will enable one to select the most suitable type of car for a particular route. 5000 w. Mach Engr—March 22, 1902. No. 47283A.

Competition.

Competition of Steam vs. Electric Parallels. C. H. Davis. Read before the Canadian Soc. of Civ. Engrs. Showing that it is the created or induced traffic of electric roads and not that taken from parallel steam roads, which makes their success, and that if the same methods were applied to steam roads the results would be the same or greater. 4200 w. St Ry Jour—March 29. 1902. No. 47233 D.

Dispute.

The Eastern and South African Telegraph Company, Limited, v. Cape Town Tramway Companies, Limited. Reviews the cause of this dispute, and the first decision, discussing the appeal. 2300 w. Elec Rev, Lond—March 28, 1902. No. 47438 A.

Electric Railways.

Problems of Electric Railways. J Swinburne and W. R. Cooper. Read before the Inst. of Elec. Engrs. Discusses the series distribution of power for railways, especially for short lines. Its use for main lines is also considered; also other systems. 5200 w. Elect'n, Lond—April 4, 1902. Serial. 1st part. No. 47426 A.

Electrolysis.

Damaging Effects of Electrolysis on Pipe. Reports of its action at St. Paul, Minn., Dayton Ohio, and Taunton, Mass., with illustrations. 5300 w. Fire & Water—April 19, 1902. No. 47627.

Electrolysis Decision in Dayton. Slightly abstracted report of the decision rendered by Judge O. B. Brown. 12300 w. St Ry Jour—April 12, 1902. No. 47482D.

Germany.

An Analysis of Street Railway Operations in Germany. Wilhelm Mattersdorff. Abstract of an article in the *Zeitschrift fur Kleinbahnen*. Data relating to traffic density, gross receipts, operating expenses, etc. Diagrams. 3800 w. St Ry Jour—April 5, 1902. No. 47411 D.

Opening of the Electric Elevated and Underground Road, Berlin, Germany. An illustrated account of this important engineering work. 900 w. Elec Wld & Engr—March 1, 1902. No. 46617.

Statistics of Electric Railways in Germany (Statistik der Elektrischen Bahnen in Deutschland). The usual annual tabulated review of the progress of electric railway construction and operation; the data are brought down to October, 1901. 10000 w. Elektrotech Zeitschr—March 27, 1902. No. 47746 B.

We supply copies of these articles. See page 487.

High-Speed.

The High-Speed Electric Railway between Manchester and Liverpool (Elektrische Schnellbahnen Zwischen Manchester und Liverpool). F. B. Behr. A full account of the proposed Behr high-speed mono-railway from Manchester to Liverpool. Two articles 10000 w. Zeitschr d ver Deutscher Ing—April 5, 12, 1902. No. 47714 each D.

'Iudson Valley.

The Hudson Valley Railway. An illus-'rated description of the characteristics ınd operating details of an electric road which operates in competition with a steam road and a canal. 5200 w. St Ry Rev—April 15, 1902. No. 47636 C.

Interurban.

Overhead and Track Construction in Connection with Interurban Railways. Gilbert Hodges. Address before the New England St. Ry. Club. Urging a good, substantial, well laid track, and overhead construction, discussing points in detail. 4500 w. St Ry Jour—April 19, 1902. No. 47632 D.

The Brockton & Plymouth Street Railway. Illustrated detailed description of the line and its operation. 7200 w. St Ry Jour—April 5, 1902. No. 47407 D.

Italy.

The Electric Tramways of Leghorn, Italy. Enrico Bignami. An illustrated description of the city and suburban electric railway lines of an Italian seaport. 1000 w. Elec Rev, N Y—April 19, 1902. No. 47639.

Liverpool.

The Liverpool Overhead Railway New Equipment. An illustrated article describing the equipment of trains with new motors which enable the trip to be made in about 20 minutes that formerly required 32 minutes. 1000 w. Engr, Lond—March 21, 1902. No. 47301 A.

Modern Practice.

Discussion of Papers by Messrs. Armstrong and Berg on Modern Electric Tramway Practice. Discussion at Buffalo, Aug. 24 1901. 14000 w. Trans Am Inst of Elec Engrs—March, 1902. No. 47571 D.

Municipal Ownership.

Municipal Ownership and Operation of Street Railways. H. M. Sloan. From an article published in the *Calumet Record*. Presents practical facts, and discusses methods of disposing of difficulties and securing compensation to the city. 4000 w. St Ry Rev—April 15, 1902. No. 47-637C.

Potential Drops.

Potential Drop on Tramway Rails. Gisbert Kapp. Read before the Electrotechnischer Verein. Describes a rail booster system, illustrating by an example, 3000 w. Elect'n, Lond—April 11, 1902. No. 47584 A.

Power Plants.

Power Plants of the St. Louis Transit Co. Describes and illustrates the Central Power station in the present number. 3000 w. Eng News—April 3, 1902. No. 47459.

The Evolution of Electric Railway Power Plant Apparatus, as illustrated by the Cedar Avenue Station of the Cleveland Electric Railway Company. H. W. Woodward. An illustrated descriptive article. 3500 w. Engr, U S A—April 1, 1902. No. 47352.

Repair Shops.

Repair Shops of the North Jersey Street Railway Co. Illustrates and describes machines and devices for facilitating repairs, giving a list of prices for all street-car repair work. 5200 w. St Ry Rev—April 15, 1902. No. 47638 C.

Signals.

Block Signals on Heavy Electric Railroads. Reviews some of the principal work that has been done on the electric elevated and subway roads, giving illustrated descriptions of two systems. 4500 w. St Ry Jour—April 5, 1902. No. 47409D.

South Africa.

Camps Bay, Cape Town, and Sea Point Tramways. Illustrates and describes the construction and equipment of this line. 3000 w. Tram & Ry Wld—March 13, 1902. No. 47313 B.

South Lancashire.

The South Lancashire Electric Traction and Power Company, Limited. Map and information of one of the most extensive schemes for the application of electric traction in the United Kingdom. 3000 w. Tram & Ry Wld—March 13, 1902. No. 47316 B.

Sub-Station.

Sub-Station Plant of the London United Tramways. Illustrated description of the sub-station. Tram & Ry Wld—March 13, 1902. No. 47314 B.

Vibrations.

Vibration on Railways. Editorial review of Mr. Mallock's report on the complaints against the Central London Railway. 2500 w. Engng—April 11, 1902. No. 47596 A.

Worcester.

The Worcester Consolidated Street Railway Company. Illustrated description of an extensive interurban system in Massachusetts, its power stations, rolling stock, etc. 4000 w. St Ry Jour—April 5, 1902. No. 47410 D.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
American Telephone Journal. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Armee und Marine. *w.* Berlin.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, Eng.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin Scientifique. *m.* Liege.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Age. *m.* New York.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical Times. *w.* London.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.

Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemist & Metallurgist. *m.* London.
Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
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Revista Tech. ed Agr. *b-m.* Catania.
Revista Tech. Ind. *m.* Barcelona.
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Revue Gen. des Sciences. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
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THE WORLD IS ITS FIELD.

THE ENGINEERING MAGAZINE

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THE TRANSVAAL MINES UNDER THE NEW REGIME.

By John Hays Hammond.

WITH AN EDITORIAL INTRODUCTION.

THE declaration of peace in South Africa has at last ended the paralyzing uncertainty—economic and political—which for three years has weighed upon the mining industry of the Rand. We have reached the conclusion foretold editorially in these pages in January, 1900:

"This war, springing from the struggle of the new spirit of industrial progress against the old forces of political repression . . . sooner or later, by force of arms or by sheer moral power, is certain to end in emancipation of enterprise and the freedom of engineering effort to develop to the utmost the economic resources of one of the richest mineral regions of the world."

The Boer oligarchy has disappeared, because it misinterpreted the meaning of freedom. With British rule, or colonial self-government according to Anglo-Saxon ideals, South African mining will be free to develop to the uttermost limits permitted by the natural resources of the country and the engineering methods which can be brought to bear.

The field eclipses, in interest to the world of mining engineering and mining machinery, any other region on the earth. For a technical study of its mining geology and mining practice, reference may be made to the full study presented in THE ENGINEERING MAGAZINE by Mr. Hammond and his associates, February-July, 1898, or to Mr. Hammond's recent paper before the American Institute of Mining Engineers. We are fortunate in being able to present, in the following pages, Mr. Hammond's summarized conclusion as to the conditions and possibilities of the Rand. It is the opinion of the greatest living authority.—THE EDITORS.

THE Transvaal comprises about 120,000 square miles, and includes three important gold-mining districts—the famous Witwatersrand, and the quartz-mining districts of Lydenburg and De Kaap. The entire mineral development has taken place within thirty years, for mining in the Transvaal was prohibited up to 1868, at which time the government, being in dire financial straits, threw open the gold fields to exploration and exploitation, even going so far as to offer a bonus for the discovery of profitable mines. The resultant prospecting in the early 70's led to the discovery of quartz veins and the inauguration of mining in several parts of the Northern Transvaal. The Lydenburg district first attracted attention in 1876, when exploration of the alluvial deposits began, followed later by vein mining. The De Kaap gold fields were discovered in 1884, and the conglomerate or "banket" beds of the Witwatersrand—destined to supersede all others in importance—in 1885. In that year a small stamp battery was erected to crush quartz from a vein a few miles west of Johannesburg, and in this a crushing of conglomerate was made; but it was not until April, 1887, that a battery of three stamps was erected to treat the ore of the Witwatersrand banket. This was followed by the erection of other batteries, and the output of gold for 1887 was 23,000 ounces. For 1898, the last complete year before the war, it was 4,295,609 ounces, valued at £15,141,376, and for nine months of 1899, it was 4,008,326 ounces. There were in operation in 1898, 77 mines, which in the year produced 7,331,446 tons of ore, crushed by 4,765 stamps. They employed 9,476 whites with an average monthly wage of £26, and 88,627 native workmen receiving on an average £2. 9s. 9d. each per month. During the same year in the Lydenburg district five companies, running 137 stamps, produced 154,560 tons of ore, yielding 108,884 ounces of crude gold valued at £392,378, and in the De Kaap gold fields seven companies, running 200 stamps, produced 89,760 ounces of crude gold, valued at £314,792.

The companies ceased working in October, 1899, by reason of the declaration of war, but the late Transvaal government continued operations upon its own account in some of the richest mines up to May, 1900. In May, 1901, crushing operations were resumed by the companies themselves, though upon a very small scale, only 150 stamps being run at three mines. The number was steadily increased, and by the end of 1901, 653 stamps were running, representing 12 mines; during the eight months ending with the year, 412,006 tons of ore were milled, 238,995 ounces of fine gold, valued at £1,014,687, were produced and £415,812 were paid in dividends.

The mines of the Witwatersrand district may conveniently be classed in three groups: 1. Those of the Heidelberg and Klerksdorp districts, the former about 30 miles southeast and the latter about 90 to 110 miles southwest of Johannesburg; these collectively produced in 1898, 77,393 ounces of fine gold, valued at £319,140, of which about 5/9 was from Klerksdorp. 2. The Main-Reef series, by far the most important of all, producing 93 per cent. of the total output. 3. The Deep Levels; it is in these properties that the consolidation of claims under a single management has its most useful application. A Transvaal mining claim, 150 Cape feet wide and 400 Cape feet along the dip, confined to ground contained within vertical planes drawn through its boundaries, is obviously too small to permit of profitable working as a separate unit. Companies are therefore formed by the amalgamation of a number of claims—usually 30 to 60 on the outcrop, 150 to 250 in the first row of deep levels, and a larger number still in the second row of deeps.

The Main Reef series is situated on the southern slope of the Witwatersrand, a ridge of quartzite situated just north of the town of Johannesburg and extending in an easterly and westerly direction. This ridge has a general elevation above the country to the south of from 300 to 500 feet. It is nearly 6,000 feet above sea level, and forms the watershed between the Atlantic and the Indian oceans.

In ascending order, the following are the most important conglomerate beds in the Main Reef series: 1, the Main Reef; 2, the Main Reef Leader; 3, the South Reef. The Main Reef, which gives its name to the series, consists generally of several beds of "banket" separated by layers of quartzite, though sometimes forming a solid body of conglomerate as much as 12 feet in thickness. It is worked in but very few places, being of low grade, carrying rarely more than five or six pennyweights of gold to the ton, and on the average considerably less. Overlying this reef, separated by a few feet of quartzite in places and at times without any demarcation, is the Main Reef Leader. The pebbles of the Leader are usually larger than those of the Main Reef. In some of the mines the upper portions of the Main Reef are stoped in conjunction with the Main Reef Leader itself. The thickness of the Main Reef Leader varies from a few inches to about three feet. About 16 inches would represent the average width. In its value also it varies considerably, running from a few pennyweights to several ounces of gold per ton. From 30 to 100 feet or more south of the Main Reef Leader is the South Reef, varying in width from a few inches to 5 feet.

In the Main Reef series there are sometimes as many as three "payable" parallel reefs; but while these reefs may be continuous throughout a certain section, it is rare that they are all at one time payable, the pay ore being usually confined to two of them, and in some places to one only. The reefs vary in width from a few inches to 20 feet or more. The combined stoping width of the reefs worked may be stated, however, at an average of 5 or 6 feet. The matrix of the gold and the filling of the reef is chiefly well-rounded pebbles of quartz, cemented by secondary silica, and also by sesquioxide of iron and pyrites, and chloritic matter. The gold very rarely occurs in quartz pebbles, being usually confined to the cementing material of the conglomerates.

The methods of mining in the Witwatersrand district present no features specially different from those followed in the exploitation of similar deposits elsewhere. Fortunately the ground stands well, and little timbering is required—a most important consideration in a country where mining-timber is so scarce. The mines are what mining engineers would call "dry," the water being usually seepage, and varying from 50,000 gallons per day, for a shaft sunk upon the outcrop of the reefs, to less than 5,000 gallons for a shaft sunk upon the second row of deep levels, where the reefs are reached at a vertical depth of about 2,000 feet.

The amount of water available for boilers, batteries, cyanide treatment, etc., is, even in the present state of development of the industry, inadequate, and presents a difficult problem to the mine operators. The water from the mines is usually acid, and hence not desirable for boilers. The necessary supply of water is at present made up by local storage of rain water. The average rainfall in the vicinity of Johannesburg is from 25 to 30 inches per annum; but, being more or less torrential in character, and limited to a few months, it is somewhat difficult to impound. There are, however, within 20 or 25 miles of Johannesburg, other sources of water supply, which will probably be utilized in the future.

Great attention is given to the preparation of maps of the underground workings, geological sections, and plans upon which assays are plotted. In these respects the Rand practice is far ahead of that of any other country with which I am familiar.

Reference has already been made to the labor question, in statistics of the relative numbers of whites and blacks employed. The white workmen are predominantly British, though many of the important members of technical staffs are Americans; the mine and mill foremen are usually either Americans, or British subjects who have had mining experience in America. This labor is generally below the American standard, but is rapidly improving. Manual workers on the surface and all miners except those running machine drills are blacks, and the quality of the black labor is very poor, especially on first arriving at the mines. A few months' sojourn brings them into fine physical condition, and occasionally they remain long enough to become expert miners, though it is rare to find among the "boys" great efficiency in drilling holes. Holes are located by the shift boss and fired by him. The rapidly increasing demand for labor and the obstacles interposed by the late government caused a great deficiency of native workmen, and compelled the use of a large number of air drills in stoping, to considerable disadvantage. Where the reefs are flat or small, much larger blocks of ground must be broken down than with hand drills. More dynamite also must be used—an important consideration when dynamite is as costly as it has been on the Rand, particularly under the monopoly granted to foreign concessionaires with whom leading officials of the former government were privately associated. Another disadvantage of the use of dynamite is the undue amount of fine waste, lowering the yield of ore in the battery and increasing the production of slimes.

Long transportation, and excessive railway rates heretofore charged by the South African Railways, have made mining supplies excessively high on the Rand. How exorbitant these charges were may be indicated by the charges, in pence per ton mile, given by the late Mr. L. I. Seymour in 1897 before the industrial committee of inquiry:—On the Cape Line, 2.34; the Orange Free State, 2.34; the Natal, 3.04; the Portuguese, 4.07; the Netherlands-Cape, 7.69; the Netherlands-Natal, 5.06; and the Netherlands-Delagoa, 4.27.

Generally speaking, the cost of the principal machinery, erected on the ground, will be two and one-half times its home cost. In respect of labor, cost of dynamite, and charges for railway transport, marked improvement is confidently to be expected from the change of governmental conditions.

The mining laws of the Transvaal are most excellent in character, and while the claims cover every square foot of land for an area of nearly 40 miles long by from 2 to 3 miles wide, there have been practically no conflicts over extra-lateral rights.

Notwithstanding the change in the political status of the Transvaal which will follow the recently concluded peace and final establishment of British rule, it may be confidently assumed that the main features of the mining law of the South African Republic will be retained, and certain oppressive features of monopolies, etc., bearing with special weight on the mining industry, will be abolished. The dynamite monopoly was one that bore most heavily on the mining industry; and, according to the reports of the State mining engineer, explosives, including fuse and detonators, amounted to nearly 10 per cent. of the total working costs of the mines. Furthermore, it was impossible to obtain the proper quality for the most economical working, and often 30-per cent. or 40-per cent. gelatine had to be used in many instances where 60-per cent. gelatine would have been much cheaper. These, indeed, form no part of the mining law proper—that is, the law regulating the tenure of mining titles. It is to be expected, both in the nature of the case and in view of the declarations already made by British statesmen, that the "ancient laws and customs" of the Transvaal will be retained under British rule, as far as possible. At all events, the principles of the English common law and the immemorial precedents of English practice will undoubtedly require the determination of present rights according to the statute in force at the time of their inception. The mine operators of the Transvaal whose titles were acquired from the Republic will therefore be secured in the position thus defined.

During the eight months ending in August, 1899, after which the commencement of active hostilities interfered with the active working of the mines, the Witwatersrand produced £12,485,032 sterling. At this rate, the year's production would have been £18,727,548. As a matter of fact, it would have amounted to some 20 millions sterling, by reason of the progressive increase in the monthly production already shown during that year. Of this output 71 per cent. was derived from what is known as the central section, extending about 1.5 miles west and about 8 miles east of Johannesburg, and 24 per cent. was derived from the deep-level properties within that section. The total gold product of the Witwatersrand was 25.5 per cent. of that of the entire world. Notwithstanding the increased production of gold elsewhere, this ratio would have been more than maintained had mining operations not been interfered with by the South African war. Within one year after the resumption of mining operations, upon the scale existing immediately prior to the war, an output of gold at the rate of over 20 millions sterling annually may be reasonably estimated; and this rate of production will be steadily increased, partly by the increase in the crushing plants of some of the companies, but more especially by the starting of many of the deep-level properties which will then reach the producing stage. Within the next three or four years, after operations have been resumed on a large scale, the annual gold production from the Witwatersrand may reach 25 millions sterling. Beyond this amount there should be a further increase, the amount of which it is impossible to estimate. In from 6 to 8 years some of the important gold producers among the outcrop companies will fall out of line, by reason of the exhaustion of their mining areas. To what extent this deficit will be counterbalanced by increased yield in the deeper-level properties cannot be as yet determined. Much depends upon the policy adopted.

In the reliability of its ore-bearing formation, the Rand is unique in the history of gold mining; but in the minds of many an exaggerated importance is attached to the persistency of payable ore bodies in strike and in dip. There is indeed considerable fluctuation in the value of the ore within the same reef, even within short distances; but a remarkably even grade of ore has been maintained since the inception of the industry. Where there has been an apparent falling off in yield per ton during any year, the fact is to be attributed rather to the working of lower-grade ores, made possible by improved economic conditions, than to a depreciation in the ore values of the reefs themselves. With the exception of the additional costs of haulage, pumping, and ventilation, there are no factors operating against mining on the Witwatersrand to a depth of at least 8,000 feet vertically. These costs will not afford any insuperable obstacle to profitable mining, provided, of course, the geological character of the deposit is not adversely changed. So reliable is the formation, from a geological point of view, as regards its mining potentialities, that engineers have felt justified in assuming the existence of payable ore at depths of 1,000 feet and more vertically beyond the extent in depth of any mining operations. Thus far the results of actual operations upon these areas have justified their position. It is estimated that for every mile in length along the course of the reefs, down to a vertical depth of 1,000 feet for the dip of these reefs, gold to the value of about £10,000,000 will be extracted. This is a conservative estimate—at least as applied to the central section of the Rand. If we assume these conditions to obtain to a depth of 6,000 feet vertically, we have the enormous sum of £60,000,000 for each mile in length. It is not unreasonable to suppose that these conditions will be maintained along most of the central section, say for a distance of 10 miles, in which case we would have an auriferous area, within practicable mining depths, containing upwards of £600,000,000 value of gold.

It is less safe to make any prediction of the gold product to be expected from the east and west sections; but it is perfectly safe to say that the output of these sections would very greatly augment the amount I have named. Messrs. Hatch and Chalmers, well-known engineers of extensive South African experience, compute the available gold from these portions of the Rand at £200,000,000.

It is impossible to predict with any accuracy the duration of mining in the Witwatersrand district, by reason, especially, of the indeterminate factor of the rate at which exploitation will be carried on. It may be observed, however, that the tendency is to exploit the auriferous areas as rapidly as possible, and that engineering methods are all adopted with that end in view. If the exploitation of the deeper levels is not delayed pending the proving of the ground lying above, but is carried on concurrently with the exploitation of the higher horizons of the reefs, the industrial life of the district will, of course, be correspondingly shortened. The working of lower-grade ores, made possible by improved economic conditions or other circumstances, would tend to increased longevity of the industry. But, were I called upon to express an opinion, I would estimate the future duration of profitable operations on a large scale in the district at less, rather than more, than 25 years.

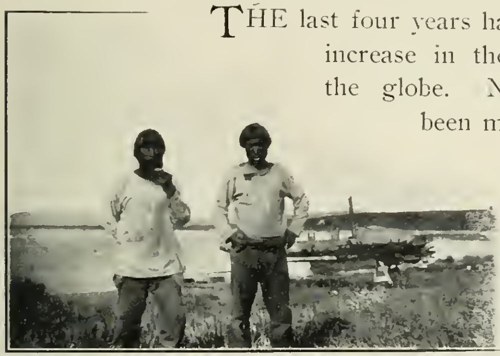
The future looks from all points of view encouraging. We may reasonably anticipate important improvements in economic conditions as the result of the establishment of a better government. I believe that, as the result of economic reforms, there will be an ultimate saving of 6s. per ton of ore treated. This refers to all savings, both direct and indirect, and especially to economy resulting from increased efficiency of labor due to the betterment of living conditions. Positions formerly commanding a salary of $15,000 a year will be satisfactorily filled for $10,000. For the tonnage of ore crushed in 1898, this would result in an increase of annual dividends of £2,199,405.

The Transvaal generally is fertile, but requires irrigation, and lack of facilities for storing water makes this at present infeasible. There is a rainy season of four or five months, between the months of November and April. The thermometer rarely reaches 95 degrees in the shade, and the heat is "dry." During the remaining winter months —April to October—rain is exceptional and there is no extreme cold. Snow is rare in the Witwatersrand. While the climate is remarkably salubrious and invigorating, the rate of mortality has heretofore been high, owing to lack of proper sanitation. Undoubtedly this will be greatly improved under better government.

THE GOLD SANDS OF CAPE NOME.

By Augustin L. Queneau.

Mr. Queneau's account of the Nome region, the character of the deposits, and the methods of mining, is written from personal experience and illustrated by his own photographs. It has the authority of expert professional knowledge and the interest of individual contact with the people and the country.—The Editors.



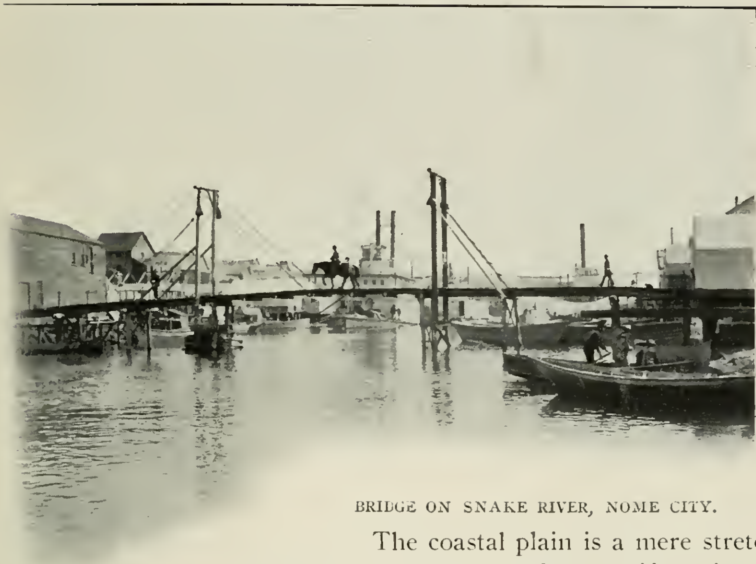
THE last four years have been remarkable for an increase in the gold-producing areas of the globe. Nowhere has this process been more evident than in Northwest America. After the various strikes in British Columbia, came in 1897 the discoveries in the Klondyke, followed in 1898 by the great finds on the Seward Peninsula in what is called the Nome mining district. In the spring of 1900 the United States Geological Survey formed geological and topographical parties to map these newly discovered mining districts. This was in pursuance of the established policy of the Department of the Interior to help the prospectors and miners in their pioneer task. I had the good fortune to be attached to the topographical party at the head of which was E. C. Barnard, who in 1898 had mapped the "Forty Mile District." Our special task was to map a territory of about 5,000 square miles, extending from Port Clarence on the west to Golovin Bay, and reaching as far as the head waters of the Fish River and Casa de Paga to the north. Bering Sea formed the southern limit. The Bering, for its size, is the shallowest sea in the world, soundings of six to seven fathoms being very common in its whole eastern portion. It is also particularly trying for the navigator owing to the ever present fogs and the frequency of its severe storms. The sand bars of the Yukon delta extend over a hundred miles into the sea and are constantly changing their position.

The Nome mining region includes the greater part of the Seward Peninsula. The interior is very mountainous. It is rarely, however, that the magnificent sight of the numerous snow-clad peaks can be enjoyed, owing to the almost constant presence of fogs or of clouds which linger around the highest points. From Mount Osborn (4,860 feet) on the west to Mount Benteleven (4,600 feet) on the north, there extend, fan-like, as from central buttresses, series of mountain ranges. These enclose valleys, the rivers of which may be divided into three drainage systems, viz., Golovin Bay, Port Safety, and Bering Sea proper. These valleys are similar in character one to another, their upper portions forming narrow precipitous gorges. As the sea is approached the mountains become lower, the valleys broader, the slope less steep. Cape Nome, West Point, Cape Rodney, etc., are among the secondary promontories. A characteristic feature of the orography, the low divides between the various valleys, makes this region well-adapted for inland travel. The mountain range culminating with Mount Osborn is especially broken with divides, and is appropriately called the Sawtooth Range.

The coast has a general trend north 22° west. With the exception of a few rocky headlands, the shore is sandy and rises only a few feet above the high-tide level. At the western extremity of the district a good anchorage is afforded by Port Clarence, with Grantley Harbor at its upper end. There flows the Blue Stone. To the east the coast is difficult of approach; only small boats can cross the bars at the mouths of the Cripple, the Penny, the Snake, and the Nome Rivers. A not always reliable shelter is given by the lee of Sledge Island, some twenty miles from Port Clarence.

Port Safety lies fifty wiles from Port Clarence. It is the narrow channel of a large lagoon into which flow the Flambeau, Eldorado, Bonanza, and Solomon Rivers. Sandbars render it difficult of passage, ships of over four-feet draught not being able to enter. This lagoon has a very indented shore line and is quite shallow. The many mouths of the tributary rivers make it a veritable labyrinth of waterways, most hazardous to the uninitiated.

Thirty miles further down the coast, between two bold capes, Point Rocky and Point Derby, lies Golovin Bay which affords a good harbor. Into this bay flows Fish River with its large delta. In general the rivers have torrential headwaters, but become sluggish, deeper, and very circuitous in the coastal plain. In their meanderings their lower courses have shifted. This is true of the Snake, the Flambeau, the El Dorado, and the Fish Rivers, the old beds being marked by sluices and elongated lakes. This feature may prove of value in mining operations in this region.



BRIDGE ON SNAKE RIVER, NOME CITY.

The coastal plain is a mere stretch of marshy land or tundra, perfectly uniform in appearance, frozen or spongy according to the season, and thickly dotted with argillaceous knolls a few feet high, the so-called *"têtes de femme"* of the Canadian *voyageur*. To cross these dreary wastes, the traveler has to jump from knoll to knoll at the risk of falling into the intermediate depressions or getting entangled in the matted roots of the herbaceous or woody vegetation. The knolls arise from a gathering, during the warm period, of a soft mud of clayey material below the compact felt formed by the matted roots and peat. When the cold weather sets in, the upper crust freezes first and forces out the still liquid substratum of mud which then bursts through the covering and expands in mounds. The ground is permanently frozen below the surface. The moisture being thus prevented from filtering through, the upper strata even on the slopes of the little hills become swampy in the warm season.

The geology of the Nome Region is metamorphic. Schistose rock is the prevailing type. Gneiss and mica schists pass one to the other without sharp dividing lines. The gneiss has sometimes very thick laminations which often cause it to be taken for a granite. Hydro-mica schists or phyllites, hornblende schists, slates and limestones are also met with. Gold is finely disseminated in the gneiss and mica schists, but owing to the rapid rate of erosion, it has been quite easily collected in satisfactory quantities.

NOME CITY, SHOWING BOURBON AND EXTRA DRY CREEKS.

Many useful minerals have been found. In Anvil Creek platinum and iridosmin, and in Sinrock Valley small amounts of native bismuth with sulphurets rich in antimony, lead, and silver. The schists and gneiss carry large amounts of small red garnets and magnetite. Often pyrites and fine apatites are seen. There are many quartzose veins in the limestone and the mica schists. They follow in general the foliation, pinch out very suddenly, and are not highly mineralized. I remember a large quartz vein some eight feet thick having almost a vertical dip, in the mountains of the headwaters of the Sinrock. A specimen picked up showed $15 to the ton in gold with ½ ounce of silver. Dr. Cabell Whitehead of the United States Mint mentions a vein bearing $40 to the ton. These veins, however, are rare. The whole country has suffered from violent dynamic disturbances. All rocks are sheared and folded. Numerous small faults are seen where the rock is exposed, as is the case on the tops of the highest peaks. The rocks forming the Sawtooth Range, mica schists and gneiss, stand almost on edge. The strike is in general northeast to southwest and the dip to the southeast with varying angles.

Because of the schistosity and of the high dip, the moisture penetrates deeply during the warm months. This moisture in the severe weather freezes, and in expanding shatters the rock. The fragments are washed in the following spring, or carried away by the avalanches. After the great storm of September, 1900, the whole side of a mountain was laid bare by the sudden formation of an avalanche of mud and disintegrated rock. The heavy precipitation of both snow and rain, favored by a high slope, makes the journey for the debris between the mountains and the sea comparatively easy.

The violent waves of the Bering Sea wash over the sand beach and over the sand bars, formed of the materials carried down by the rivers. A sorting action ensues, effected by the undertow and the littoral current. The minerals of high specific gravity, such as the garnet, magnetite, hornblende, and gold, resist this action much more effectively than the lighter grains of quartz, feldspar, mica, and calcite. This work varies with the velocity of the wind and its direction. Thus a section of the sea beach shows an alternation of nearly pure siliceous sand and of black iron sand. The latter in layers of one-half inch to six inches are often coated with grains of red garnet—hence the name of ruby sand given by the miners. During a violent storm a new sorting of the bars takes place with a temporary enrichment of special spots. This has given rise to the fallacious theory that the gold comes from the sea. Gold nuggets still attached to mica-schist particles have been found, leaving little doubt as to the origin of the gold.

No true bed rock has yet been found, though a hard blue or ferruginous clay some eight feet down is sometimes so called.

A STERN WHEELER AT WHITE MOUNTAIN CITY ON THE FISH RIVER.

The population in the Nome Region is a floating one and very difficult to ascertain. There were in 1900 fully 40,000 people, but now not a fifth of the number remain.

Among the towns of most importance are Nome City, located at the mouth of the Snake River which divides it into two parts connected by a good bridge; Fort Davis, on a sand spit at the mouth of the Nome River; Port Safety, which was utterly destroyed by the storm of September 1900, the several hundred inhabitants removing to Solomon City on the Solomon River; Tupkuk, thirty-five miles east of Nome City on the Bering Sea; Chinik, an Eskimo village and reindeer station at the entrance of Golovin Sound; White Mountain City, near the hill of that name on the Fish River—here the stern-wheelers stop to transfer their cargoes to flat boats; Golovin City, formerly Council City, on the Nukaluk near the rich placers of Ophir Creek; finally, Teller City, of considerable importance on account of the placers of the Blue Stone and Kugrock Rivers.

A PROSPECTING PARTY READY TO LEAVE NOME CITY.

Discovery of Gold. Up to 1898, the Seward Peninsula was visited by only a few white men, most of them being whalers, traders, or revenue-cutter men. The news of the gold finds in the Klondyke, Circle City, Forty Mile, and Eagle districts was communicated to the dwellers about Norton and Golovin Sounds and a stampede followed. A Laplander, a herder of reindeer, while roaming through the country, met Esquimaux having gold nuggets in their possession while they in-

A STREET IN NOME, AUGUST, 1900.

formed him were picked up in the Sinrock Valley. The Laplander told the story to N. C. Hultberg, a Swedish missionary, who at once formed a party to locate claims. On their way from Chinik to the mouth of the Sinrock, they were compelled to land near the present location of Nome City. At the mouth of the Snake River they found some coarse colors in the lower bars, but left without making any strikes. Later a new party, composed of Eric O. Lindbloom, Jafet Linderberg, and John Borjensen, reconnoitered the same grounds and discovered, on July 26th, what has proved to be the richest creek of the region. Lindbloom named it Anvil Creek from the peculiar shape of a neighboring mountain. They staked numerous claims on this as well

ON "NUMBER 4," BELOW DISCOVERY ON ANVIL CREEK.

as upon other creeks. After their return to Chinik they told of their good fortune and a still greater rush ensued. All the immediate vicinity was staked in the names of the stampeders and of all their friends. This was done by the use of the much abused power of attorney. The lateness of the season deferred further exploration at this time. When the winter had set in, parties with dog sleighs explored the district over an area of about one hundred square miles. Every day new comers arrived by land from the Yukon Valley. No prospecting was possible, however, through the ten feet of snow and ice. When the work was once begun the whole course of gulches and creeks was often staked by a single man with forty or fifty "powers of attorney" in his pocket. This explains the bitter outcry of 1900, when the newly arrived men were able only by an undue amount of travel in absolutely unknown land to find an acre of free ground. The claims were of the usual size, 600 by 1320.

As might be expected, most of the men relied on lucky strikes being made in their neighborhood, in order that value might be given to their holdings and thus make them marketable. Finds were not as numerous as had been expected. The whole region was thus tied up.

No assessment work was done. It was very difficult on torrential creeks to prove that $100 worth of work had not been done, as floods are of yearly occurrence. Only on the few creeks which from the first proved rich, such as Anvil, Glacier, Dexter, Ophir, and Dry, was work undertaken. From these large amounts of gold have been obtained. The three discoverers, who later formed the Pioneer Mining Co., were foreigners without naturalization papers and thus not entitled to hold any ground. Their claims were jumped; costly and lengthy litigation followed, which interfered with further progress.

At first, attention was given entirely to the beds of the creeks. Later the miners began to prospect the higher ground. They were rewarded by very rich discoveries near Anvil Mountain, Nikkola Gulch, etc. Here as in Klondyke, the bench claims have proved rich and will lengthen considerably the life of the camp.

Beach Gold. Up to the summer of 1899 the work was confined to the creeks and gulches. That gold was to be found on the beach was discovered by a soldier of the 7th Infantry digging for a well. The men who, unfortunate in their search, were loitering about Nome City, took up at once the prospecting of the beach all along the coast. Claims

THE NOME BEACH AFTER THE GREAT STORM OF SEPT. 5, 1900.

were staked, but owing to the wise ruling of the commanding officer of Fort Davis, no man could hold more than the ground on which he was working. When the news of these finds reached the States late in the fall of 1899 a repetition of the Klondyke craze started, particularly along the Pacific Coast. Nothing was known of the Nome country except that gold was to be had in abundance for the mere picking. Men of every walk in life pressed to Seattle, anxious for one thing to get to the northern El Dorado. Very few of them found what they had hoped for. They were, in fact, little prepared for the arduous work of prospecting. Unused to the Arctic clime, they became affected with the common disease—"cold feet." As early as June 1900 one

ROCKING ON THE BEACH.

might have seen written on the walls of stores or upon rocks such legends as this:—

"Tired, busted, and disgusted,
And a thousand miles from home."

Many lost what little money they had brought with them. Some four thousand men applied to the army posts for food, and the transports of the quartermaster department brought back many totally destitute to the States. They told frightful tales of woe. The climate was un-healthful; the smallpox and typhoid fever were rampant; no gold was to be found. Yet many had not set foot outside of Nome City. Thus Nome's reputation fell, very unjustly, however. There is still much gold to be found there. As the unfairly staked claims are thrown open, new work will be done and many new strikes will be made. Until recently the work has been done for the greater part by

SLUICING ON THE BEACH NEAR NOME CITY.

individuals without large capital. The short working season, the distance from the base of supplies, the absolute necessity of bringing every supply from the United States, make it imperative to have large capital.

The greatest activity was displayed on the beach when fifteen hundred sluice plants were at work at one time between Cape Rodney and Tupkuk. More than half the gold was taken by rockers. The beach diggings were exceedingly pockety and some of the pockets were fabulously rich. Three men in the Tupkuk cleared $36,000 in a little over three days, working without rest on a small plot of ground.

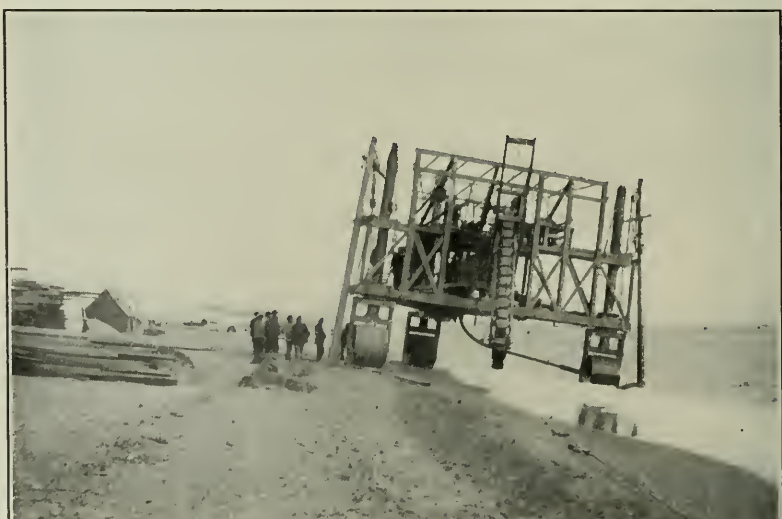
Generally two men work together at a rocker—one digs and carries the pay streak in pails to the man in charge of the rocker. The water is usually found a few feet below the surface; if not, the rocker is placed near the edge of the surf.

The sluicing requires several men. The sluice boxes are 12 feet in length, made of rough lumber spiked together. The sluice rests on a trestle 6 to 8 inches in height. Two to four men shovel the dirt. Advantage is taken as far as possible of the tundra rivulets for water. If none can be obtained, a pumping engine is installed, the water being taken from the sea. Almost every type of pump may be seen. The gasoline engine gives best results with the least outlay of expense.

The beach gold is very fine, clean, bright, and well-adapted to amalgamation. Cleaning up is done usually once in twenty-four hours, and as there is no darkness during June, July, and early August, the work goes on without stop. The clean-up is placed in a cleaning barrel and quicksilver added. As far as possible the black sand is removed by a magnet. The remaining sands, magnetites, and garnets are blown off after the drying.

Amalgamated-copper plates, or even silver-plated ones, are used in almost all plants as well as in rockers. The losses are quite large, owing to the very large proportion of flour gold. Better results would be obtained with more complete and expensive plants.

In 1899 most of the beach gold had been taken out. In 1900 the last remnants were taken. Men engaged in rocking could make a fair living—$5 to $8 per day—but most sluice plants barely paid expenses. A noteworthy exception was Tupkuk, where half-a-million was taken out in three weeks. $10,000 was taken out in 1898; in 1899, $2,000,-



A BEACH DREDGE AT WORK ON THE NOME SANDS.

A DREDGE USED AS A HOUSEBOAT ON NOME RIVER.

000, of which $900,000 came from the beach; in 1900, $5,125,000, of which $1,250,000 came from the beach. It is doubted is as much was taken in 1901, owing to various litigations.

Much the same methods are employed in all creek mining. The water is used over and over again by means of dams. The gold is coarser than the beach gold, more angular, and sometimes is coated with iron oxide, but more of this gold can be saved.

In passing a few words should be said on the dredging operations. Some dredgers have been imported, others built in Nome. All have proved failures. This is due to the shallow and rough water of the Bering Sea. On a fair day, some good runs are made on bars, but this is very exceptional. The only district which might prove suitable for dredging is Port Safety Lagoon with the numerous arms of its tributary rivers.

The greatest difficulty in the gold mining arises from the lack of, or superabundance of, water. This is especially felt in bench claims. For the Anvil Claims, Chas. D. Lane of the Wild Goose Mining Co. has plans for the creation of a central pumping plant to raise the necessary water from the Snake River. This last work would fitly crown the many enterprises undertaken by this company. They have installed telegraphic and telephonic communication between their various holdings on the Snake, the Nome, and the Nukaluk. They have built a railroad between Anvil Creek and Nome City, and have arranged for a water supply for ordinary use for fire service.

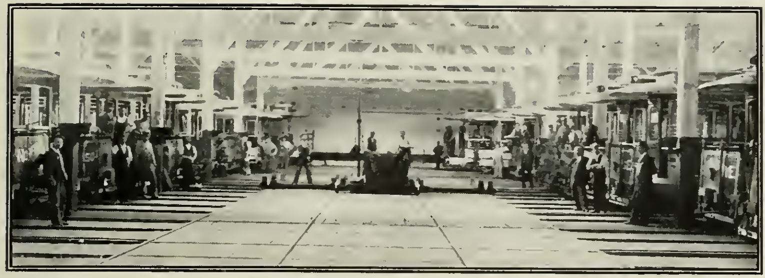
ESKIMO GRAVES.

The future success in the obtaining of Nome gold lies in hydraulic mining, when the now rich creek diggings shall have been worked out. Water in sufficient quantities can easily be collected by means of dams. In the upper parts of many creeks and rivers are to be found excellent dam sites. The building materials are to be found on the ground without any quarrying. The slope of the valleys will always afford sufficient head.

The tundra has not yet been fully prospected, but from numerous test pits sunk 20 to 30 feet deep, values from a few cents upwards to the pan have been found. The geological evidence of an emerged beach also indicates that mining here would prove valuable.

Now that the litigations which tied up the richest diggings have been settled, a bright future may be expected. Telegraphic communication is now to be had between Port Safety and St. Michael. A wireless system is also to be established. As the country becomes more developed many mineral resources will be dicovered. Good coal has already been found at Cape Lisbon and on Kotzebue Sound.

The men who are now in Nome are the men for the work. They are fully acquainted with the difficulties of the district. Experience has shown the fallacy of many theories, and henceforth mining in Nome will be conducted along the lines that have been successful in other regions.



THE MECHANICAL ENGINEERING OF AN ELECTRIC RAILWAY.

By Howard P. Quick.

The writer speaks from an experience of twelve years in the mechanical department of the West End Street Railway and Boston Elevated Railway systems, and counts it fortunate that he began his mechanical training earlier under the inspiration of that masterful machine—the steam locomotive—and started with the beginning of things in the electric-railway line at the same locomotive works in 1887, when both the science and the art were in their infancy. He considers it equally fortunate that he has witnessed the crowning achievements of 1902, not only in the development of the high-speed electric train and locomotive, but in high-powered prime movers and generators and allied apparatus and constructive methods. The illustrations are all drawn from the Boston railways mentioned above.

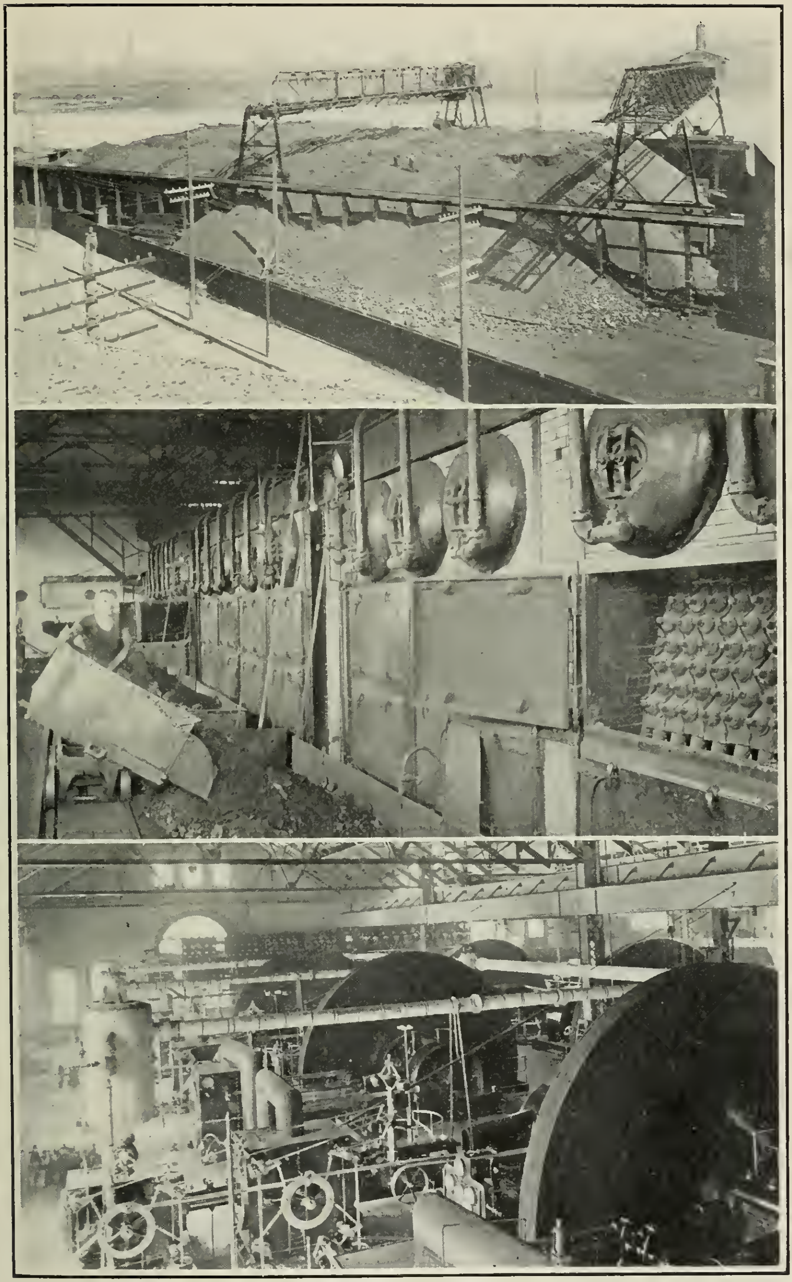
MUCH has been written descriptive and illustrative of the engineering features of large street-railway systems—their stations, rolling stock, lines, organization, and development. In this paper however I shall endeavor to bring out more in detail the mechanical problems met and methods used in the operation of a road, the relations of the various departments to one another, and the scope of their work, and in particular that of the mechanical departments.

In Boston, street-railway engineering has been a gradual development and has required the constant study of a large force of trained engineers and experienced managers, who have found it necessary to originate much of the apparatus in use, have sought for machinery that they were unable to find developed to the high standard required—in fact, have been leaders in bringing manufacturers and users to a true realization of the extraordinary demands of this new force upon machinery of all kinds. And so there have been there established certain standards in materials and design which have been generally adopted in other places. It is of course understood that this line of experience is that of the direct-current type of electricity, generated by steam-driven machines, supplied with power from coal-fired boilers, and transmitted as direct current for the propulsion of the cars.

The organization of the engineering force of a large street-railway system is very important, and perhaps no single company has an ideal arrangement. That of my company works very satisfactorily. The vice-president, who is a trained financier, is in effect the general manager and supervising or chief engineer. In some companies the latter might be the title of a distinct officer ranking with the vice-president. Under him are the heads of the different engineering departments—the mechanical, electrical, and civil, or the mechanical and electrical combined in one department under the title of "Motive Power and Machinery." The civil engineering will naturally include the architectural department and all structural engineering so called.

Under the executive engineer would of course be the superintendents of the different constructive departments, such as the superintendent of wire and conduits or of electric-line construction, the superintendent of tracks or maintenance of way, the superintendent of shops or master mechanic or master car builder, and the superintendent of buildings and building construction, plumbing, and all architectural construction. Each of these departments would have several subdivisions, handling under trained heads all the various classes of work involved.

The engineering operations of the electric-street-railway business are so largely mechanical that its management grows more and more dependent upon the executive ability and advice of the trained mechanical engineer. The electrician, civil engineer, and architect all have their spheres of usefulness, and special knowledge is required in these departments, but they require for the practical applications of their ideas many materials, tools, and devices which are purely mechanical or mechanically produced. Thus it happens that the principal and most important department will usually be the mechanical department —the department of motive power and machinery—under the leadership of a man who must be an all-around engineer—a man of tact, good judgment, and plenty of horse sense. He has under his care the design, maintenance, and control of power-station machinery, rolling stock, and all electro-mechanical apparatus. Under him are first shaped the plans which later involve the thought and labor of all the engineering departments and call into requisition the varied industrial resources of the country at large. The department of motive power and machinery is especially under consideration in this paper, and to give an idea of the magnitude of the operations involved it may be



THE GENERATION OF POWER FROM COAL.

At the top is a 15,000-ton coal-storage pile, unloaded from cargo by mechanical appliances and taken to stations by electric coal cars running in tunnels under the piles. In the middle is a battery of stoker-fired boilers, to which coal is delivered by push cars raised by a log chain. At the bottom is a generating station containing 25,000 horse power of Corliss engines and General Electric direct-current generators.

well to state in detail and in round numbers the variety of apparatus controlled or maintained by the different engineering departments of a street-railway company, all depending largely on this department for maintenance and repairs. In the railway company under consideration the equipment in all departments approximates the following proportions:—

1. There are about 3,450 surface and elevated cars, both closed and open, of 9 different styles, and 300 plows and service cars. These use about 30 different styles of trucks, with a total of 4,880, and are run by 11 styles of motors, with a total of 4,420.

COAL POCKET AT AN INLAND STATION.

Supplied by 10-ton hopper cars from a distant coal wharf. The car, shown above, ascends by a spiral track.

2. There are 8 power stations, widely scattered, with 15 different styles of engines and generators ranging in power from 62 to 2,700 kilowatts nominal, making a total of 38 engines and 78 generators and more than 200 feeder machine and station panels. There are 200 different smaller machines—motors, pumps, injectors, economizers, blowers, stokers, coal hoists, etc., and 80 boilers of 6 different styles.

3. There are about 40 car houses, scattered among many cities and towns, with the usual mechanical equipment—cranes, hoists, ele-

A 25,000-HORSE-POWER BOILER PLANT.

Coal is delivered by an electric mining train from a wharf across the street.

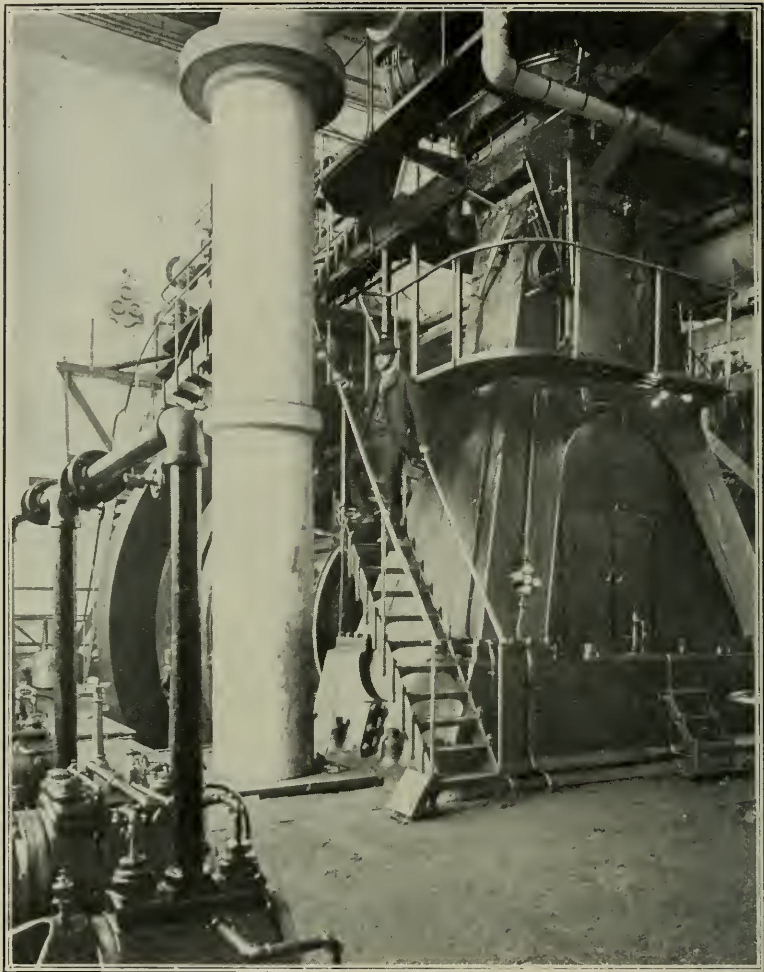
vators, transfer-tables, boilers, fire pumps, machine tools, and blacksmith apparatus, to the number of several hundred.

4. A car-manufacturing, equipment, and repair plant, with paint shops, machine, pattern, and carpenter shops, motor-repair shops, brass foundry and blacksmith shop, maintaining besides the regular car equipment that of all the other departments, including 125 stationary motors and several hundred vehicles of every description for regular and special service.

5. About 800 miles of steel rail with 1,100 miles of overhead and underground trolley and feed wire, each with a multitude of electromechanical devices and connections and special appliances maintained or furnished by the mechanical department.

6. A store house filled with large supplies of the many thousands of appliances, either made in the manufacturing department or supplied by outside firms and subject to the order of the various departments requiring a number of freight or service cars and the handling of a vast number of separate items monthly.

Scanning the list of apparatus enumerated above it can be seen that the design of new equipment and care of old, the repairs, changes, tests, and operations, require a very large force of men skilled by long experience with its many and various eccentricities. All railway apparatus is still in the process of evolution, and perhaps always will be, so that the new problems coming up for solution every day are manifold and



ONE OF FIVE GIANT POWER-STATION UNITS.

Vertical cross-compound engines of 8,000 horse power each, maximum, direct-connected to direct-current generators.

intricate and new devices are constantly being presented for trial or criticism.

Whatever the size of the system, the manufacturing, repairs, and equipment operations should preferably be centralized near a large power station, and usually are so placed; but if that is not convenient, a large tract of land should be secured near a waterway and railways where land is cheap and abundant, and here should be laid out a system of one- or at the most two-story buildings, convenient to transfer ways, steam and street-railway tracks, and built with fire-proof materials. They should have proper sanitary, ventilating, heating, and lighting apparatus, and afford space for all the mechanical departments, draughting rooms, store rooms, lumber, and building materials. Here cars are built, equipped, and painted, and damages repaired. Trucks are constructed, overhauled, and supplied with motors. Motors are cleaned, armatures and commutators rebuilt and tested, wheels are ground, bored, and pressed on or off axles, all bearings are made or repaired, brass, copper and miscellaneous metal work is done for the different departments, registers and all electrical car apparatus are cleaned, repaired, and tested, and all general forging and pipe fitting is done. This brings the heads of all mechanical departments together where frequent conferences can be held, tests and performance of apparatus can be closely watched, progress of shop work noted, condition of supplies ascertained, and, in short, harmony of all working forces secured to the highest degree. Here may well be located, besides the mechanical engineering offices and draughting rooms, those of the lines, electrical, civil, and architectural departments, although this is not essential.

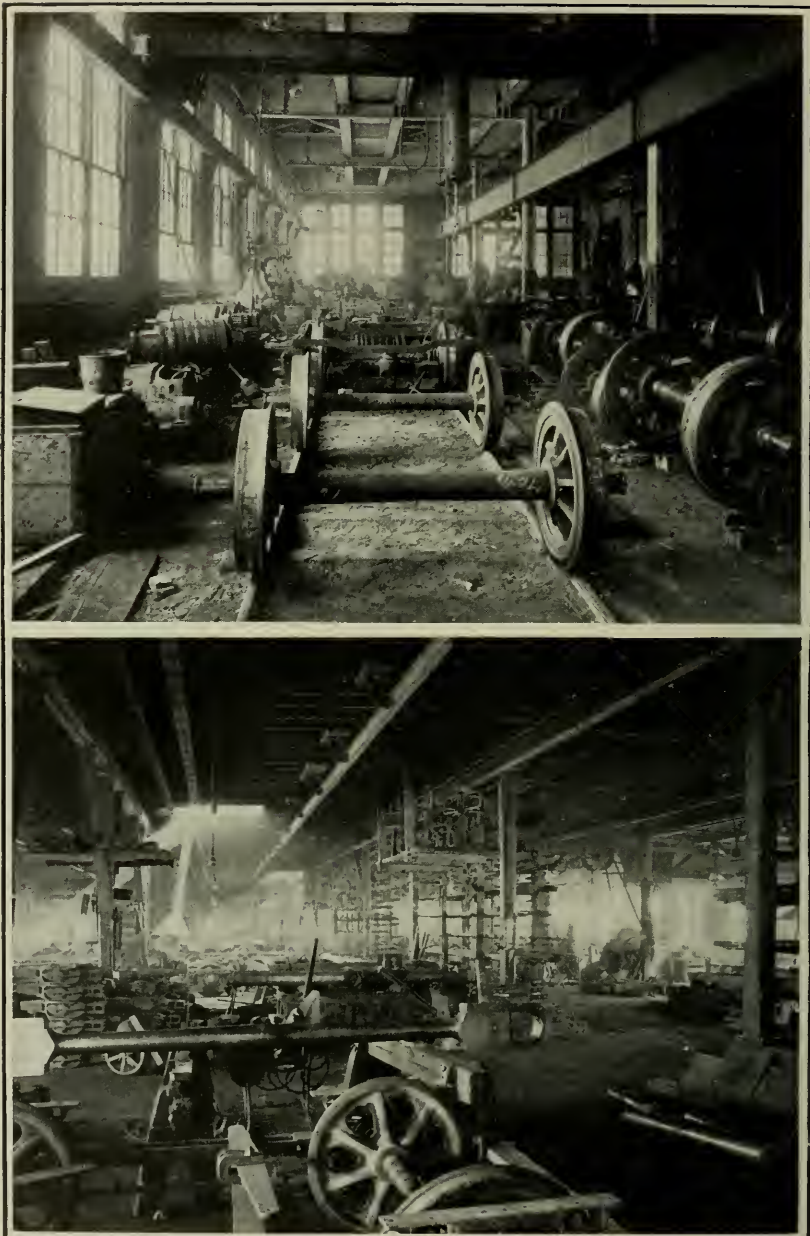
The subdivisions of the department of motive power and machinery may be:—

1. Car-motor and lighting equipment, having full charge of all new truck and motor mounting, motor and armature repairs, remounting old trucks, equipping cars electrically, care of all special and service cars, besides an electrical corps for equipment and care of stationary motors, special station electrical apparatus, electric lighting, heating, bell work, etc., throughout the system, including buildings, stations, subways, and elevated railways—all under a *superintendent of car equipment.*

2. New car construction, painting, glazing, upholstering, signing, and repair of old car bodies and vehicles of every description, with its mill room and lumber sheds, conveniently situated—under a *superintendent of car construction* or *master car builder.*

3. General minor car repairs at car houses, concerned with the daily inspection, cleaning, and handling of cars and car-house equipment, snow-plow equipment, repairs to all parts of the trucks and electrical equipment, shifting of cars and supplies—under a *superintendent of car repairs.*

4. That for manufacturing and machinery repairs, concerned with the making and fitting up of all mechanical apparatus and other devices in connection therewith, such as wood and insulating materials;



ABOVE IS THE TRUCK SHOP FOR ELEVATED CARS; BELOW, THE MANUFACTURING AND REPAIR SHOP.

The truck shop contains modern motor-driven tools, such as wheel grinders, wheel press, double-ended tire lathe, radial drill, shaper, hoists, turntables etc.; the manufacturing and repair shop builds and repairs all kinds of railway machinery, from a clock to an electric locomotive.

here are received daily orders from all over the road, embracing everything from delicate electrical instruments to 5,000-horse-power engine repairs; here are handled all car and track parts, power-station machinery, line construction, subway and elevated apparatus, and car-house appliances; this department operates the pattern and carpenter shop, brass foundry, and blacksmith shop, and has facilities for securing other castings and large forgings at various cast-iron, malleable-iron, and brass foundries and forge shops. All this work is under the supervision of the *superintendent of machine shops.*

5. Draughting, inspecting, testing, photographing and experimental laboratory work, comprising the usual draughting-room facilities, dark room, chemical and testing laboratory, with a full equipment of testing apparatus, and space not only for making indoor tests but for storage of testing apparatus, valuable instruments, specimens of tests, models, photographic plates, and chemicals—the whole in charge of an *assistant engineer,* or *chief draughtsman.* This department would of course supplement and assist those of similar nature required by the other engineering departments, each of which will have such a variety and quantity of apparatus as to require a laboratory of its own.

Having briefly described the scope of the various departments of this feature of the railway company's work, let us take up the matter of the origination and progress of orders in and through these departments, a system which requires careful planning to avoid delays, give satisfaction, and prevent friction where, as in a street-railway organization, necessities of operation require a great deal of emergency work by day and night. Such a system can hardly be the same for any two roads, but in general I believe that the final shop orders for work to be made there, as well as the requisitions for new apparatus to be supplied by purchase or contract (all of which are usually based on the department's drawings and specifications) should emanate from the draughting room by request of the chief engineer or superintendent and be accompanied by, or refer to, definite plans and specifications; after approval by this officer they should pass to the shops or purchasing department direct.

In the draughting room sufficient time could be given by clerks to the preparation of these orders, and the necessary information should be there to make them properly descriptive and accurate, referring definitely to plans or sketches and always supplemented by that kind of information.

For the purpose of information, reference, and record in the different departments involved in each particular class of work, these orders can be duplicated or triplicated if desired and can then do their part in following the work to completion.

The value of this plan should commend itself because of the centralization and classification of data and information it permits, the records it aids to preserve in case of future duplicate orders, and the relief it affords other departments of the necessity of carrying a large stock of samples, models, irregular information, and sketches on miscellaneous scraps of paper, or of trusting to the memory of foremen or workmen. Further, it avoids any chance of shifting the responsibility for errors.

Of course, where operations are carried on night and day every day in the year in so many departments as is the case in a street-railway system, there must be a great deal of rush and night work and some special method is necessary to carry the work through properly and uninterruptedly under competent men.

Closely associated with the matter of orders is the department of stores—an ally of the mechanical departments, though perhaps directly responsible to the purchasing department or the chief officers of the company. This store room may receive, with few exceptions, all orders for material to be supplied from stock or purchases; but these, together with all orders for drawings or repairs from the various mechanical departments, should first be seen and approved by the superintendent or his representative, and a brief notation made therefrom for reference; then the order can be transmitted direct to the store room, if the material is kept in stock or to be purchased without plans or specifications. Otherwise it should go to the draughting room for such suitable plans, sketches, data, and specifications as the superintendent may order. For example, suppose a car-house foreman or station engineer requisitions the superintendent for a number of boiler tubes of a certain size and make of boilers, with a rough sketch on his order or note. The superintendent, after receiving it, ascertains if any are in stock; if not, he transmits the order to the draughting room marked for the chief draughtsman's attention, perhaps sending a note with it. The draughting room then makes perhaps a freehand copy-book sketch on memorandum sheets in copying ink or pencil. Then as many copies as the purchasing agent will desire may be struck off on the simplex or hektograph pads, including one in the proper copy book; or a drawing may be made in the usual way, traced and printed, and any number of prints taken. These copies are then sent to the superintendent with a new draughting-room order on the purchasing department and by the superintendent forwarded to the

THE ARMATURE ROOM, MACHINERY END.

store keeper; a duplicate of each order is kept by the superintendent while the draughting room retains a triplicate and the original order. The store keeper then requisitions the purchasing agent, retaining thereby a copy of the material with name of department and person ordering, for reference when the material is received, and with this order forwards the sketch.

To give another example; a station engineer may order a duplicate of some broken part of an engine, sending a sample, or the broken part itself, or a sketch from it with a reference to some pattern or drawing number. In any case the order goes to the draughting room and is made out anew when drawings are ready and forwarded to the manufacturing department. If a new drawing must be made and time is not sufficient for a tracing, a varnished shop sketch on small cards may be made, retaining a copy in the copy book; or if too elaborate for this size, it would be made in the form of a penciled shop drawing on larger sheets of drawing paper and sent out in this form to be traced later when time will permit. If still more time is allowed, these drawings may be traced as soon as made and sun-printed for use in the flexible form, or mounted on cards or boards of various sizes suitable for shop use. Then the order will be transmitted to the shops, calling for work from the various drawings enumerated. These will be sent for when the shop is ready to undertake the work and returned when finished. The foreman of the manufacturing department will then requisition the superintendent of motive power and machinery, the store keeper, and purchasing agent, for any material required to build the parts himself, or

ARMATURE, COMMUTATOR, AND COIL REPAIR SHOP.

A TYPICAL WRECK.

Illustrating one sort of work the shops are called upon to do.

will requisition for the whole work in case he finds he is unable to undertake it.

Another matter of importance in connection with orders is that of having the different departments order mechanical parts properly—that is, use the right name for the part wanted, its pattern number, material, and size, and refer to the machine name, number, or general type. To this end all the apparatus having a multiplicity of parts, such as cars and engines, should be studied in detail, each part given a proper designation, and tabulated with rough sketches and all the data available, in some form suitable for use by station engineers, car-house or shop foremen, store keepers, or heads of departments generally. For example, each one of the different trucks should have its parts listed on perhaps 8 by 12 sheets of tracing cloth for multiple reproduction, showing all the castings, forgings, and non-metal parts separately. These data sheets should give a sketch, name, number per set, pattern number (either builder's or railway company's own), size, weight, and drawing number, arranged in vertical columns for ready reference. In the case of engines each size would have its list of parts arranged in a similar way, separating those for the different sizes of cylinders in case there is more than one. Another aid of considerable value would be what might be called data sheets or schedules for the various groups of standard parts, such as armature shafts and brasses, commutator segments, axles, axle brasses, wheels, boxes, brake shoes, bearings, springs, and gears, of all of which there is likely to be such a profusion that one will find the tables of great assistance. Then there are such matters for tabulation as brake mechanisms, leverages, and sizes, shoe pressures, loads on axles or at contact points of wheels on rails, general dimensions of cars and trucks with weights, and relation of cars to tracks, wires and various structures in the streets, subways, buildings, or bridges.

Every complicated mechanism should be laid out to insure accuracy in the shop work, and all departments should assist the draughting room in keeping these drawings up-to-date, not ordering changes to suit somebody's fancied discovery without having their value scientifically demonstrated.

Every piece of apparatus, machine, or vehicle should have a number and a record of its location, type of equipment, dates of changes and nature of them recorded in a card catalogue. This leads us to the method of collecting and filing reports, letters, orders, data, drawings, sketches, prints, specifications, foreign plans, etc.

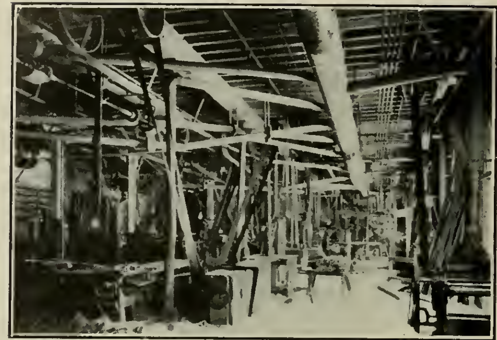
In the first place, it is not advisable for a department head to try to be a man-of-all-work himself. Clerical help is absolutely indispensable to the proper keeping of records, and leaves him free to carry on the more important work of his department, go over his field, and study his jobs. In the second place, records not kept up to date and down to detail are really a waste of time for perusal, and memory or a general pigeon-hole classification will better serve the purpose. Standard forms of reports of operation from the different stations, car houses, and shops are of course necessary, and these must be assembled, summarized, condensed, and tabulated for daily or weekly reports to the officials whose time is limited. For the filing of the general run of papers not larger than specification size (such as sketches, estimates, photographs, patents, catalogues, etc.), for which a subject classification by the numerical or decimal system is sufficient, the best arrangement found by experience is to have drawers about 12 by 14 inches in cross section and 30 or 36 inches deep, modeled on the card-catalogue cabinet idea. These may be arranged in a case about three drawers high, each one pulling out full-length, supported by telescoping bars and divided by manila-card partitions, adjustable to give any width between cards. An alternative is to use a lighter drawer or slide having the so-called book-shaped letter boxes, which are about 12 by 12 inches, containing manila-paper partitions, and set on their backs with open end upwards. In either case the matter will be readily got at by using a card index to subjects, and numbers or letters in connection therewith, and it will be found to be elastic as to quantity, size, and classification.

For the larger type of records—original drawings, tracings, maps, and blue prints—different methods must be used. For tracings a method of filing which I use and recommend is that of having, in a fire-proof vault, separate drawers for each important group of machines, each station or class of station work; these drawers are about 3 inches deep, and all of the largest size required. The drawings in each drawer are arranged in sets, flat-wise, and fastened together at their right-hand edges in a paper cloth cover which serves several purposes—that of carrying a label, of keeping drawings from getting lost in a drawer, of keeping them clean, and of forming a ready means of running over the titles and numbers when searching for a particular drawing, without lifting, displacing or missing a single one. Some minor devices are necessary to facilitate keeping, handling, removing, and replacing tracings, but the method is a compact and serviceable one. Paper originals should be kept flat in drawers, arranged in similar groups and classification, and those pertaining to one job secured together. Since many of these will be traced and others are apt to be of no great value, except perhaps the general layouts, which can be kept in vaults, they may be filed in cases, where there is more space available for handling the heavier drawings than there is in a vault; so also with blue prints, which, if lost, can be duplicated from the tracings, are more often referred to and generally used, and should be even more accessible than any of the drawings. This refers to foreign blue prints as well as to home prints. There should also be blue-print copies of all tracings kept on file for daily reference, to save handling the more valuable tracings; a most satisfactory and compact method of filing these was early devised by me and has proved its efficiency by years of service. It is rather unusual and can best be understood, perhaps, by saying that it is in adaptation of the newspaper racks used in libraries and clubs. Along a blank wall space are hinged to the wall metal or wooden wings, to which sets of prints, corresponding to the tracing classifications, and fastened together by special binders, are suspended by screw eyes and hooks. The binder carries file and set number and labels; it covers the brass fastening pins and inequalities in prints and by a method of overhanging the sets on brackets enables an edgewise movement of the sets for perusal which leaves nothing to

THE MECHANICAL DRAUGHTING DEPARTMENT.

Here ideas are shaped, turned, bored and polished. The blue-print files are shown on the rear wall.

be desired. In this way many thousands of prints can be filed and reached without taking up valuable space required by other methods. A set may contain from one to seventy-five prints without inconvenience, while twenty of such sets may be hung on a wing within easy reach in a horizontal space of one foot. It is well to keep up several forms for indexing and recording drawings. One should be a system of consecutive numbers recorded in books, with all the requisite information following each number. Another should be a card index of subjects, with all classes of drawings pertaining to each subject grouped together. As to miscellaneous data, records of patterns, machines, costs, employees, stock, orders, equipment, transactions, etc., there can be no question about the advantage of a card index.



THE WOOD-WORKING SHOP.

The success of a road depends in a measure on the quality and care of the materials used in its various machines. To this end the original specifications and plans should be very complete and specific in detail and careful tests should be made of the material furnished, both during manufacture and after delivery before final payments are made. A constant watchfulness and record should be kept of the actual condition of all running machinery, wear and tear of parts, consumption of supplies, coal, oil, and waste of power, light, and heat. This requires the co-operation of the designing, purchasing, testing, electrical, and operating departments. Such questions as the economy of engines, leakages of current, electrolysis, distribution of wire, handling of coal, alignment, and condition of track and roadbed, are problems for constant study.

A railway must buy most of the machinery it uses. It may manufacture some of its cars, trucks, and small machines of which special types are required, but as a general thing its manufactured product is purchased, and all its raw material likewise, from companies making specialties of these things, reserving for the function of its shops that of finishing this raw material or of repairing machinery.

As far as possible, a railway company should have its standards, both as to quality and form of parts. The conditions vary greatly on different systems and standards are therefore not uniform. The types of apparatus developed by the street-railway company in Boston are undoubtedly the best adapted to meet the conditions. Take the rolling stock for instance:—Every part of the two standard types of surface cars and

THE PAINT-MIXING ROOM.

the elevated cars, to the minutest detail, has been the special study of certain men in the company's employ to make them not only durable machines but simple in construction so as to minimize the cost of repairs and maintenance. Their design is in a measure adapted to suit the conditions imposed by narrow streets, but great attention has been paid to the convenience and comfort of the traveling public, and the eradication of all elements of danger. Consequently the plans and specifications have been widely copied throughout the world where similar cars were wanted. The equipment is kept clean and receives an annual painting and overhauling at the company's shops.

In the matter of running gear, trucks, and motors, the company, in common with other roads, has a large variety, for this part of the equipment is still in a state of evolution. Not that satisfactory types are not built, for they are, and the company possesses some of them, and besides it has certain safeguards in the matter of standard parts which eliminate much of the wear and tear and costs of repairs due to a miscellaneous collection of these parts, such as would be furnished by different truck builders. The latter are not wholly at fault, for standards are as various almost as the different roads throughout the world are in their requirements, and of course the separate builders must vary their treatment of the same feature.

In the department of lines and wiring of every description, the wire attachments are to a large extent specially manufactured by the company and standard for the places used. These standards are the results of careful study and long experience and embrace a very complicated field with more than fifty bridges crossed, reservations, subways, inclines, and elevated railways, overhead trolley and third rail and various submarine, subterranean, and aerial difficulties to deal with. The company has a uniform car-house arrangement and equipment in the matter of the disposal of transferways, pit rooms, wash room, boiler room, and shops, and the use of a flush transfer table, motor- and axle-handling, heating, lighting, and fire-service appliances.

Operating methods and economy in operation compare favorably and agree in the main with those in other cities. Power and load distribution are still the vital question, and by their maximum concentration and pull for a few hours daily in the season of greatest travel and consumption of power, affect the life, safety, and economy, of even the best power-generating apparatus of the day. Other uses and methods of storing power at periods of light traffic demands have not yet presented an attractive field for investment to relieve station apparatus of this tremendous destructive expenditure of energy.

THE ECONOMY OF MECHANICAL STOKING.

By William Wallace Christie.

Mr. Christie's discussion is doubly appropriate in the pages of THE ENGINEERING MAGAZINE—first as it relates to practical mechanical engineering and especially the generation of power; second as it displays the application of labor-saving and intensified-production methods in the boiler room. This paper is concerned chiefly with the structural and operative features of the principal mechanical stokers. A second will take up the consideration of the general economy of machine firing, and will be illustrated with views of many important installations.—THE EDITORS.

THE small number of men to be seen in a modern large machine works or steel mill, as compared with an old-time shop of similar importance, is a matter which has been a frequent occasion for comment, and this doubtless is due to the very general use of labor-saving machinery. The cost of production in industrial establishments is made up of the costs of raw material, wages, toolage, taxes, and interest, of which the largest single item usually is the wages cost. One way by which this item may be reduced is by the instalment of mechanical stokers.

In the great majority of steam plants, the coal is wheeled to the boiler room by hand, it is fired by hand, and the ashes are removed by hand, making, in plants of 2,000 boiler horse power or over, a wages cost of some considerable amount. The familiar hand-stoker, as we know him, is not to be entirely supplanted by any mechanical device, but by its use his work can be made to cover a much greater proportion of the plant, and it will be performed with much less fatigue to himself.

The mechanical stoker may be defined as a system of grate bars, dumping bars, coal feeders, and automatic devices to feed fuel and control its combustion, and subsequently to drop the ashes and unburnt coal. That a mechanical stoker is not in any sense a new invention is to be learned from the fact that James Watt took out a patent in 1785 for a device, having for its object the getting rid of smoke, in which the coal was placed in an upright conical tube or hopper, built in the brick work of the boiler immediately behind the furnace front, and the coal, after being coked at the front end of the grate, was automatically pushed back towards the bridge; but this stoker did not meet with much success. In 1819 John Walker, of England, brought out a furnace with a coke oven attached. Nathan Waddington's coking furnace, developed about the same time, was made up of two inclined grates, and each of the above is in part the forerunner of the Murphy stoker, as made in the United States. The mechanical stoker is therefore a device of English origin, though it has been very thoroughly developed in the United States to suit the local fuels and boiler furnace conditions.

Mechanical stokers may be classified according to the manner of their delivery of fuel to the grates as:—

a. Over-feed.
b. Under-feed.
c. Chain-grate.
d. Coking.
e. Sprinkler.

Their discussion will be taken up in order of this classification.

a. Over-feed stokers.

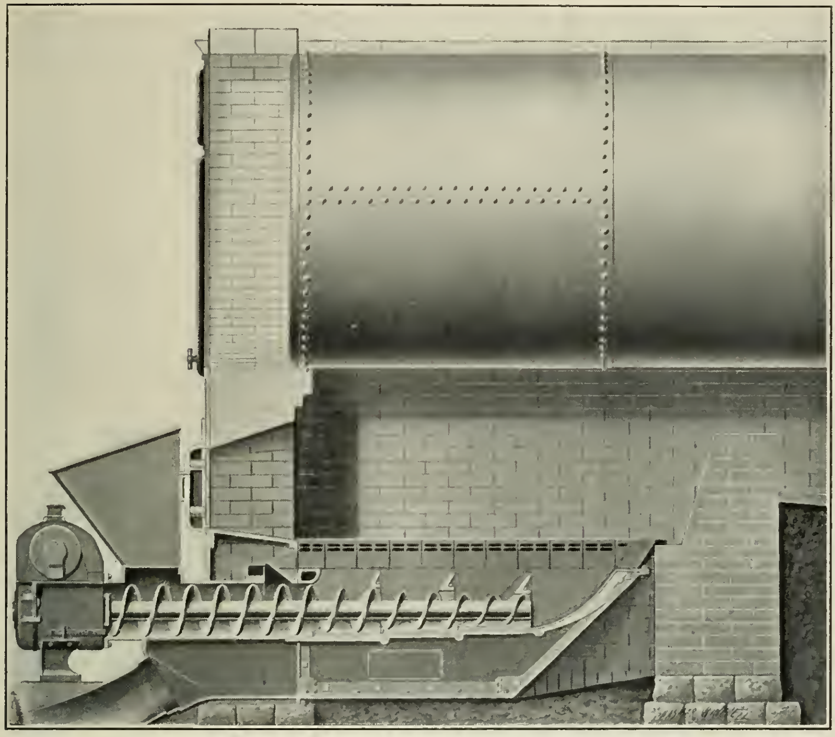
The two principal stokers of this type are the Wilkinson and Roney.

The Roney stoker consists of a hopper which receives the coal, from which it is fed by a reciprocating pusher upon a dead plate, and from there it passes to the step grates, and then to the dumping grate at the bottom or extreme end. The grate bars are made in two parts, one of which is a vertical web, the other a fuel plate which is ribbed underneath and is bolted to the vertical web, and is readily renewed. The webs being perforated, the condition of the fire can be seen at any time from the front. When this type of stoker is used for anthracite coal a special guard is provided, to retain the small coal on the grates while the dumping grate is being dropped. For bituminous coal, a coking fire-brick arch is thrown across the furnace to cover the upper portion of the grate, forming a coking furnace. This is primarily a hard-coal stoker. The Brightman and Meissner stokers are also of this general type.

The Wilkinson stoker is an over-feed stoker, in which the coal is fed from a hopper onto horizontal bars set at an angle of about 25 degrees with the horizontal. The bars on the lower ends are carried on hollow boxes, with finger bars projecting in their rear. The adjacent inclined bars are moved by lever connections in opposite directions, so that the feeding is accomplished solely by this method. Steam jets with an opening of about 3/32 of an inch are placed in the upper open end of each bar to supply the air necessary for combustion. Mr. J. M. Whitman, *Trans. A. S. M. E.*, Vol. 17, page 563, states that the stoker jets used 10.59 per cent. of the power developed, the stoker engine 0.21, or a total of 10.80 per cent. Other tests gave totals of 7.83 and 10.18 per cent. When using a fan driven by a slide-valve engine he found the per cent. of power developed used to operate the fan engine was 3.21, that used to protect grate bars 5.62, and to drive stoker engine 0.25, or a total of 9.08 per cent. The engine horse power developed by the fan engine was 5.92; its steam consumption per one horse power was 76.6 lbs., and the boiler horse power developed 410.5. Steam blast is preferred for this type.

The Kincaid locomotive stoker, used in the United States, consists of four principal parts—a hopper, a trough, a stoker engine with its steam valve, and a controlling engine. The hopper bottom is like two semi-cylindrical channels, in each of which is a spiral conveyor with shafts journaled in its front and rear ends. This hopper is hinged so that it may be turned up out of the way to allow hand charging at the round house when firing up. By an arrangement of various cams, the coal, after being fed by the screws to the pocket below them, is forced varying distances along the grate. The machine, being self contained and fitted to the usual fire-door fixtures found on any locomotive, may be removed in about one minute, so that delay to trains is prevented; at the same time, by throwing up the hopper, the locomotive may be hand-fired with the stoker in position, but not so well. This stoker is said to hold up steam well, and with zero for no smoke, 100 for dense black smoke, the average when using the stoker has been 22; sparks have been reduced to 25 per cent. of those shown by other locomotives of the same class, hand-fired, with equal load behind them. A month's record on a freight train credited the stoker with saving one or two 30-ton cars of coal.

One cause of loss of economy in boilers is the constant opening of fire doors with the resulting inrush of cold air. This is especially frequent on locomotives, and is an objection easily removed by a stoker. A point that might be raised by the fireman is that his services may be rendered less valuable. I think his services would be needed all the more to think for the stoker, and besides the fact that his work as fireman is lessened and made easier, his services as engineer's assistant will be in greater demand, and of greater value.

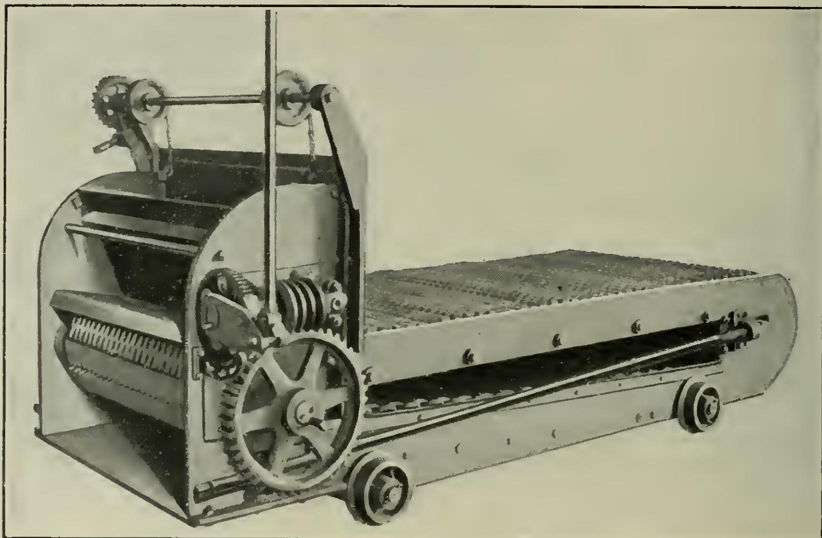


SECTIONAL ELEVATION OF AMERICAN COMPANY'S UNDERFEED-SYSTEM STOKER.

b. Under-feed stokers.

The American stoker is constructed as follows: Immediately beneath the coal hopper, and communicating with it, is a conveyor pipe, this in turn communicating with the coal magazine. A screw conveyor or worm is located in the conveyor pipe and extends the entire length of the magazine. Immediately beneath the conveyor pipe is located the wind box, having an opening beneath the hopper. At this point is connected the piping for the air supply, furnished at a low pressure by a volume blower. The other end of the wind box opens into the air space between the magazine and the outer casing. The upper edge of the magazine is surrounded by tuyeres, or air blocks, these being provided with openings for the discharge of air, inwardly or outwardly.

Each stoker is driven independently by a small steam motor, located immediately in front and beneath the hopper. The motor has a reciprocating piston. The piston rod carries a cross head, which by means of suitable connecting links, operates a rocker arm having a pawl mechanism, which in turn actuates a ratchet wheel attached to the conveyor shaft. The stoker is thus entirely self-contained and complete in itself, and consequently there is no danger of the driving mechanism and feeding mechanism (the only working parts) ever getting out of alignment. The rate of feeding coal is controlled by the speed of the motor, this being effected by throttling the steam in the supply pipe to the motor. No special setting is required, the location of the rear bearing bar being simply changed to suit the length



DULUTH STOKER, STATIONARY TYPE.

of the stoker, and the conveyor pipe being introduced through the front. In the use of the volume blower for supplying air, the American Stoker Co. aims to deliver 150 cubic feet of air to each pound of coal burned, and with a pressure at the tuyeres of ¾ to 1½ ounces. The air required by this stoker is stated to be from 20 to 55 per cent. less than for hand firing. This stoker has been installed with success on some of the steamers of the Great Lakes.

The Jones stoker is another one of this general type and has been described as follows:—The stoker consists of a steam cylinder or ram, with hopper for holding the coal, outside the furnace proper, and a retort or fuel magazine inside the furnace, into which the green fuel is forced by means of the ram, tuyere blocks for the admission of air being placed on either side thereof; the retort contains at its lowest point, and at a point which the fire never reaches, an auxiliary ram or pusher, by means of which an even distribution of the coal is obtained. By means of the rams, coal is forced underneath the fire, each charge of fuel raising the preceding charge upward, until it reaches the fire, which point it does not reach until it has been thoroughly coked. The gases being liberated under the fire, and at that point mixed with air, must necessarily pass through the fire and be consumed, thus giving the benefit of all combustible matter in the fuel. Air is forced at a low pressure through the tuyere blocks, under the burning fuel, by means of a blower operated by an independent engine, or from a line shaft, if such arrangement can be made. This stoker, in an adapted and improved form, is known throughout Britain as Erith's stoker.

Bodmer's stoker is made up of a single grate area between two screws; the screws, in addition to feeding the coal, give the grates a rocking motion. The helix fire feeder is a device originated and developed by Holroyd Smith.

c. Chain-grate stokers.

Among early devices was John Juckes's furnace, an English production, made up of an endless chain of bars traveling on a movable carriage. The Coxe, Playford, Babcock and Wilcox, Mansfield, Green Traveling Link, and Duluth stokers are all of the chain-grate type. Mr. Eckley B. Coxe, late president A. S. M. E., conducted extensive experiments with his stoker in connection with the utilization of small anthracite coals, and developed the machine in the most careful and scientific manner.

The furnace, as described in detail by Mr. Coxe*, consists essentially of a traveling grate moving from the right toward the left. The coal, which is brought to the hopper by a drag, spout, or any other convenient method, feeds down by gravity over the fire brick onto the traveling grate. The coal is carried slowly at the rate of from 3½ to 5 feet per hour toward the other end. In the beginning of the operation the coal on the right hand side of the furnace is ignited, the other part being covered with ashes or partially consumed coal. After the furnace is heated, the fire brick, which we call the "ignition brick," becomes hot, and the coal, passing down under a regulating gate, becomes gradually heated, and by the time it reaches the foot of the ignition brick is incandescent. In some cases the coal becomes hot enough to ignite soon after it passes the regulating gate. Under the grate there are a number of chambers made of sheet iron which are closed on all sides except on top. The blast from the fan which

* New England Cotton Manufacturers Association, 1895.

is used to furnish the air is blown into the large air chamber, the second one from the right. These air chambers are open on top, but the partitions are covered by plates. These plates are of such width that, no matter what may be the position of the grate bars, there is always one resting upon this plate, so that the air cannot pass from one chamber to another except by leakage along the bar. The result of this arrangement is that if we are blowing into the large air chamber with a pressure, say, of 1-inch water gauge, the pressure in the next air chamber to the left would be about ¾ inch, the next to that ½ inch, and the next to that ¼ inch. Of course these figures are not strictly correct, and are used merely for the purpose of illustrating, as I am now describing only the general principle of the apparatus. The pressure in the air chamber to the right would be, say ¾ inch. The result of this state of affairs is that the coal, when it arrives on the grate, is subjected to a pressure of blast sufficient to ignite it, but not so strong as to impede ignition. In order to regulate exactly the pressure of the air in each of the compartments, the partitions are provided with registers, by the simple opening and closing of which the pressure in the air chambers can be varied to suit the conditions.

As the thoroughly ignited coal passes slowly over the second compartment (where the air pressure is a maximum) it burns briskly, and then slowly passes over the third compartment, where the air pressure is less and better suited to the combustion of the thinner layer of partly consumed coal. The bed continues to diminish in carbon and to be subjected to less blast, until finally the hot ashes are cooled off (before being dumped) by a very gentle current of air, which is heated and mingles with the carbonic oxide produced in the zone of intense combustion and converts it into carbonic acid. The object is to subject the coal, as soon as it arrives on the grate, to a pressure of blast which is the proper one to ignite it, then to burn it with a blast as strong as will produce good combustion, and, as the carbon is eliminated and the thickness of the bed becomes smaller, to diminish the blast to correspond to these conditions. The mass of coal remains all the time in practically the same position and condition in which it was placed on the grate, except so far as altered by the combustion.

The Playford stoker consists of a series of grate bars hung over wheels fixed on a movable carriage placed in the boiler furnace. The water grate in the hopper is worked up and down automatically to regulate the supply of coal to the bars. Cone pulleys are used to vary the grate travel from zero to 2 inches a minute. The stoker is operated by a ratchet feed gear, itself operated from a line-shaft eccentric. In this stoker the ashes are removed by a screw conveyor. A coking chamber, with its arch, assists very materially in producing smokeless combustion.

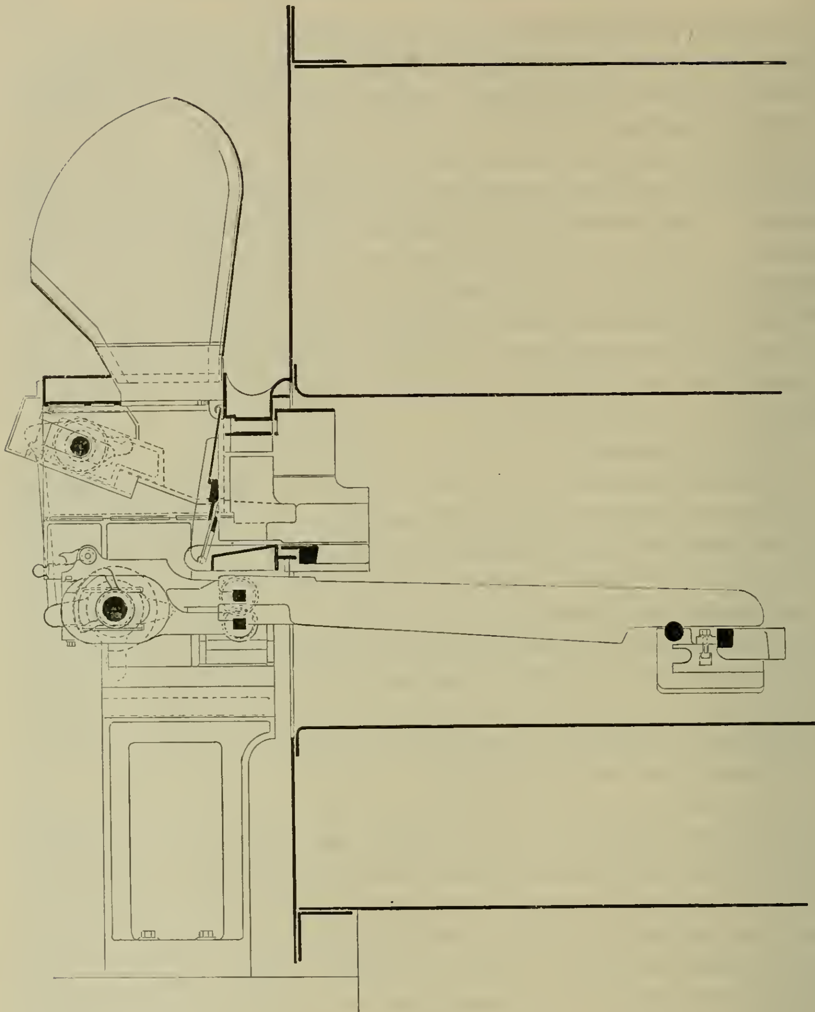
The Babcock and Wilcox, its near relative the Mansfield, and the Green Traveling Link Stokers are all of the same general type as the above. The Duluth consists in part of the Crow chain grate, and differs from others of this general type in that unburnt coal, falling through the grates, is caught up by a shoe plate and carried along on the return of the bars to the front and there dropped in front of the boiler on the fire-room floor. Eight of the largest steamships on the Great Lakes are now equipped with this stoker in successful operation.

d. Coking stokers:—

The first distinctively American stoker was patented in 1879 and is known and sold as the Murphy stoker. It is a side-feed coking stoker, chambers, called magazines, being provided in the side walls of the boiler settings the length of the furnace, into which the coal is charged and from there fed to the grate by operating the feed device sidewise, pushing the coal onto the coking table and from there upon the grate. A combustion chamber is formed over the grates by springing a fire-brick arch the full length of the furnace. A rate of combustion as high as 50 pounds of coal per hour per square foot of grate is obtained with this stoker.

T. & T. Vicars, engineers, London, E. C., write that they have discontinued publication of comparative tests, but are always prepared to guarantee the best results known to modern practice, viz: high CO_2 and low combustible in ash when burning from 10 to 50 pounds and over per square foot of grate, and from 70 to 75 per cent. efficiency with suitable boilers. This is a practice which is gaining favor among several American manufacturers. Smokeless combustion is obtained when the gas analysis shows 14 to 15 per cent. of CO_2 and an absence of CO.

The Vicars stoker is supported from ground level entirely and not hung on studs from the boiler front; it is so arranged as to clear the ordinary arrangement of boiler fittings. The upper part of the machine is fixed on rollers so that it moves backward and forwards as the boiler expands and contracts. The fuel in the hoppers falls by gravity into boxes, usually two to each furnace, from which it is gradually pushed in small quantities alternately by reciprocating rams or plungers onto the dead plate. Special arrangements are made



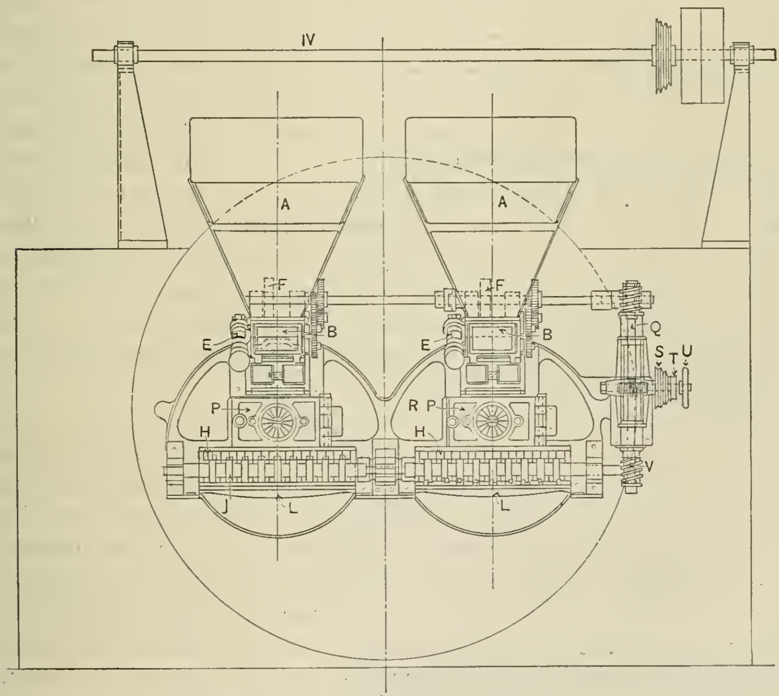
SECTIONAL VIEW OF THE VICARS' STOKER.
T. & T. Vicars, Earlstown, Lancs.

at this point for the rapid ignition and coking of the fuel. From the dead plate it is pushed onto the moving bars, which gradually take the burning mass further into the furnace. One of the distinctive features of this machine wherein it differs from all others is that no pretence is made of burning all the fuel on the moving grate. In fact, the speed of the bars is so regulated that there is always a layer of partially consumed coke with clinker and ash about six inches thick, passing over the ends of the bars and discharging on the bottom of the furnace, where it banks up and forms a bridge preventing the passage of any free air into the flue, and allows very high percentages of carbon dioxide to be maintained. A bridge of brickwork is built in the flue some feet from the end of the bars, thus forming a sort of combustion chamber, and at this point the final reduction of the coke to clinker and ash takes place. At certain intervals the clinkers forming the face of the bank at the end of the bars are withdrawn, and the combustible matter brought forward to take its place and in turn be converted to clinker. With ordinary fuel the backs do not need cleaning more frequently than every five or six hours, and the furnace is still hard at work during each operation, so that the evaporation in the boiler is hardly affected at all. The supply of the fuel and the travel of the bars are regulated with facility and independently in each furnace. The coal feed is varied by altering the rate of motion of the plungers. This also applies to the motion of the bars, but the actual stroke of these can also be varied up to say four inches. The bars of each furnace are arranged in two sets, each composed of the alternate bars, and move together, traveling in towards the bridge, but return at separate intervals. Thus fuel is carried inwards by the simultaneous action of both sets of bars, and remains in place without being disturbed by the return of either set. Each successive inward movement of the bars serves to carry the fuel, together with the clinker and ash, nearly to the end of the grate, where the mass at length drops over the end of the bars as already described. On externally fired boilers the system of dealing with the coke, ash, and clinker after it reaches the end of the bars, differs. Generally speaking, however, it drops into another set of stationary inclined bars, which with the flame bridge wall form the pit or combustion chamber. There it accumulates till the pit is practically full on top with incandescent coke, and on the bottom with clinker and ash which is removed at intervals. The inclined bars can be tipped so as to remove any clinker which may have accumulated on the face, and when suitable a plate forming the base of the pit can be made to tip so as to get rid of the bottom layer of clinkers and ashes automatically. Instead of two plungers or rams, three are often used for pushing the fuel onto the bars. The brick work is so arranged that the smoky hydrocarbons are brought into contact with the incandescent portion of the fire, and meet with sufficient air at the proper moment to assist in smoke prevention. On all types of this machine the various parts receive their motion from either an overhead or underground shaft, running at a speed of 20 revolutions per minute and invariably actuated by a small motor, engine, or adjacent shafting. There is a positive metal connection between the driving shafting and stoker ratchet wheels, and owing to the slow speed of the driving shafting the wear and tear of the moving parts is almost inappreciable. Large doors are provided which can be used for hand firing in cases of emergency. Although a portion of the unconsumed coal is delivered over the end of the bars into the combustion pits, independent tests have shown that the proportion of fixed carbon or unconsumed combustible in the ash drawn from the backs is very small, and much less than the leading authorities agree is permissible for the proper maintenance of CO_2.

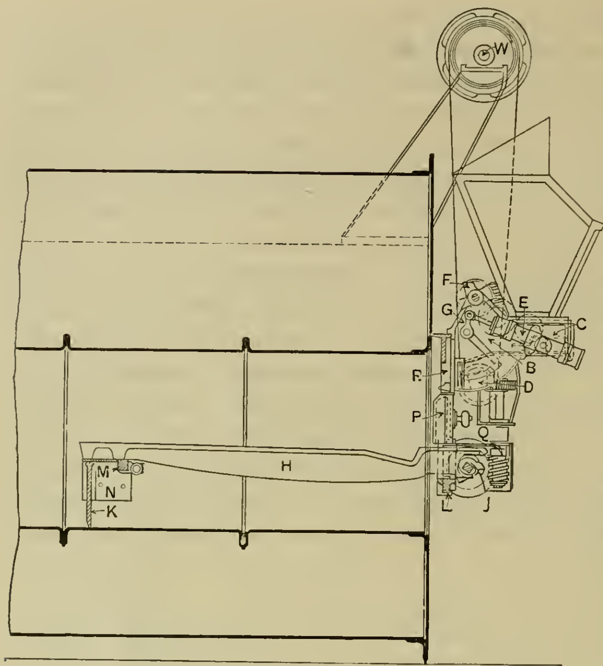
Vicars' stokers are made to operate with all forms of accelerated draught—induced or forced obtained by means of fans, steam jets, etc.—but the latter form is generally adopted. The ends of the bars and front of the furnace are boxed in and vertical or horizontal blowers attached to the bottom of the casing which is about level with the bottom of the furnace. A pressure equal to 1 inch or more can be easily maintained under the bars and round the air passages in front of the furnaces. Very low-grade bituminous fuels can be used, either caking or non-caking. The same machine can be made to give the very best results when working under all conditions, and the change from natural draught to forced draught or *vice versa* can be made instantly.

James Hodgkinson's coking stoker is another of the coking type.

This stoker has a minimum number of working parts, none of which come into actual contact with the fire. It consists essentially of a suitable receptacle for holding the fuel, the base of which is a hollow ram or pusher having forward and backward motions, actuated by means of sectors and racks fixed within. The sectors are keyed to a shaft which is rocked only by means of a crank disc and lever arranged to give a variable movement to the ram at will. The ram on its forward movement allows the fuel to fall into the space formerly occupied by it, and on its return pushes it over a top plate so constructed as to spread the fuel onto the bottom coking plate, always keeping the sides well filled. Immediately above the ram is a steam jet of special shape which induces a current of air through the incandescent mass of coke which is always at the front. The back of the stoker front casting is well protected by means of cast-iron blocks filled in with non-conducting material, and allowing of an air space between them and the front, so keeping the whole cool. Immediately under the ram is the fire door which is of the usual hand-firing size, although during work it is never opened as the action of the firebars efficiently carries the fire to the back end and deposits the clinker and ashes into the chamber at the end of the firebars, from which they are removed underneath the bars. The bars are worked by triple cams, so arranged that each alternate bar is drawn forward, the remaining bars being meanwhile held back until such time as the leading bars are at their full travel; then they are released and drawn forward to a common level. All the bars retire together. This action ensures that the air spaces are always open, particularly when a fresh supply of fuel is added, and the cams are further arranged so as to give a short dwell at this point in order that the fuel may be properly ignited before being disturbed. The overhead shaft makes about 200 revolutions per minute, which is reduced by means of worm gearing running in oil so that the ram shaft makes about 1½ movements per minute. Beyond filling the hoppers and removing the ashes the machine needs little or no attention. At one of the mills of the Fine Cotton Spinners' Association a Lancashire Boiler 8 feet 6 inches diameter, with two flues, fitted



FRONT SECTIONAL ELEVATION OF THE "TRIUMPH" STOKER.
Ransomes & Rapier, Chiswick, London.



SIDE SECTIONAL ELEVATION OF RANSOMES & RAPIER'S TRIUMPH STOKER.

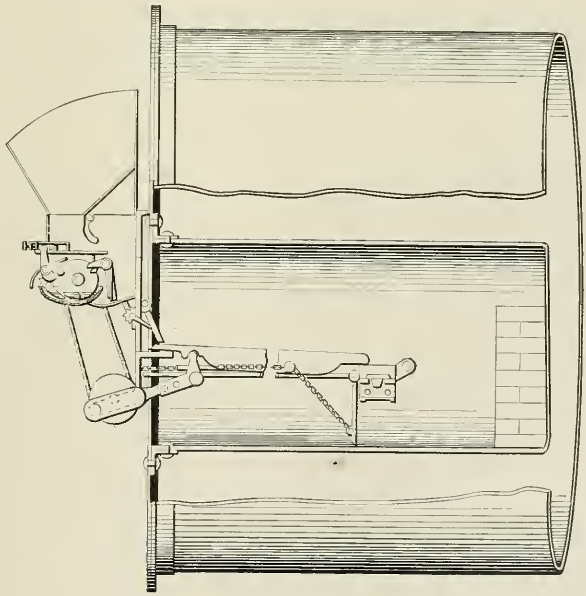
with these stokers and bars, consumed 17½ cwts. of coal per hour for months together during alterations, without causing visible smoke — a result impossible with hand firing. On a four-day test this stoker showed 33 per cent. economy in expense and 21.6 per cent. increase in boiler duty over hand firing. In another trial with the latest type of Hodgkinson stoker, the gain over hand firing was 11.66 per cent. in economy and 30 per cent. in boiler duty. Using Newcastle small slack under a Hornsby water-tube boiler, the boiler efficiency secured was 63.35 per cent., and the evaporation of water from and at 212° per pound of coal was 10.43 pounds. Tests with the Hodgkinson stoker on a Hornsby boiler in competition with hand firing showed a gain for the mechanical stoking of 0.3 pound water per pound of coal.

The McDougall and the Auld stokers are generally similar to Vicars, and a test of the former by Mr. R. B. Longridge showed a gain in evaporation over hand firing of 8 to 12 per cent. The Cass stoker, which has a flat grate, is spoken of as being very efficient. The Falmorden stoker, by Haworth and Horsfall, has a coking chamber built of firebrick between the hopper and the boiler front; the fuel is agitated by toothed rakes which rise between the grates and cut the fuel, moving it about two inches at a time. Meldrum's "Koker" stoker has been used at a rate of combustion as high as 40 pounds per square foot of grate per hour, giving 11.9 per cent CO_2 and 7.4 per cent. O in the escaping gases.

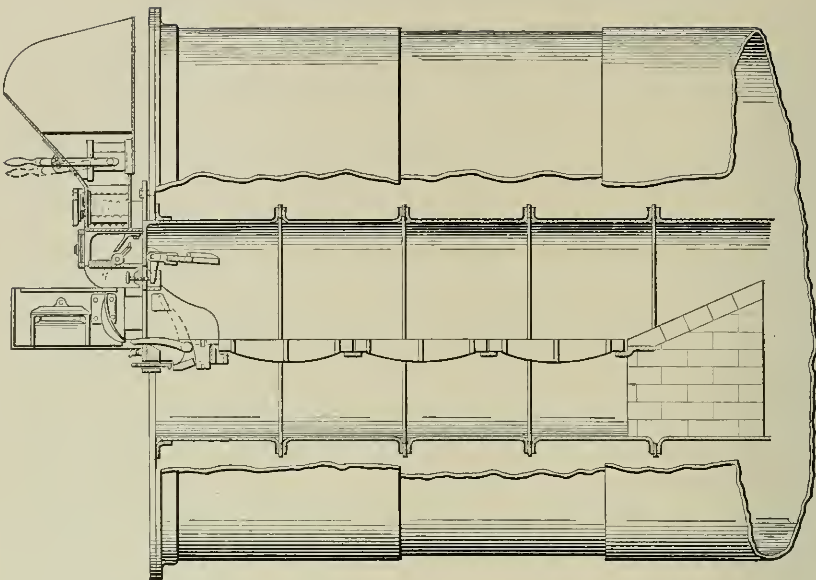
e. Sprinkler stokers:—

In the Triumph stoker, made by Ransomes & Rapier, the coal descends from the hoppers into a box containing an adjustable slide having a reciprocating movement. At regular intervals this allows coal to fall on a shovel, which by a cam, trigger, and spring is driven sharply forward but with a varying throw, so that the coal is uniformly distributed over the grate. The firebars have a come and go motion of about 2 inches, being drawn forward by two and two in succession, and then after a slight pause, all pushed back together. By this means the clinkers and ashes are caused to travel backward until they finally fall from the extremity of the bars into the ashpit. A series of small steam jets helps to keep the bars cool and to increase the draught. In a twelve-hour test, burning South Hetton unscreened coal (bean small) in a Galloway boiler with 47 square feet of grate surface and 1,140 square feet of heating surface, the fuel burned per hour was 1,150 pounds, or 24½ pounds per hour per square foot of grate, giving an actual evaporation of 8.45 pounds of water per pound of coal, equivalent to 8.9 pounds from and at 212 degrees. The feed water was at 204.1 degrees, steam pressure 122.3 pounds, average draught at induced fan 0.81 inches of water. The gases left the boiler at 868 degrees, and the economizer at 348 degrees. The fuel left 8.9 per cent. of ashes.

Other forms of sprinkler stokers are Henderson's, in which the coal is broken up as it comes from the hopper, falling onto fans which spread it over the bars. This, together with Deacon's improvements, is now controlled by the Mechanical Stoker Company. Proctor's stoker spreads a thin layer of fuel over



PROCTOR'S SHOVEL STOKER.



WHITTAKER'S MECHANICAL STOKER. SPRINKLER TYPE.
William Whittaker, Yorkshire St. Ironworks, Burnley, Lancs.

the fire by the quick sharp movement of a vane or shovel of sheet iron, the motion being produced by a cam. In the E. S. E. mechanical stoker the same action is obtained by three blades set at equal angles, the spreading being effected by a special fan-like deflecting disc. The quantity of coal fed can be regulated at the feeding boxes, the sprinkler shaft being turned at uniform speed.

Wm. Whittaker of Burnley, builds a sprinkler stoker having revolving shovels and spreading plate which cover the fire bars equally all over. The annual cost of repairs is given as 1 per cent. of the cost of the stoker, and the only gearing used is one gear and one worm wheel, and two ratchet wheels and two engaging dogs. The fire bars are stationary. The Leach stoker is a form of sprinkler stoker much used in Germany and on the Continent, and has shown under a Lancashire two-flue boiler a boiler efficiency of 66.3 per cent. The Frisbie is an American type of sprinkler stoker in which the fuel is fed on a circular grate.

My next article will discuss the general economy of mechanical stoking, with many illustrations of important installations at home and abroad.

FEATURES OF EUROPEAN LOCOMOTIVE CONSTRUCTION.

By Charles R. King.

II.—THE LOCOMOTIVES OF ITALY AND AUSTRO-HUNGARY.

Mr. King's first article, which appeared in the June issue, reviewed the structural and mechanical peculiarities and the running qualities of the French compounds. A concluding article will present a brief study of the latest locomotives of Switzerland, Saxony, Russia, and Northern Europe.—The Editors.

INCREASING volume of modern locomotive boilers interferes with the easy sighting of signals by the engineman, and for this reason on the largest American engines built for the French State Railway and in the latest Bavarian-built engines on the French Eastern Railway, the engineman's place has been transferred to the left-hand side of the cab. The new compound engines of the Southern or Adriatic lines of Italy are also disposed in this way.

Express Compound Engine, Southern Railway of Italy. This novel type of locomotive, the peculiarities of which are illustrated by the engravings, has—besides the recognised advantages for outlook possessed by tank-engines specially designed to run either end foremost—many features interesting for the future construction of locomotives. The engine, constructed at the company's shops at Firenze to the designs of Signor Plancher, was first exhibited at Paris in 1900 and a number were subsequently built by Borsig of Tegel near Berlin and Breda of Milan and put into regular service in May, 1902.

Its appearance in 1900 drew out many criticisms and notes of interrogation, but since that time the design has been followed to some extent in recent French tank locomotives and has been indicated, by competent men, as a solution to the question of how to obtain a large effective heating surface with fireboxes and boilers of moderate length, as opposed to the customary plan of extending the whole generator forwards to a great length and coincidentally removing the cylinders from the source of the heat and lively steam, a plan by which a serious loss of power is inevitable unless some form of superheater is provided to recover part of the lost thermal efficiency. The placing of all the driving and coupling axles beneath the boiler very conveniently leaves the low space beneath the firebox for a four-wheeled truck just where, in the four-connected type of engine, a simple radial axle is now

FOUR-CYLINDER COMPOUND EXPRESS ENGINE, SOUTHERN RAILWAYS OF ITALY (STRADE FERRATE MERIDIONALI, RETE ADRIATICA)
The whole of the engine is painted enamel black and highly polished; chimney, dome, and boiler bands are also polished black; there is no picking out whatever. The engine runs cab first.

very generally added. By thus turning the boiler around on its frames an extra pair of wheels has been avoided.

The cylinders have accompanied the boiler in this reversal, although there is reason to believe that in the locomotive of the future they may be returned to their original position over the pivoting truck. The firebox stands above the four-wheel truck, and in that position the footplate is necessarily situated above the free-swinging end of the locomotive where the lurches ordinarily felt upon striking a curve are hardly perceptible except by a sinuous lateral movement of the foot plate. The pivotal oscillations or side-lash common to long engines with a short rigid wheel-base and radial displacements at either end of the frames are here reduced to about half—as I have had opportunities of noticing in the riding of American "Atlantic" type engines and the Italian locomotive over the very same section of the French Western Railway—the reason being that the latter locomotive is rigid at one extremity—the smoke-box end.

This locomotive has no "idler" wheel behind the drivers and the truck at the front end allows possibilities for an immense development of the firebox, far beyond that attainable with any single axle below the furnace. With a very short grate the area in this engine is, nevertheless, superior to that of the *Nord* "Atlantic" type.

The outlook from the cab in front of the boiler is of course the very best that could be devised for a locomotive, and altogether preferable to the half-way arrangement adopted many years ago by the Reading road. The entire width and length of the track up to within a few feet of the cab are visible to either the engineman or fireman from any position on the footplate.

The disposition of the high- and low-pressure groups of cylinders is also novel. As in the Vauclain compound, there are but two piston valves, 7½ inches and 7⅛ inches respectively, for the high-pressure and low-pressure pair of cylinders; but that pair, with the Italian engine, consists of high- and low-pressure twins, the distribution realised for the two equal-sized cylinders being more perfect than if the valves served two odd fellows. The steam passages from each valve are crossed so that each opposite end of the twinned cylinders is always in connection—ensuring thus uniformity of pressure in the two cylinders and compensating for the irregularities of distribution due to the varying angles which the connecting rods form with their respective cranks. Unlike the ordinary Vauclain, the Continental practice is followed in the placing of two of the cylinders inside the frames, with these differences; that, in place of two low-pressure cylinders, there is but one high-pressure and one low-pressure located inside; and instead of the connecting rods having only two driving pins (as in the ante-1902 Vauclain) they have four—that is, each outside crank stands at an angle of 180 degrees with its nearest fellow inside, and the two sets stand at 90 degrees with each other. Here again the Italian differs from the usual Continental practice in having all the main rods working on the same pair of driving wheels (the middle pair) instead of equally dividing the work as usual between two pairs of the connected wheels; the result, however, is the same as regards obtaining an equalised twisting moment with diminished strains and wear as compared with a two-cylinder or ordinary Vauclain compound. The appearance of two small cylinders on one side of the engine's axis and two big ones on the other would, at first sight, suggest some want of balance, but as far as could be judged by the movements of the machine at all rates of speed the whole engine appears to be most perfectly balanced longitudinally, vertically, and transversely.

As they are arranged the cylinders, in spite of their crossed passages, have the very low proportion of clearance volumes of 10 per cent. for the high-pressure and 7½ per cent. for the low-pressure, but from actual experiments made with the Exhibition locomotive it was decided to increase these volumes by tentatively augmenting the piston clearances, in order to enable the engines to steam yet more freely and economically at high speeds.

The Italian locomotive was designed for an effective rather than an apparent simplicity—two very different matters. It has only one reversing screw, placed along with the throttle handle in the front end of the cab, and the admission of live steam to the low-pressure cylinders when starting the engine is always automatic and due to the opening of the throttle. This regulator is a double-slide relieved valve of bronze, which when slightly opened uncovers a central hole in the dry-pipe seating so that steam escapes away to the low-pressure valve chest, and when opened still farther this small aperture becomes thenceforth closed and is not reopened in the return of the valve across the live-steam inlet, and this by reason of the preliminary closing up of the supplementary valve with the first half-inch of return travel.

The special manner of introducing the live steam to the low-pressure valve-chest by passing it first into the casing of the high-pressure valve spindle extension, has some resemblance to the Gölsdorf starting system as far as concerns its valve-seating inlet for live steam. With the Italian engine, however, a groove combined with a "flat" on a false valve extension-spindle permits the auxiliary steam supply to enter the high-pressure exhaust whenever the high-pressure valve is in such position that starting must take place by the low-pressure cylinders and to this it arrives by passing from one chest to the other via the horse-shoe bend in the smokebox. On this bent pipe are placed (just back of the chimney) a relief valve and an air suction valve; the steam pipe in the smoke box is also fitted with an air valve. Each set of piston valves is worked from the middle driving wheels by an eccentric crank and the Walschaert form of valve-gear now universally adopted on the European continent.

The Exhibition engine had a very low-placed blast orifice variable by an internal pear-shaped plug, and only regulatable by a screw from beneath the smoke box.

The outside cylinders are horizontal and those inside the frames are inclined 8 degrees from the horizontal in order to clear the rear coupled axle. The main guide bars are single with a truss bar below, the flat bronze slide of the piston cross-head being guided in the narrow interval between the two. The middle webs, only, of the crank axle are inclined 95 degrees from the center line of the axle, and the outside webs stand, as usual, at right angles. The crank axle and journals are 7½ inches in diameter. The main driving rods inside have forked ends closed by fixed blocks and the brass is set up by a screw wedge. The outside main rods and coupling rods are of solid or box pattern. A peculiarity exists in the method of attaching the fire box to the plate frames by means of four broad feet, forged solid with the foundation ring at its front and back lower edges, these feet riding in special brackets and engaging in large buckles secured to the frame sides to prevent any chance of lifting.

The truck cradle differs from the usual arrangement in having the laterally swinging frame so broad that the lower centres of the pendulum links are spread apart equal to about the width of the road gauge, while the fixed centres on the truck frame above are set yet wider apart. The truck frame is of course of a special pattern, with outside sills of I section and with outside journal boxes. To prevent a too free transverse oscillation of the cradle frame, the pivot bearing is made of very large diameter according to the latest American practice for steadying this movement. The direct lateral swing allowed is 2 inches. A fore-and-aft oblique vertical movement of the truck is also possible under the same restriction, the two ends of the cradle-frame casting being rounded underneath where they rest on the bellied longitudinal tie bolts of the hanging links.

The boiler is of a type which has come into favour recently on progressive lines in east-central Europe, with the American form of spreading firebox standing above the frames and a slightly coned ring at the firebox end of the barrel. The inner firebox crown is flat with long-radius corners. Its stays are not radial, but the outer crown sheet is very strongly stayed with heavy channel gi. ders connected together with a double row of transverse ties.

In conclusion it may be mentioned that the engines are very finely painted in a brilliant black, without any relief lines of any sort, and present externally a remarkably fine appearance.

Ten-Wheeled Express Locomotive, Mediterranean Railway of Italy. This six-connected two-cylinder compound locomotive was constructed by Gio. Ansaldo & Co. at Sampierdarena to the plans of C. Frescot and G. Bartoldo (former and present superintendents of mechanical power of the *Strade Ferrate Mediterraneo*) and named the "Alessandro Volta." It is the first of an entirely new type in Class 4, to be numbered 3151-3200.

As a cross-compound it represents many up-to-date features, although preserving the general external characteristics which have distinguished the locomotives of this line of railway for a number of years past, and of which a specimen—an eight-wheeler, the "Giovanna d'Arco"—was exhibited at Paris in 1889.

This compound engine, of which the boiler pressure is 174.5 pounds, has one piston valve with external admission for the high-pressure cylinder and a balanced slide valve, with its more reliable steam-tight qualities, for the low-pressure. Both valves are of bronze. The low-pressure channeled valve is relieved by two projecting circular plates 11 inches in diameter. The back covers of both large and small cylinders have the same diameter. The low-pressure back cover is fitted outside, and the high-pressure back cover fitted inside the cylinder, and all four covers have 1¾-inch relief valves. A combined air inlet and relief valve is also provided on the receiver. The spring for the receiver steam-pressure is set at 94 pounds. No receiver gauge is provided.

An automatic Von Borries intercepting valve is located transversely to the locomotive at the foot of the 8¼-inch horse-shoe receiver pipe above the low-pressure valve chest. This is a disk valve of bronze, 7½ inches in diameter, which, when the engine has to be started on the low-pressure side, closes the way between the two cylinders under the pressure of live steam taken by a 1¼-inch pipe from the elbow pipe in the smokebox. This steam enters a large bore in the valve-spindle guide at a place where the spindle is so turned down in its diameter as to form a shoulder, or piston, against which the steam acts in forcing it inwards, so closing the large valve mentioned, and at the same time uncovering four holes in the spindle-guide through which the same steam enters into the passage just above the low-pressure valve chest; but, as the pressure is slight from the small surface presented by the shoulder, the whole is driven outward again upon the first exhaust from the high-pressure cylinder, thus covering up the leak holes into the low-pressure and opening the receiver to the exhaust steam, which then works compound. An automatic attachment has been designed by Signor Giordana by which, whenever the engine is reversed and run against steam, a jet of water under pressure is thrown up the blast to prevent the aspiration into the valves and cylinders of gases and cinders from the smoke box. This is arranged by an extension on the spindle just mentioned, carrying a 6½-inch cylindrical valve which can be forced outwards by the action of steam and water, admitted from the boiler by a special cock, and which, when it has forced the valve into a position corresponding to the intercepting-valve being set for working compound, escapes by a hole in the bottom of the cylinder into a ⅝-inch pipe leading down to the exhaust pipe of the low-pressure cylinder and thence to the blast.

A very suggestive feature is to be remarked in the front end of the framing—the side frames are contracted to only 2 feet 10⅝ inches between plates, and are of Siemens-Martin steel 1⅛ inches thick. In this way, even with the large cylinders employed (21¼ inches and 31½ inches diameter) the distance between piston centers is reduced to 6 feet 4 inches and so the main rods are brought in against the pin seats, while the side rods, contrary to custom, are placed outside. This reduces the bending stresses on the pin and diminishes the leverage on the axles, the result tending to promote as much steadiness as it is possible to attain in outside-cylinder engines. The second half of the side rods is of course brought inside against the pin seats for the second and third pair of drivers. The truck has inside frames with outside axle boxes. Its wheel base is 8 feet 2½ inches. The frame carrying the pivot is swung upon 11¼-inch vertical links. This pivot is of a novel kind, being in the form of a hollow sphere 12⅝ inches in diameter and bolted underneath the transverse main-frame casting previously mentioned. It is carried in a cup bearing of bronze, the rectangular external sides of which are fitted within a steel-casting box, and this in its turn is supported underneath by two transverse rods coupling the ends of the truck swing-links and guided transversely between the vertical girder plates of the truck. There being no side rests for the main frames the truck has in consequence a universal movement, and to permit of this the domed collar which covers up the top sides of the pivot, bearing etc., is allowed a certain clearance and, as this space might admit dust, a flexible hermetic joint has been made by inserting a ring of 1¼-inch rubber piping into opposite grooves turned in the collar and in the flange of the pivot. Combined with the universal movement there is an arrangement for controlling the side swing by means of a short tension-rod pinned by one its ends to a lug at the bottom of each side of the pivot box and passing thence through coiled springs contained in muffs outside the frames, to a cap at the other end of the rod which compresses the spring in against the frame whenever the lateral effort exceeds 1 1/5 ton.

The Exhibition locomotive was constructed of the finest quality materials and with the greatest care, the specifications containing very rigorous clauses as to the particular nature of the metals employed and concerning their testing and final working up. All the principal screws are cut to English standards. The finish of the whole locomotive exhibited was of the highest order; it was painted a dark green relieved by brass bands and beadings. Signori Giordana and Cuttica de Caffine both collaborated in the designing of this new type of locomotive. In service it runs the fast passenger traffic between Rome, Pisa, and Genoa, where the grades vary from 1 in 100 to 1 in 83. It is capable of taking loads of 220 tons net at 56 miles per hour under favourable circumstances. If the speed is not high, that is due more to local requirements and regulations than to the capabilities of the locomotive.

Hungarian State Railroad Compound Express Engine. The two-cylinder compound locomotive exhibited by the Magyar Királyi Allamvasutak is the first of a new type which includes also some simple-expansion engines.

It is of the ten-wheel four-connected type, which with its uncovered wheels and extended smoke-arch is suggestive of American origin. Although presenting a great departure from previous models of the same railway, yet it is not susceptible to the reproach of being an innovation, and therefore a "gimcrack-freak," for it is made up in detail from constructional features which, though they may be novel to us, have for the greater part all passed that trial stage indispensable to a legitimate incorporation with the time-honoured mould patterns that have so far served to cast Stephenson's locomotive.

The Exhibition locomotive, No. 701 of Class (Osztaly) II, was designed by the state railway engineers Paul Roth and Hubert Dvorak for the heavy express-train service on the Marchegg-Budapest line. The grades are of about 0.7 per cent., the loads 220 tons, and the coal employed, from the Austrian mines of Dambrau and Karwin, is equal to that generally employed on Austrian railways, producing six pounds of steam per pound of coal. The speed required is not high, but in this, as is general in Central Europe, it is not the want of engine power which is responsible. The coaches forming the trains worked by these locomotives are of great size, hardly smaller than those of Russia, and equipped with an attention to comfort that is not excelled elsewhere. The engine is started with a half-automatic valve somewhat resembling in its parts the Von Borries valve. It is placed longitudinally above the low-pressure valve chest and controlled from the foot plate by a lever operating two parallel rods. The upper rod works the valve at the foot of the 2-inch live-steam pipe, which takes its supply from the elbow pipe in the smoke box. The lower one passes through a larger hollow rod working in a stuffing box, and to its end is screwed a 6½-inch disk valve serving to close up, whenever required, an auxiliary exhaust pipe from the high-pressure cylinder to the chimney. The outside or hollow rod mentioned is not worked by hand. At its end is an 8¾-inch disk valve which closes up, independently of the smaller disk, that part of the receiver passage leading from one cylinder to the other.

In action the apparatus works thus:—On starting the engine the direct exhaust for the small cylinders is opened by pulling the fulcrum lever backwards. The live-steam valve on the upper spindle being opened at the same instant, the boiler steam flows into a conical annular chamber, back of the stuffing box, and thence passes by four holes into an internal bore in which a shoulder, turned upon the hollow rod, forms a sort of piston which is driven backwards until the 8¾-inch valve closes the way to the high-pressure cylinder while, at the same moment, a number of grooves milled in the circumference of the small piston are thrust into the receiver allowing the live steam to escape past it through the receiver into the horse-shoe pipe and around to the low-pressure valve chest.

Whenever the engineman considers the speed sufficient he pushes the lever forward, closing thus the direct high-pressure exhaust and shutting the small live-steam valve. The exhaust steam from the high-pressure now acts automatically in driving forward from its seating the large valve, which until then had barred the way to the low-pressure cylinders.

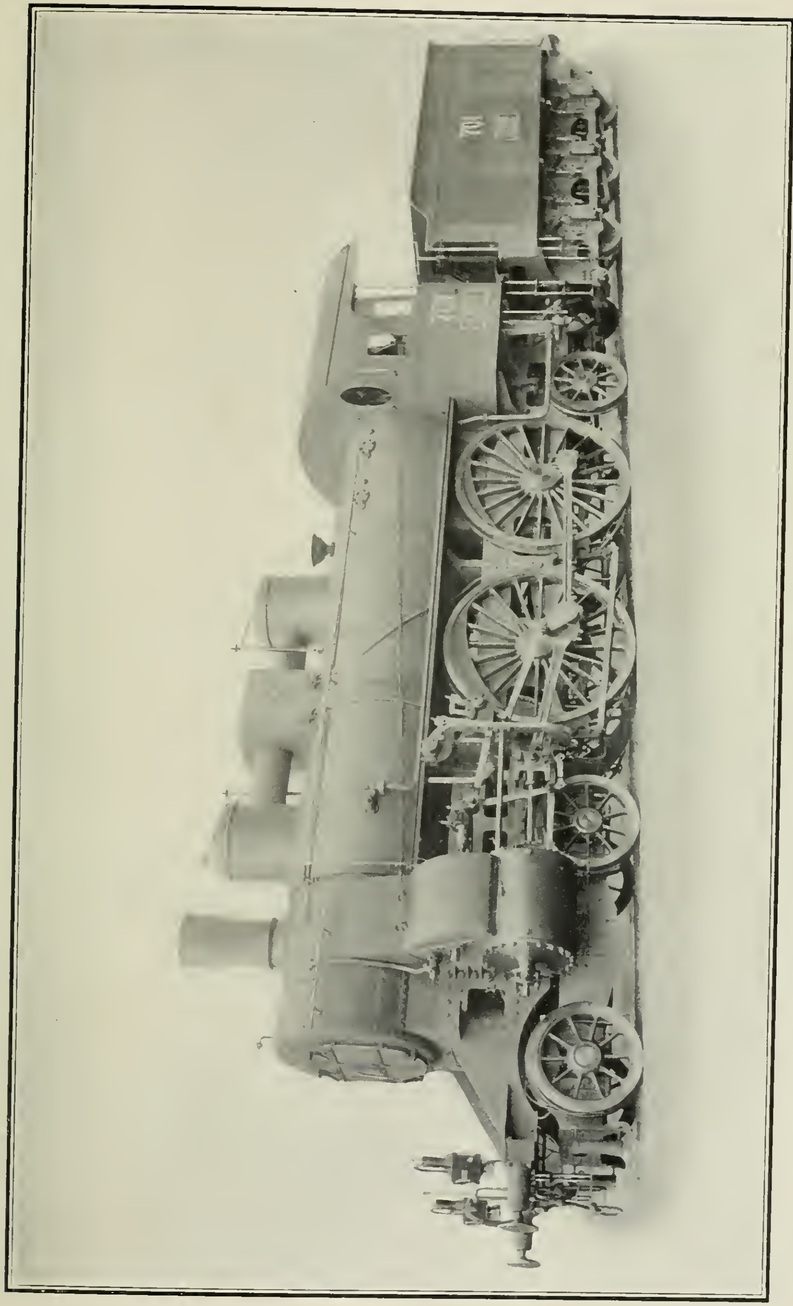
Unlike some live-steam valves or cocks, taking their supply direct from the boiler, in this case the auxiliary steam is to some extent regulated in proportion to the pressure of that in the high-pressure cylinder, since it is controlled by the amount of the opening given to the throttle. And, moreover, if at any moment in starting the throttle should be suddenly shut, that action cuts off the live steam independently of the starting valve. The relief valve on the receiver is set for 95 pounds; the normal pressure therein is about half that quantity. The boiler pressure is 175 pounds.

The cylinders are 19⅜ inches and 29½ inches diameter with piston stroke of 26¾ inches. The driving-wheels are 82⅜ inches diameter and the maximum tractive effort is 10,912 pounds.

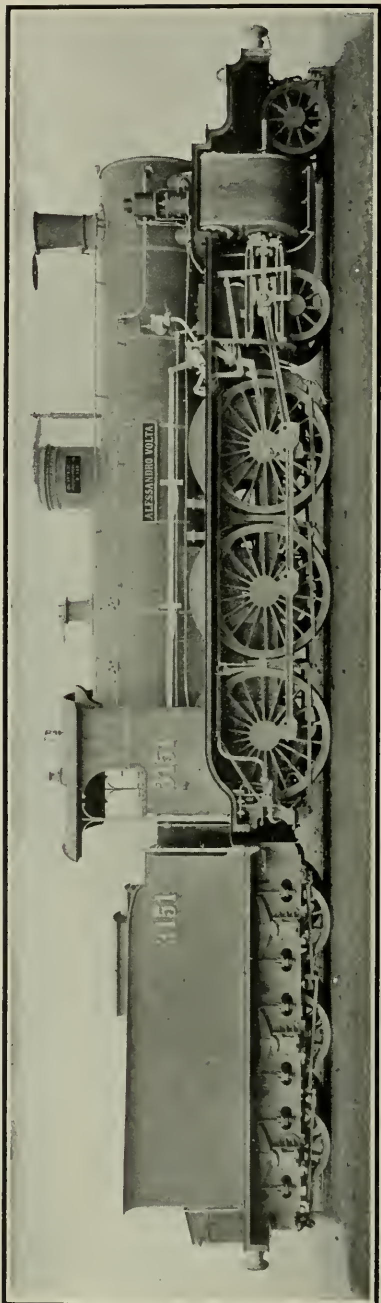
The valves are of the half-balanced type, steam channelled, and backed with Von Borries' relief plates, and the valve seatings are inclined at about 45 degrees. The valve gear is Heusinger's. The main driving-rod big ends are of great size in proportion to their rods, and present a remarkable contrast with American rods. The brasses are strapped in and held up with double gibs and a simple cotter. The side rods have solid or box ends, with their cotters fixed as usual by a stud screw.

The frames of the engine present a number of peculiarities. First and most striking is the built-up plate saddle beneath the smoke box, from which the side frames descend to below the cylinders in a line unbroken by the running boards, which usually conceal these front ends. The side frames are of steel 1 3/16 inches thick, and their edges along the oblique line from the smoke box to the side buffers are polished. A steel caisson extends from the smoke-box front to the motion brackets—a length of 9 feet 7 inches—which is stayed transversely by a horizontal plate of steel castings. Vertical flanged plates descend from the smoke box down to the base of the pivot trough, a distance of 4 feet 3 inches. The whole construction is such as to present a very rigid fixing for the cylinders. Further back the side frames are braced by vertical plates supporting the boiler under the first and third rings, and finally by the drag-beams under the foot plate.

The truck under the front end has universal movement without a hanging cradle. The truck frame is made up of cast-steel plates 1 inch thick and has a length of 11 feet 10 inches and a width of 3 feet 4½ inches; the frames are placed inside the wheels and the journal boxes outside the frames. At the front end the deep transverse plate forms a rail guard or pilot, and besides the transverse plate behind



EXPRESS COMPOUND LOCOMOTIVE, HUNGARIAN STATE RAILWAYS.

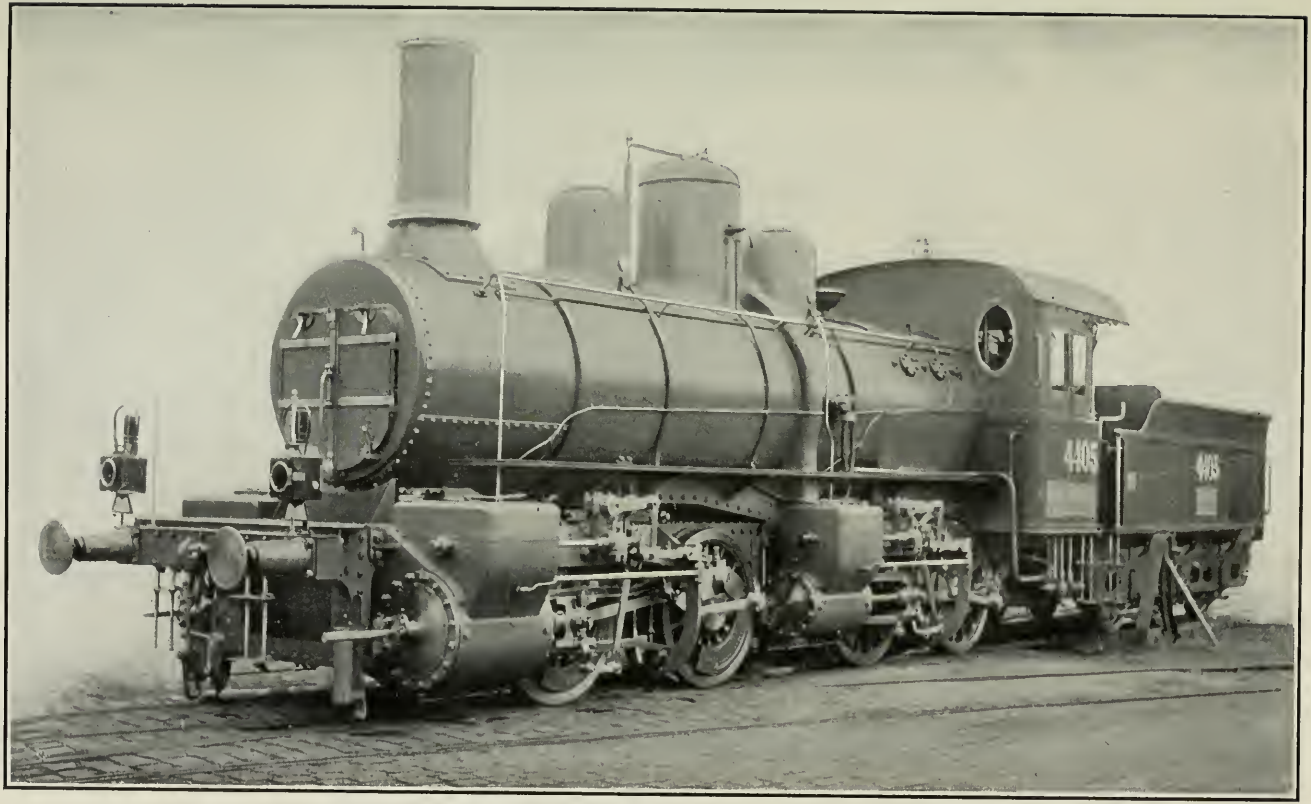


COMPOUND LOCOMOTIVE ALESSANDRO VOLTA, MEDITERRANEAN RAILWAY OF ITALY.

Is fitted with combined Von Borries Giordana valve.

there are four tie rods bracing together the opposite axle-box guides. In the middle two vertical-plate girders support a fixed transverse steel casting or bed, having a cup seating for the pivot $17\frac{1}{2}$ inches diameter, displaced 2 inches behind the middle of the truck. The pivot itself is a high rectangular casting with a spherical bearing, and its sides are planed to fit exactly and slide between the main-frame traverse or trough already mentioned. Consequently on curves the engine frame is permitted a direct lateral play, of 1 13/16 inches on each side of the pivot. The energy of this movement is reduced by plate springs set longitudinally at each side of the frames, and acting in antagonism by their free ends being coupled together by transverse rods and their camber pins butting against the opposite sides of the sliding pivot.

The pivot is held to its seating by a large-headed bolt passed from the inside of the casting, through a conical hole in the sphere and into a tight-fitting long socket in the seating below, to which it is secured by a wedge key. This step bearing is run with white metal. Vertical swivelling of the truck is controlled by two



HUNGARIAN COMPOUND FREIGHT ENGINE WITH NO EXPANSION LINK.

The fixed link of the ordinary Walschaert gear is replaced by a combination of radial arms which fulfils the same function.

springs under the frames at their outside edges. Such flexible side supports for the main frames must, at the same time, not interfere with direct lateral displacements nor tilt on their seatings through any momentary vertical divergence of the truck. All this has been effected by the use of spherical side rests, cast beneath lateral projections on the pivot casting. These round feet rest in cup bearings; the flat seatings of the latter are free to slide about on the recessed circular heads of two plungers below, which in turn are supported upon fine volute springs contained within cylindrical cavities cast on each side of the truck bed.

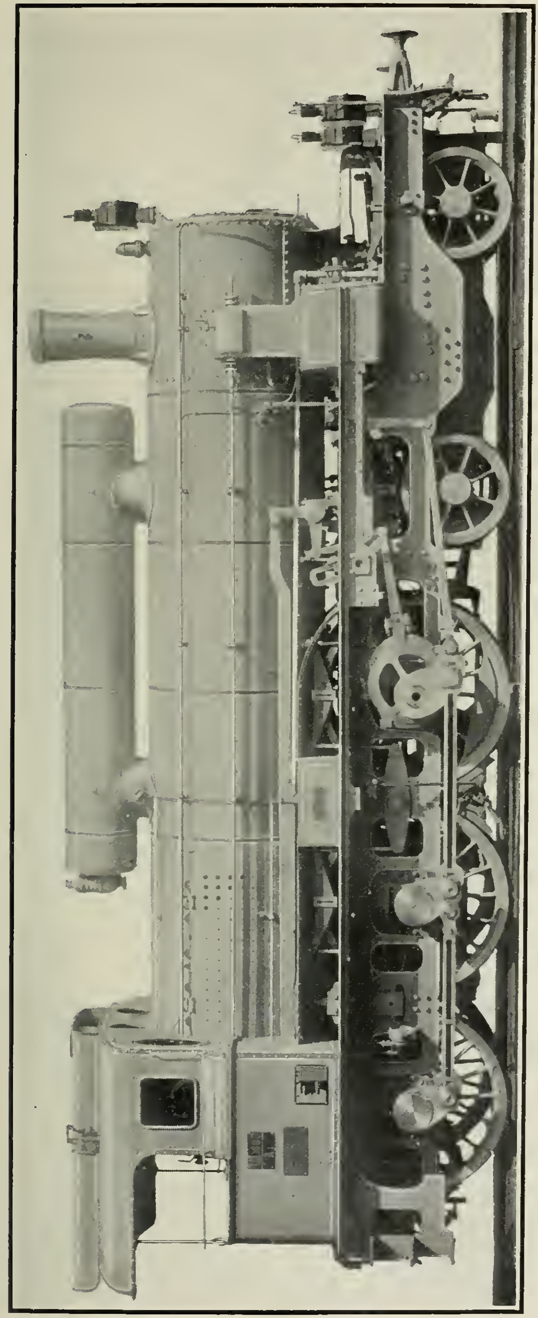
At the opposite end of the engine frame an equally uncommon device is employed for allowing the engine to swing radially around the quadractic pivot represented by the four points of rail contact below the driving wheels.

First of all the journals here have a direct lateral play of 5/16 inch on each side of their boxes, and these boxes are pivoted vertically so as to rotate partially around a shallow stud 3⅛ inches in diameter turned upon their crowns. The vertical ends of the boxes, to permit this rotation, are shaped to a radius of 4⅝ inches upon a width of 4 inches. They are accurately fitted into a special shoe or fork of cast steel, answering to the ordinary axle box with its flanges, which in this case are made very deep so as to allow a play longitudinally of ⅝ inch for the back and front guides of the horn blocks.

On curves the axle keeps square with the rails, but is drawn askew with the frames—without, however, those strains usually set up in all the parts concerned nor the wear and tear and necessarily increased frictional resistance.

Two-Cylinder Compound Engines, Austrian State Railways. Each of the Austrian locomotives exhibited at Paris presents certain peculiarities of construction differing from those of countries lying more to the west, and all have but two cylinders, arranged in such manner (on the Gölsdorf system) that no intercepting valve in the receiver is necessary. There are, instead, two small live-steam inlets in the low-pressure valve seatings, so located at each end of the valve travel that it is only when the engine is starting or is otherwise demanding much power from the boiler, with the reversing screw in full forward gear, that one of these apertures is uncovered; the counter opening for running backwards is then closed by a rib cast in the slide valve. The arrangement is sufficiently interesting to bear describing again for those who may have forgotten its action.

This system has found an extensive employment in Austria and



TWO-CYLINDER TEN-WHEELED COMPOUND LOCOMOTIVE, AUSTRIAN STATE RAILWAYS.

Peculiar in the disposition of the eccentrics and of the rod to drive the advance lever; and (for Austrian practice) in having inside cylinders, which are so large that the frames have to be spread on the outside of the wheels. Gölsdorf valve gear.

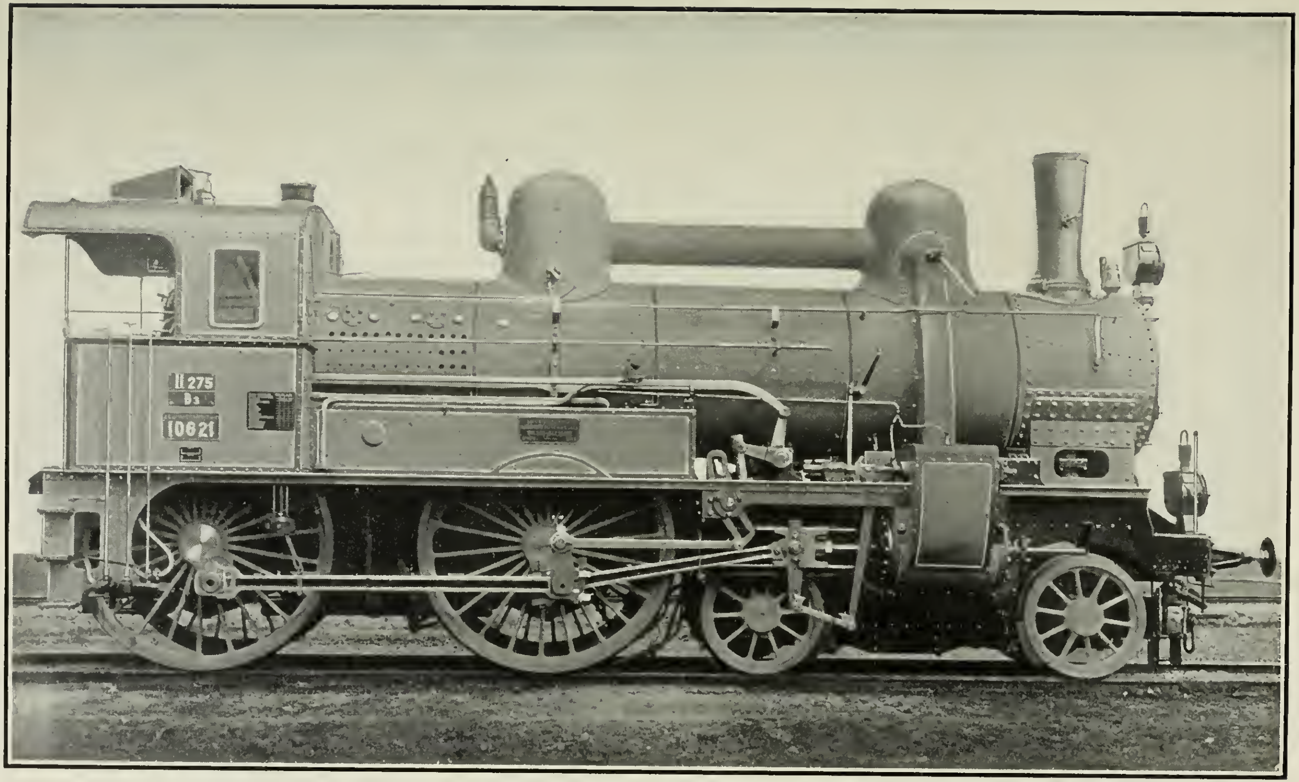
Russia, since, joined to its great simplicity, it avoids the expenses for maintenance and repairs incidental to special starting valves. It has, moreover, rendered a two-cylinder compound engine equal to, or, with the valve gear as employed, even superior in starting powers to a single-expansion engine; while the crippling effect of an automatic valve, cutting off the live steam after the first exhaust, is here entirely suppressed.

The six-connected two-cylinder engine is not only remarkable in its general external aspect, but, as will be seen by comparison of the principal dimensions of this and other engines, it is notable also for its power, particularly for a two-cylinder engine. It has a larger grate area than any European express locomotive of which mention will be made in this review, and its theoretical tractive effort at point of rail-contact is, with its two cylinders, but little less than that of the Nord four-cylinder 4/10-connected express locomotives. Its height is about 4 inches less than that of the imposing, but less powerful, two-cylinder engine of the Hungarian State Railways. The Austrian engine has also the longest stroke of any of the engines mentioned. A long stroke means greater starting power, for if carried to an extreme it means(always given the requisite adhesion) the tractive effort of a freight engine in starting and, later on at high speeds, a degree of expansive working with a very early cut-off which would render compounding unnecessary.

It means also a very high average piston velocity, but this, according to American experience, is not prejudicial; so that, pursuing this comparison—long versus short stroke—*ad absurdum,* it is simply surprising that such an elastic form of power as is available in the first should be so little utilised with all its unsurpassable range of adaptation on the scale of adjustment between power and speed, comparable to the crank-pin being gradually slid inwards from the periphery to the axle center as to the requirements for power diminish from the maximum of adhesion to nil.

The boiler, it will be at once remarked, is increased very considerable in its capacity as a hot-water reservoir by the addition of a longitudinal cylinder in place of domes, distantly resembling the Nord superheating locomotives of M. Petiet, exhibited in England in 1862, and also the more recent and still highly satisfactory Flaman locomotives of the Est. The form of the cast-iron chimney is seriously detrimental to the æsthetic apearance of all these *Oesterreichen Staatsbahnen* locomotives.

The location between the frames of such a large casting as that, having cylinders 20⅞-inches and 31⅞-inches with their valve chests, presented some difficulty. To accomplish this the inside-cylinders engine of Mr. Worsdell had the axes of the cylinders in a different plane; some German and Swiss locomotives have the frames bent outwards, and M. de Glehn, without bending the frames, built engines with two inside 23¾-inch cylinders by allowing a part of the inside cylinders to protrude through an opening slotted in the side plates. In the Austrian locomotive M. Gölsdorf obtained all the room desirable by the very unusual Continental practice of placing the frames well to the outside of the wheels, similar, it may be remarked, to the designs for com-



LATEST TYPE OF TWO-CYLINDER FOUR-CONNECTED EXPRESS ENGINE WORKING THE PARIS VIENNA TRAINS, AUSTRIAN STATE RAILWAYS. GÖLSDORF VALVE GEAR.

pound-engine arrangements submitted by Mr. A. Mallet to the Institution of Mechanical Engineers, London, 1879. This arrangement called for a longitudinal frame plate in the middle as a central bearing for the cranked axle, which is moreover of a very strong design.

The cylinders are inclined from the horizontal in order to clear the front truck axles of the cross-head guide bars. A distinct peculiarity of arrangement, necessitated by the various changes, is in the Heusinger valve gear, the advance lever of which had to be driven from some other point than the usual one on the cross head. The motion is therefore derived from the end of the coupling rod; and in place of the usual eccentric cranks for driving the links, a very large eccentric was substituted. The valves are placed vertical and their chests project outside the frames. The main steam pipe is brought through the smoke box just above the high-pressure valve chest and the throttle valve is very simply fitted thereto.

The front truck, with an immense wheel base but in proportion to the driving-wheel base, supports a swing frame or cradle, the oscillations of which are controlled by a traversing rod and short central coiled spring. The play limit on each side is 1½ inches. A hollow step bearing in the cradle supports a small half-sphere pivot, but vertical motion, or rolling, is prevented by side supports under the cylinder casting and resting upon angle brackets projecting from the truck-frame sides. The rear coupled axle has a play of ¾ inch on each side. The main frames are so wide that they project over and partly conceal the truck wheels.

The cabs of these railways have an upper clerestorey ventilator so as to keep the cab clear from the emanations of the lignitic coal whenever the throttle is closed. The cab is ten feet wide. The air inlet valve is combined with the receiver relief valve and mounted above the horseshoe pipe in front of the smoke box. The engine illustrated was constructed by the Maschinenfabrik der Oesterreichen Staatseisenbahnen Gesellschaft (late John Haswell) of Vienna. It is not intended for the fast speeds common in Western Europe, but it can haul loads of 450 tons up grades of 1 per cent. and eight miles in length at a steady speed of 26 miles per hour. It indicates 1,300 horse power in its regular work on the Amstellen-Pontelba division, whereon the curves descend to 720 feet and 625 feet in radius.

Four-connected Compound Engine, Austrian State Railways. The two-cylinder compound here illustrated is employed in one of the fastest Austrian service of International trains. It is of a new class, No. 106, resembling very much the precedent class "Series 6" but of greater neatness in external appearance. Its distinguishing features are the great wheel-base of the front truck—8 feet 10 inches as compared to the driver wheel-base—9 feet 2 inches—and to the total wheel-base—23 feet 10¾ inches. In the motion are to be remarked the very long and straight advance levers of the Heusinger gear—curved in the Series 6—and the hollow driving- and side-rod pins. It will be noticed that all the rods are channelled and, proportionately, very light. The main-rod big end is forked; the side-rod has the rear end of box pattern and the front end forked—instead of the reverse as customary. The manner of fixing the bearings for the expansion link-pivots to a short longitudinal frame below the running board is a practice peculiar to the *Oesterreichen Staatsbahnen.*

In these new engines the lever safety valves on the dome connecting pipe have been replaced by Coale valves behind the dome; some previously existing boiler fittings and discharge pipes have here been covered in by a large casing pipe projecting through the top of the cab, and the sloping ventilator on the cab roof has been made much higher than in the previous class.

The throttle valve in the forward dome is cylindrical and operated by an outside rod, and the steam pipe is carried direct from the dome to the high-pressure valve chest under a jacketing. The small mounting in front of the chimney contains a double-seated valve—one valve for relief of the receiver, the other with a light spring unseating readily for the inlet of air. The front truck pin is fitted with a round-edged collar bearing to prevent strains.

In actual service these locomotives haul trains of 265 tons net load upon rising grades of 1 per cent. at from 25 to 28 miles per hour, or up grades of ½ per cent. at from 40 to 44 miles per hour. With a light load of 155 tons on the level they have made 65½ miles per hour, and with experimental trains of two coaches they have run at 81 miles per hour. It has to be remembered that the coal used is very poor.

These Austrian locomotives are painted in black with red fine lines.

The principal dimensions are:—Boiler pressure, 191 pounds; cylinders, 19⅝ inches and 30 inches by 26¾ inches stroke; drivers, diameter, 84¼ inches; tractive effort, 14,960 pounds; heating surfaces:—fire box, 123.7 square feet; tubes, 1,554.8 square feet; total, 1,678.5 square feet; weight, empty 55 tons; loaded, 61.25 tons; under driving wheels, for adhesion, 31.5 tons.

MONEY-MAKING MANAGEMENT FOR WORKSHOP AND FACTORY.

By Charles U. Carpenter.

VI.—THE MACHINING AND TOOL EQUIPMENT.

Mr. Carpenter's articles began in The Engineering Magazine for February, 1902, the first and second papers dealing with factory organization in its general principles and concrete examples, the third with departmentalization and systematization of the works, and the fourth and fifth with the stock department and its systems. His next paper will deal with the very important subject of piece work. Mr. Falconer's article on pages 573-582 is an interesting supplement to Mr. Carpenter's discussion.—The Editors.

IT seems almost superfluous to state that a manufacturer should give most careful consideration to the best effective means of manufacturing his product accurately and cheaply. I believe, however, that it will prove profitable to approach this important subject on the most rational and scientific basis that we can. If any question deserves the attention of every manufacturer or superintendent, it is: "What are the secrets of cheap and accurate production, and how can I apply them to my own business?"

In considering the question of production we should keep in mind the processes and means that should be adopted to attain those results which mean so much to a business—*cheap, accurate and quick production.* To secure this, every device of modern organization, machinery, and system must be called to our aid. The organization should be so devised as to bring out the best efforts of the foremen and workmen and provide the closest supervision over the work. The machinery and tools should be selected with a view to meeting the special peculiarities of the product. The systems should be such as to give perfect checks on both the men and the product, and to supply data for a system of reports which are comprehensive and give the closest insight into the conditions of all departments. The product must be manufactured in large quantities; its parts must be standardized; accuracy of parts must be insured; fitting must be reduced to as low a point as practicable so as to insure quick and cheap assembling.

These requirements may be grouped into three classes under the general heads of Organization, Machinery, and Systems.

Organization of the Machine Room.—Careful and close study is not often given to the organization of the forces of the machine rooms in such a manner as to produce the best results. Too often is it the case that foremen and assistants are secured, placed in charge of a department, and then left largely to their own resources. The results are a number of departments developed according to the comparatively limited ideas and experiences, and, possibly, broad prejudices, of a number of men. Each man will develop his department along the lines of his "old shop" and will hang on to those ideas and their consequent development "like one possessed." After each one has put his pet ideas and theories into practice it is very difficult to get new ideas introduced. If, however, a general plan of organization, a well-digested policy of handling men, and a thoroughly comprehensive series of systems are introduced, it is comparatively easy to get the new comer to "fall into line" and assist in these new ideas.

Arrangement of Machining Departments.—Wherever possible, machines should be grouped together according to the class of work which is performed upon them. This is usually not possible in cases where large work is turned out. In such a case, the machines should be so placed as to insure, so far as possible, the steady progression of parts through the shop from one end to the other until the parts are finished. In cases where the machines themselves are brought to the work, the problem is simplified. However, where the parts are many and comparatively small, the different machines should be grouped as stated. One or more groups can be placed in charge of one foreman.

The principles of organization described in the earlier articles can, with profit, be adapted to the machine rooms. It was shown in those articles how the head of the factory has as his advisory board the different factory supervisors; how each supervisor has authority over, and is held responsible for, results from a certain number of departments selected for him according to his particular ability. Each foreman of a certain group of machines, or department, then looks to the supervisor of his group for orders and advice.

At the very beginning of the discussion of departmental management, consideration must be given to the question of securing the full efficiency of the high-priced foremen. It is certain that one of the most important links in the chain is the foreman. As he is, so will his department be; as the departments are, so will be the quality and the cost of the product; and on the quality, quantity, and cost of the product hangs the success of the business. I contend that one of the greatest mistakes of many, if not most, firms, is the loading up of the foreman with detail work that cheaper men can do as well as he. A firm employs a foreman and pays him a high price because of his supposed knowledge, experience, and ability. His chief aim should be to improve the quality, lower the cost, and investigate improved methods, machinery, and systems. To accomplish this and also to carry the load of detail work usually pushed on him, is impossible.

Study the conditions of each department and never hesitate to appoint one or more assistants if the conditions justify it. Any other course is false economy in the highest degree. The number of men that a foreman should have supervision over will vary according to the character of the work. It is safe to say, however, that no group of over twenty men should be left without supervision. I do not mean to say that an assistant foreman should be appointed for each group. Instead of this, I suggest the selection of one of the best workmen as "job boss"; let him continue his work at the bench, paying him a small sum per day more than the remainder of the men. Enough authority can be given to each job boss to enable him to secure the results desired. Each assistant foreman should have certain jobs and job bosses under him, and all should be accountable to the foreman.

Meetings.—Meetings of foremen, assistants, and job bosses should be held weekly. There can be taken up for intelligent discussion the troubles and defects of the product. Men can make suggestions that will better their product, or they can tell what is hindering them from securing certain results. Give them proper encouragement, and the results will be surprising. Ways will be found out of difficulties, valuable suggestions will be made, surprising economies will be effected, and personal interest in the work will be aroused. The effect on the rank and file of the workmen will soon be in evidence. Each workman will see advance only a few steps ahead of him in a job-foremanship, and many of them will make up their minds to aim for it. Each job boss will realize that his next step will be to an assistant foremanship, should he prove capable. The assistants feel that they have an opportunity to show their worth, and a healthy rivalry will soon spring up and creep down to the bench bosses and to the men. With such a system of organization, it will be possible for the foreman to unload upon his assistants a great deal of the detail work that is hindering him from giving to the firm the real and greatest benefit of his brains, experience, and ability. His assistants will soon find that they can safely trust their bench bosses with a part of their details. These men will take pride in their responsibility and will give the closest attention to the carrying out of their orders. Working at the bench they have a knowledge of the smallest details of the work, which, when made use of, is very valuable.

Reports.—It is important that a very comprehensive system of reports, showing details of output, hours worked, payroll, costs, amount of piece work and day work, be devised for each department. It is a most satisfactory and necessary thing for the superintendent and will be found invaluable for purposes of comparison. It is only by means of such reports that the superintendent can be kept in close touch with the factory work. This is usually as much neglected as it is important. In a large establishment it is a very easy matter for large losses to occur, especially when the non-productive payroll is a goodly percentage of the total. A system of reports will show this before any large losses are made.

Machinery.—I am a strong believer in the policy of scrapping old machinery when new and improved machinery appears upon the market. Of course, consideration must be given to the interest on the cost of the old and new machines and the amount gained in economy by the increased output. But if, as is often the case, the advantage is decidedly on the side of the new machine, it is, to say the least, shortsighted to hang on to the old slow machines. But I hear you say: "Let us keep the old machines until we can better afford it." What will you do when your competitor seizes the opportunity, installs new machines, and you find that you are unable to compete with him? You will then not be equipped to meet him. No, force your tools; wear them out quickly. Your depreciation will be high, but your product will be cheaper, your profits larger, and the old machines the sooner make way for new machines that will give an increased output at the same expense for power and labor.

Careful study should be made of the recent great improvements in the quality of tool steel and the processes of hardening. These subjects bear a most important relation to that of "large output." "High cutting speed" means a material lowering of costs, and is a subject that will well repay investigation. In fact, in some shops keeping all machines up to the highest possible point of efficiency, this is deemed so important that a special "speed foreman" is appointed. It is his duty to see that all tools are running so that the greatest output possible is being attained. This is certainly a good idea.

It is conceded that one of the chief reasons for America's commercial success is her automatic and multiple machinery. These marvels of speed, accuracy, and output (the American automatic screw machines) are in many cases kept below their capacity by lack of knowledge of what can be done with them. There is required a man of the highest type of mechanical knowledge and ingenuity at the head of an automatic-machine department, in order to get the best results from the machines. In up-to-date departments, work that was formerly declared impossible is now being done. This work is remarkable not only in amount, but also in accuracy. Certainly no set of machines gives so large a return on the investment as do these.

The "magazine attachment" now makes possible in the case of partially completed parts the same economy gained by producing parts automatically from the solid raw material. The parts loaded in the magazines are automatically delivered to a special fixture, which holds the parts firmly while the machining is being done. This is a decided step in advance of the hand machine and will result in large economies.

It is of interest to note the advance in the quality of work produced on automatic machines. Parts requiring the greatest accuracy can be manufactured in very large quantities and at a very great reduction in cost. Work is being done on automatic machines to-day that a few years ago was regarded as absolutely impossible. It is very difficult to convey any definite idea of this work without elaborate illustrations. Pieces of all sizes and complicated forms are produced from the solid stock. I have in mind many pieces that are produced, the working points of which must shut out light when they are put on the gauges. These pieces are produced by the thousands daily with a percentage of loss from defects so small as to be inappreciable. Many of these parts have over ten machining operations on them. The relation of these points one to the other must be almost absolute. Such pieces are now produced on the automatic machines at about one-fifteenth of the cost of the hand machines.

The same advantages are obtained by much of the multiple machinery now on the market—for example, a new type of automatic multiple drill press operated by a boy, from which can be procured four times as much work as can be gotten from the ordinary drill press with an expert operator working it. Horizontal and vertical holes can be drilled at the same time with this press, three jigs can be used, and the drilling is well-nigh continuous. The work done is of the highest quality. Such machines will pay for themselves within a few months in decreased cost of product. I believe that the field for automatic, multiple, and special machinery is only beginning to open up.

The special-machine designer certainly has a place in our shop organization of to-day. Such a man, of original and inventive mind, can make a study of the special needs of any product and can design special machinery that will produce parts cheaper by far than is done with the ordinary machinery and processes. The duties of this position would differ from those of the designer or inventor of new machines or products for the market. The importance of having an entirely distinct department for inventions of new product and improvement of the old, will be considered later.

Special Tools and Gauges.—The modern up-to-date manufacturer needs no argument to convince him of the great advantages of having a generous tool and gauge equipment. However, many firms, not so progressive, have not yet been convinced that the returns from such an investment would justify the expense. The outlay is very apparent—the returns problematical, in their opinion. Modern practice tends more and more in the direction of a large equipment of this character. With proper tools and gauges, the output per man will be much larger and more accurate; the chance of error will be reduced to a minimum; duplication of parts becomes possible; a lower grade of workman can be used on work requiring even the greatest accuracy.

I wish to reiterate a statement made in a former article, viz.:—tools and gauges should be frequently inspected. As will be shown later, this should be the duty of the man who has charge of the models. By using a "Daily Reminder Card Index" the work can be systematized and so simplified. When a foreman secures a tool from the tool supply room he should have some assurance that that tool is in good condition and that accurate work can be produced by its use. It often occurs that the jig or fixture becomes worn little by little, and this is discovered only after a large amount of stock has been manufactured.

Tool-Designing Room.—As the accuracy and cost of the product depends very largely upon the character of the tools used, so does this latter depend upon the tool designer and the organization of the department. Good tool designers are as scarce as they are important. They must be men who are of an inventive turn of mind, practical, and open to receive suggestions and absorb new ideas. Many men in this line of work are both ingenious and practical, but fall far short of their full efficiency because of their mental attitude toward suggestions from others. The tool-designing department is the one of all others for discussion and suggestions. There should be the fullest and freest expression of thought and interchange of ideas between the members of the department and the foremen who use the tools. Ordinarily, this is far from being the case. There is usually a distinct line between the designer of the tools and the men who have acquired the knowledge of their defects and good points in everyday work. I have seen cases where expensive sets of tools were designed and made, even though a set built upon similar lines had proved anything but successful. If the designer had availed himself of the foreman's ideas and knowledge which was gained from experience, large sums of money could and would have been saved. The fact must be constantly borne in mind that, in the handling of small work, particularly, more time is required to put the parts into the jig or fixture and remove them than is consumed in doing the actual work itself. This "jig time" is a most important factor and should never be lost sight of or neglected. It is necessary also that the condition of the machinery, its style and capacity, should be borne in mind when any new tools are designed. A tool designer should make himself thoroughly familiar with all the shop conditions, as well as the peculiarities of the particular parts for which the tools are intended, before designing these tools. He should be thoroughly informed as to what styles of tools have proved successful and what have not.

To avoid mistakes and get the benefit of the experience of others is a simple matter of organization. In the first place, regular meetings of the corps of designers should be held. Here should be discussed the best methods of designing tools, mistakes commonly made, and improvements upon the work in general. Criticisms and suggestions on the work in hand should be gotten from the entire body of designers. Ideas will be brought forward by such methods that will prove most valuable. The foremen of the tool room and some of the machine rooms should be present, especially when the question of new tools is being discussed. In such meetings the foremen should make reports showing the value of various classes of tools in everyday work. Their opinions and advice will be found to be of the greatest value. Every draughtsman should make a personal study of the tools finished according to his drawings; everything should be done to educate the draughtsmen and secure the advantage of the suggestions and criticisms of everyone, and especially of those who use the tools. In many modern shops there exists a system of inspection of drawings. These are carefully examined by the supervisors. Tools cannot be built without their approval.

I do not intend to give or suggest any ideas concerning the details of a system for a tool designing department. Such points have been clearly brought out in other articles in this magazine. My aim has been to present briefly a fundamental, though simple, idea of organization which has proved of great value many times in my experience.

Tool-Supply Department.—One man, or one department, should be held responsible for all tools and models. As suggested, this man should inspect all tools and gauges at regular intervals, to insure their accuracy. All tools when not in use should be in his custody; when they are being used they should be charged to the workmen using them. The proper time to inspect a tool is when it is handed in by a workman. If it is out of order the responsibility for its condition can be placed upon the proper party immediately. The workmen, after they have learned this fact, will use great care in handling the tools. Naturally, this man who has charge of the tools, should be a mechanic of the highest type. He will soon learn thoroughly not only the tools, but also the parts for which they were designed. He can then be appointed a "general-trouble man." A very important part of his duties can properly be the ferreting out of the causes of trouble in the producing of parts. In large establishments where parts must be manufactured with great accuracy, such a man will have a great deal of work to do. By the nature of his work he will be better fitted than anyone else to find out the cause or causes of such difficulties and to correct them. This man would be a most valuable member of the committee suggested for the consideration of tools and their design.

The Tool Room.—The tool-room costs are a constant thorn in the side of most manufacturers. It is hard for them to realize how important is a well-equipped tool room, unless they are men who have had practical experience in a machine room. The fate of many concerns rests finally upon the tool room and the character of its work. First-class tools result in first-class work and cheap production: defective tools result in endlesss expense, worry, and finally, bad reputation because of defective parts.

Thorough and effective organization is certainly needed in the tool room. The conditions there are different in many respects from those in other departments. Piece work is not possible. The work itself requires the greatest care, and should not be unduly hurried. The methods adopted for increasing the output must be carefully considered. By considering again the "secrets of cheap production" we can get some clues that will prove most valuable. We can then learn what methods to avoid and what to adopt. The work should be so divided as to leave only that requiring the greatest accuracy to the high-priced man. Each workman should have his own particular job assigned to him, and on that he should concentrate his attention. Parts should be standardized and manufactured in large quantities on automatic machinery wherever possible. In place of piece work, some system should be adopted that will spur the men on to do their best. The men should feel that opportunities for advancement exist should they prove themselves worthy. The plan outlined differs radically from the system in force in many shops to-day. This old-style plan where the high-priced tool maker builds up the tool in all its details, is not practiced in many modern shops. Such a system is directly contrary to modern ideas. In this proposed plan the tool maker is but a high-priced assembler and adjuster. Most of the parts that go to make a jig or fixture are made by cheaper men, who, working constantly at one style of work, can produce it much faster and at a greatly reduced cost. This plan should be worked out to its fullest extent. Nothing but the very finest and closest work should be done by the tool makers. The sizes for parts of jigs and fixtures should be standardized as fast as possible. The component parts of these tools should be manufactured in large quantities and carried in stock. The great economy gained by manufacturing such pieces in large lots will much more than make up any loss of material occurring from the fact that the tool may be slightly larger in some dimensions than necessary.

Other parts also, such as legs, screws, bushings, etc., should be manufactured in large quantities. Much of this can be done on the automatic machines. These can also be carried in stock ready for immediate use. Everything possible should be done to prevent any delays to the tool makers. The line should be sharply drawn between the different jobs. These jobs should have over them a job boss—a man selected with great care. Each job boss should understand that he has the opportunity to make a record for himself in accuracy and cheapness of production. Knowing that his record will be examined, his desire to call attention to his work will lead him to take great interest in getting out a large output at a low cost. Thorough inspection of tools and tool cost records can be made with great profit. This inspection of tool cost records is very important. A card for each tool containing the detailed costs should be sent to the supervisor. These details should include costs of material, designing and building the tool; the time and cost of labor in the tool room should be itemized operation by operation, together with the names of each workman. Each tool and its card should be examined by the supervisors and heads of the tool and tool-designing departments. If the tool is considered too costly, this fact and the reasons for it should be noted at the bottom of the card. After the foreman has called the attention of the tool maker once or twice to adverse comment on the quality or quantity of his work, and the workman realizes that this is making a perpetual record against him, the improvement will be astonishing.

The tool room is a good training ground for foremen and assistants. Promotions from this department should be made whenever possible. I have seen instances where the product of the tool room had increased over 50 per cent. with very little increase in cost under such a plan of organization as is briefly outlined. No detail of system should be neglected which will relieve, or tend to relieve, the high-priced tool makers of work that can be done as well by a lower-priced man. The method of supervision of work should be complete and thorough. The men should understand that individual records will be closely watched and that the sluggard is apt to be discovered and discharged and the earnest worker recognized and rewarded.

Assembling Rooms.—The same plan of organization should be followed out in the assembling rooms. The work should be divided into separate jobs, each important job having its job boss. The closest supervision should be kept of work and men. Unless the assembling-room organization is thorough, there will exist chances for large losses. The system of inspection can be extended with great profit in these rooms. As in the machine rooms, each man's time ticket should contain the name of the inspector certifying to its correctness before the man can get his pay. Each machine assembled should be properly numbered, these numbers entered upon a book, and opposite these machine numbers, the names, or check numbers, of every man who has worked upon it. Thus in case the machine develops defects in use the man responsible can be easily located. As stated a number of times in this article, nothing should be left undone to eliminate filing and fitting in the assembling rooms. The workmen should be taught (it will require teaching) that the parts should come to them in perfect condition and that, if wrong, they should be sent back to the original inspectors, who should properly be held responsible for defective parts.

Whatever piece-work system is adopted, it should provide a complete check on all day work and piece work. In a large assembling department the amount of money spent on day work when piece work should have been done will be astonishing. This is especially so when work becomes slack. Careful detailed records of output, payroll costs, etc., should be kept.

Inventions and Improvements.—Progress can be made only through inventions and improvements. A firm must exercise great enterprise in the line of inventions to hold its own in the market. The day is gone when a concern can secure and hold business simply on its reputation gained in the earlier days of its existence. Enterprise is too keen, its spirit too progressive, to hold to the old because of its age. A business concern and its product can not stand still. If it does not progress its competitors surely will. The old maxim "A stern chase is a long chase" applies nowhere better than in business. Once your competitor has improved his product, built his tools, covered the improvements with patents, and secured the prestige on the market which comes from having a superior and improved article, your difficulties multiply and your sales decrease. Invention is the order of the day. Recognizing this fact, my plan includes the organization of an Inventions Department whose sole business would be the invention of new products for the market, and the study and improvement of old products. The consideration of the needs of the market should receive attention of all the members of the organization, especially the selling force. The selling force come into close touch with the prospective customers and are thus in a better position to judge of the needs of the market than any others. The consideration of suggestions for inventions should receive the attention of the ablest men in the organization. There should be formed a special committee for this purpose. The inventions department should work according to orders from this committee.

Testing of Inventions.—Many firms can, from their unfortunate experiences, testify to the need that inventions shall receive thorough testing before tools are made and the product placed upon the market. The tendency almost invariably is to rush the new product onto the market much earlier than is advisable. An invention should be thoroughly tested and considered by a large number of men before it is finally accepted. It is always advisable to have made a tool model and testing model. The testing model should be turned over to the factory force as soon as completed. From that time on the authority of the inventions department, as far as concerns that model, should cease. These testing models should be thoroughly inspected and tested by all the experts and inspectors in the establishment who are fit to pass judgment upon the machine. Reports of these tests should be made in writing by each man. These reports should cover any defects found, or any suggestion in the line of improvement. The results will be surprising. Defects will be discovered and improvements suggested that were never dreamed of by the inventor. The testing model together with the reports should be turned back to the inventor. Such methods will insure a perfect and complete product. In no other manner can a firm guard against the dangers of placing untried and imperfect machinery upon the market.

Let a firm possess a well-formed organization backed up by good inventions, tools, machinery equipment and systems, and there can be but one result—Progress.

THE FACTORY OFFICE AS A PRODUCTIVE DEPARTMENT.

By Kenneth Falconer.

IV.—ITS RELATION TO THE GENERAL MANAGEMENT.

With this article Mr. Falconer concludes a series which began in The Engineering Magazine for April last, and which has described a system of "Money-Saving Organization for the Office" supplementing Mr. Carpenter's current series on "Money-Making Management for the Workshop."

Mr. Falconer's first paper presented the general theory of his view; his second discussed specifically the relations of the factory office to the stores department and shops; the third took up the relations to the stock room and shipping department. In this he displays its immediate and special value to the executive.—The Editors.

MUCH of the value of factory accounting is in many cases lost by regarding it strictly as cost accounting, which in reality is only one of its branches, and the effects of a really efficient system are ofter neutralized by failure to present the results obtained in such manner to be of greatest value. This may readily be caused by a misconception of the true uses of a system of order numbers—that is, of a system whereby all expenditures, whether of labor, cash, or material, and all receipts, transfers, and deliveries of any articles or goods, are made and recorded on the authority of a written numbered order, the number of which must in every case appear on the records of such expenditure, receipt, transfer, or delivery. The real value of such a system will be apparent only when it is regarded as a means of first obtaining such individual records in as minute detail as may be desired; then of grouping the individual results in such detailed divisions and sub-divisions as may be most expedient; and finally of presenting the totals of each such group in a manner not only to afford complete and accurate records of the past, but also to be of the greatest value as guides for the future.

To secure the best results along these lines, the factory office must be supplied with an official list of the ledger accounts, each account with which the factory is in any way concerned being divided into sub-account and detail as may best suit existing conditions; no new account affecting the factory in any way must ever be opened without ascertaining if the items to be charged to it do not properly belong to one of the already existing accounts, of which they should show as a part. In such case a new sub-account will retain the individuality of the items and result in more accurate and scientific accounting. Assuming the case of a manufacturing company with three productive

ACCOUNT	SUB-ACCOUNT	DETAIL
Shop Expense	Shop A	Superintendence
		Defective Work
		Miscellaneous
	" B	ditto
	" C	ditto
Repairs to Plant and Equipment	Shop A	* Fixed Machines
		Shafting Belts and Pulleys
		Tools
		Miscellaneous
	" B	ditto
	" C	ditto
Factory General Expense	Heat and Power	
	Fixed Charges	
	Superintendence	
	Miscellaneous	

NOTE A. PARTIAL LIST OF ACCOUNTS, SHOWING SUBDIVISION OF OPERATING AND MAINTENANCE EXPENSES.

departments, the accounts should be listed and divided somewhat on the lines shown in Note A, the example given being for the operating and maintenance accounts only; but all should be divided on somewhat similar lines. The illustration is purposely not carried out to great detail, but an examination of it will show how elastic it is and how capable of being adapted to suit the requirements of any produc-

* By the use of a special ledger with an account for each machine, this is further subdivided and each machine shows its own expense of maintenance, depreciation written off, and value in plant account.

FORM I. HEADINGS AND RULING FOR PAGE OF SUB-LEDGER.

Cr.				
Distribution of	Date	T.E. No.	Sub-accounts	Total

Center of Book

Dr.

(Same ruling and heading as credit side)

tive concern. If each order and the sheet or book page to which the charges against such order are entered, shows the name of the account, sub-account, and detail to which these orders are chargeable, it is a simple matter to group the charges each month under their correct headings and ascertain the totals. In the list of accounts given, the general ledger will show the gross charges against the accounts; the sub-ledger (see Form I) shows the same amounts, but distributed amongst the various shops, and the monthly transfer entries (Form II) will show further details. All charges against the orders are taken off each month, and must balance with the records of material issued and wages expended. When the transfer entries are complete a summary showing the total debits and credits to each account, sub-account, and detail is taken off on the same form. From this summary, or from each transfer entry, as preferred, the amounts in the column headed "Accounts" are posted to the general ledger and the transfer entries returned to the factory office. The amounts in the columns headed "Sub-Account," and also the total under Account are then entered in the sub-ledger, and the summary of the transfer entries is in itself the record of the monthly total of the details. For purposes of comparison these totals may be entered on a form ruled in parallel columns for a certain number of months. Form III for this purpose is ruled for a quarterly report, and a similar form to which the total of these quarterly statements is transferred is used for the final report covering the year. The value of such reports should not, however, be sacrificed to uniformity, and the information transcribed from the summary of the transfer entries need not be entered in

Name of Account	of Sub acct.	of Detail	DEBIT					CREDIT				
			Amount of Detail	Sub. Led. page	Amount of Sub. Acct.	Gen. Led. page	Amount of Account	Amount of Detail	Sub. Led. page	Amount of Sub. Acct.	Gen. Led. page	Amount of Account
Wages	Shop A									1000		
	Shop B									1000		
	Shop C									1000		
	Misc.									500		3500 00
Shop Expenses	Shop A	Suptce.	90 00									
		Dif. Wk.	90 00									
		Misc.	90 00		270 00							
	Shop B	ditto			270 00							
	Shop C	ditto			270 00		810 00					
Repairs to P & E	Shop A	Fixed Machs.	100 00									
		Shftg. B & P	100 00									
		Tools	100 00									
		Misc.	100 00		400 00							
	Shop B	ditto			400 00		800 00					
Carried forward							1610 00					3500 00

FORM II. MONTHLY TRANSFER ENTRY, SHOWING PART OF DISTRIBUTION OF WAGES.

Operating and Maintenance
Accounts for Quarter Ending ______________

	Jan'y	Feb'y	Mach.	Total
Shop Expenses				
Shop A				
B				
C				
Total				
Repairs to Plant and Equipment				
Shop A				
B				
C				
Total				
Factory General Expenses				
Heat & P.				
Fixed Chgs.				
Suptce.				
Misc.				
Total				
Summary				
Shop Exp.				
Repairs to P. E.				
Fac. Gen. Exp.				
Total				

FORM III. SPECIMEN SHEET OF QUARTERLY REPORT.

Annual reports containing totals of the quarterly are compiled on similar forms.

the sequence in which it there appears, but may be so grouped that all results regarding a certain shop or department may be found together, if so desired. For instance, the amount of non-productive labor in a certain shop, or of fuel consumed in the foundry, shown in conjunction with the total labor in that shop and with the weight of castings produced during a given period, will convey more meaning if the same figures appear merely as details of labor, of fuel account, and of output. Arranged thus, they may readily lead to economies the necessity for which might not have been otherwise recognized. A series of four such quarterly reports, with a summary showing the totals of each, will form a most comprehensive record of the outcome and totals of the year's work.

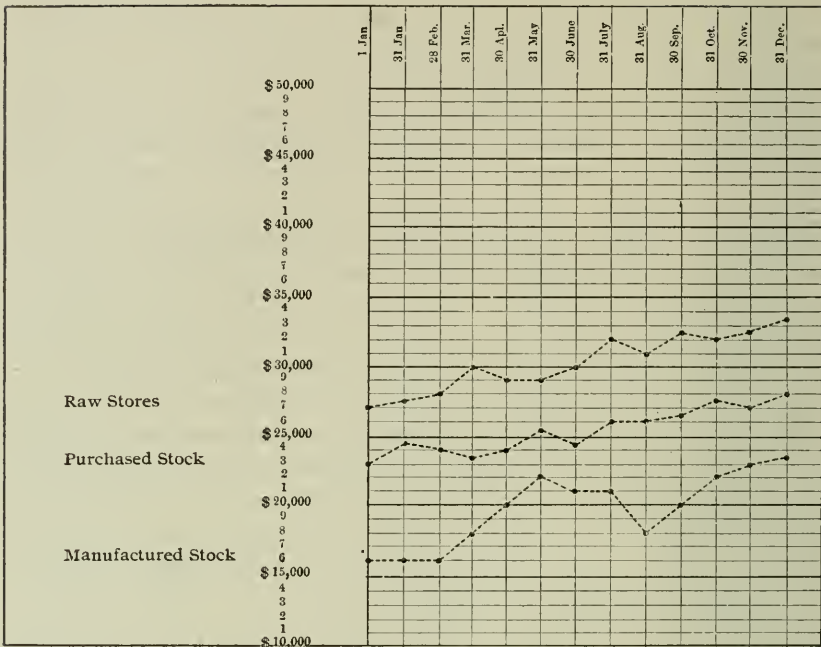
The recording and indexing of individual costs of goods manufactured or work done has been treated in a previous article. It is an open question as to how much such individual costs should bear of the extra work caused by defective material or workmanship, or by breakages during manufacture, and how much of such expenditure should show as a manufacturing or shop expense. If circumstances justify it, a close watch can be kept on this matter by having all regular manufacturing orders bear even numbers. When a defect is discovered, or an accident happens necessitating extra work or material, the factory office is applied to for a "defective order," and an order is issued bearing the odd number immediately following the even number being worked upon. This order is credited with the scrap or actual value of the defective part. A new part to replace it is charged up, and all time consumed in putting such part into the same condition as that which was found defective is booked against the odd number. On completion of the original order the extra expenditure is either added to it or allowed to remain in "Defective Work Account." In either case the management have always the exact costs, both with and without the extra charges caused by defective workmanship or material, or by accident or breakage. In addition they have a record of the total expenditure arising from such causes, and should be able to judge whether it is reasonable or abnormal.

Much of the existing prejudice felt by the managements of industrial concerns against a proper system of factory accounting arises from a feeling that the information and results to be obtained therefrom will have served their purpose when they have been carefully studied and examined, and will be thereafter of no further use. For this, accountants themselves are largely to blame. Such information and results should be so presented that their value may be best utilized as a guide to similar operations, or future transactions under similar circumstances. This may frequently be done by employing diagrams showing proportions and percentages, which will sometimes point out leaks more plainly or indicate undue increase in expense more vividly than figures representing gross amounts.

The advisability of using curves and diagrams, and the respective advantages of showing gross amounts or percentages thereby, is not merely a matter of individual preference. These questions should be decided only after examination as to what purposes the results under consideration are intended to serve, in what light they may be of the greatest value, and in connection with what other information they will carry most meaning. For instance, if the figures to be recorded represent a fact complete in itself, and whose only value lies in itself and in comparison with similar records of previous periods, then figures in parallel columns will serve every purpose. If, however, in addition to comparison with previous results it is desirable to know whether the tendency from month to month is towards increase or towards decrease, diagrams representing gross figures should be used. The value of basing curves or diagrams on proportions and percentages is evident when the meaning and value of the information to be recorded depends largely upon its relation to other items—items possibly of a different nature, but to some extent at least dependent on and affected by it. In other words, parallel columns of figures show results and afford opportunity for comparison; in the same direction curves based on gross amounts are of equal value, but in addition to making the differences more noticeable they force attention to the general tendency of the results. Curves representing percentages and proportions, if properly planned and carefully executed, afford equal opportunity for comparison, are equally insistent in forcing attention to differences and to the general tendency of the results, and to a greater extent than might be thought, will indicate the relation between cause and effect. It is well to remember that whether the ultimate result is good or bad, it is equally desirable that the causes producing such result should be known, that they may be developed and encouraged, or guarded against, as they make for, or against, success.

Of these three different ways of recording information, such items as the actual value of the plant in each shop would serve every purpose if simply recorded by figures in parallel columns as on Form III. On Form IV will be found examples of information shown by curves based on gross amounts, which convey more meaning than if figures in parallel columns were used. A glance at this diagram will show very plainly that any profits made are rapidly being locked up in stores and material—good, doubtful, or bad, as events may prove.

Examples of curves based on percentages will be seen on Forms V and VI. Looking at the profit on sales of goods made in Shop A, it will be seen that they are rapidly reaching the vanishing point and

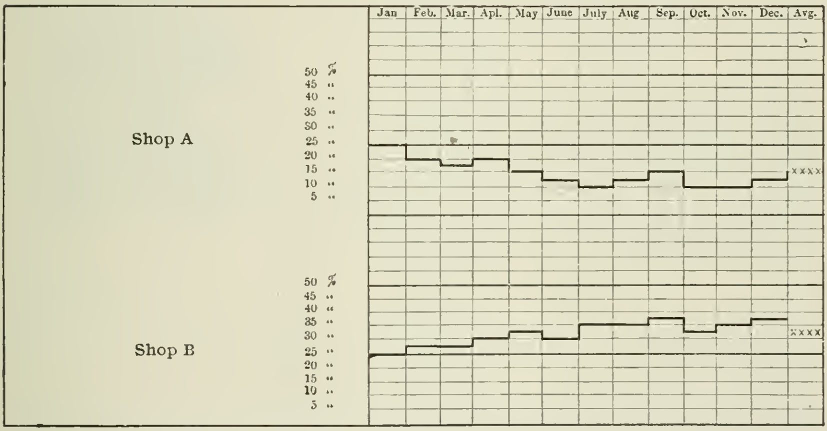


FORM IV. CURVES BASED ON GROSS AMOUNTS, SHOWING RAW STORES, PURCHASED STOCK, AND MANUFACTURED STOCK ON HAND DURING THE YEAR.

average for the year about 15 per cent. The profits on the manufacture of Shop B show a steady increase and average for the year almost 32 per cent. Assuming that both these shops produce standard articles sold at regular prices, a reference to the proportions of productive and non-productive labor in each shop, as shown on Form VI, will throw light on the cause of this condition of affairs. The non-productive labor in Shop A shows a steady increase, and an average for the twelve months of about 37½ per cent., while that in Shop B has only once gone above 25 per cent. and for the remainder of the year runs about normal, averaging a trifle over 22 per cent.

In no department of a manufacturing business can diagrams be used to more advantage than in the foundry, where so much depends upon the quantity or weight of the output. Let the total production be represented by 100, and by means of curves show in proportion the number of hours worked and the average cost in material, in moulders' wages, in floor labor, and in shop expense; the weight of fuel consumed, the loss in melting, the weight of bad castings produced, and the many other items which in a foundry may vary so greatly, according to the attention paid to small matters. The result at the end of a few months may point out possible economies or evident leaks that otherwise might not have been noticed. It is of course understood that the figures used in these illustrations are altogether suppositious, and are used more in view of a desire to show the information that can be brought out than in view of any probability of the proportions ever occurring. The improbability of the results, however, lies only in their degree, not in their nature.

It is a truism to say that these are the days of specialists. In the most advanced technical and trade papers the general tone of the advertisements is the statement that the advertiser can do some one thing or make some one article better than anyone else. In this question of technical accounting is a field for specialism, the importance of which is only now being recognized. I have tried to show that the department responsible for this work has a wider field than is generally thought, how it may be made a strong factor for efficiency in

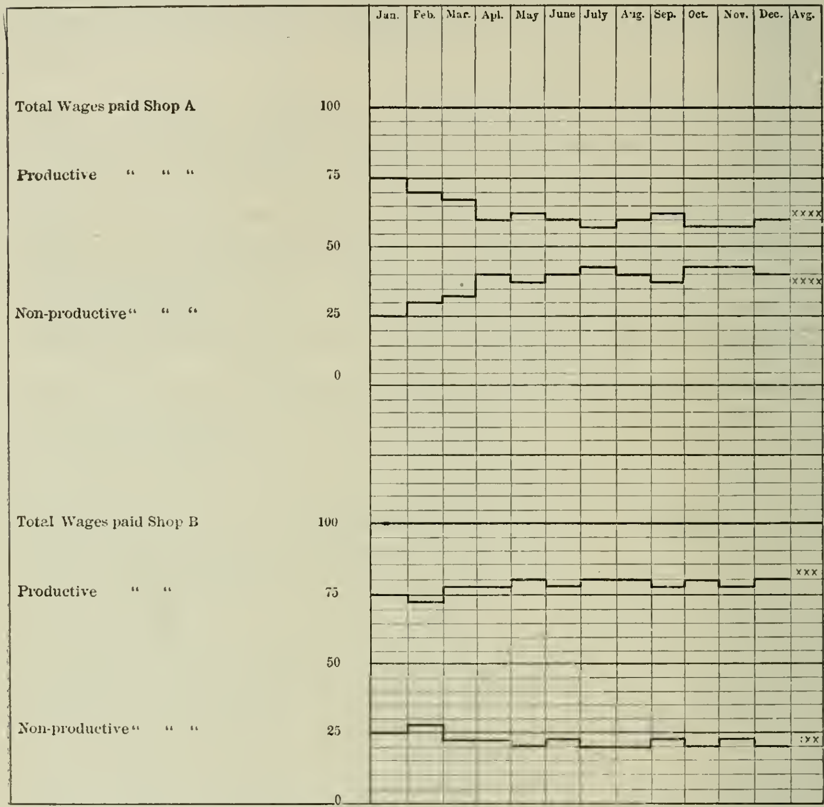


FORM V. CURVES BASED ON PERCENTAGES, SHOWING PERCENT. OF PROFIT ON OUTPUT OF TWO SHOPS.

the general management and for economy throughout, as well as an aid to purchasing and selling departments, and how its work may have a greater and more direct influence on the final outcome than is usually admitted, and it, in itself, prove a strong factor of success or failure.

At a recent convention of the Canadian Maunfacturers' Association the president said:

"I wish to emphasize the importance to our manufacturers of having skilled accountants. In our offices, we are accustomed to obtain the best help available to keep our accounts, regulate our credits, and attend to our banking; but in the factory, where we deal with materials, time and machinery, waste, and wear and tear, all representing money, the same regard for skilled help is as a rule not observed; and indeed the services of skilled accountants capable of following all these items accurately and of keeping reliable cost accounts are difficult to obtain. In these days of keen competition it is highly important that the manufacturer should know to the fraction of a cent the cost of his goods."



FORM VI. CURVES SHOWING PROPORTION OF PRODUCTIVE AND NON-PRODUCTIVE WAGES PAID IN TWO SHOPS.

To this I would like to add that it is equally important to know to the fraction of a cent the details of the multitude of expenses, perhaps trivial in themselves, which yet affect the cost of production as much as, if not more than, the wages directly expended on manufacture, and also to know whether some of these various items of expense do not at times increase in a proportion not justified, or from some cause which might have been avoided if the effects had been foreseen.

THE EFFECT OF WATERWAYS ON RAILWAY TRANSPORTATION.

By S. A. Thompson.

Mr. Thompson's article needs no heralding. Its pertinence is manifest by the activity of interest in waterways everywhere—in Great Britain and on the Continent, concerning the general system of internal water transport; in America, concerning the Isthmian canal, which overpasses in importance every other engineering or transportation issue now presented to the world.

Mr. Thompson's argument establishes itself. The salient point is the demonstration of the fact—overlooked by narrow visions—that a serviceable water route benefits and develops not only the world at large—especially the commercial world—but still more directly the pre-existing agencies of transport which, on imperfect consideration, it might seem to threaten or to supersede.—The Editors.

THE trip of the Oregon around Cape Horn showed with startling distinctness that an Isthmian canal would practically double the naval strength of the United States; no argument is needed to show the advantage of such a canal to the commercial interests of the world; and the investigations of the commission headed by Admiral Walker showed a practically unanimous opinion among the officials of the railway lines between the Mississsippi River and the Atlantic that the proposed Isthmian waterway would be beneficial to the roads under their control.

But no such agreement was found among the managers of the lines west of the Mississippi, and some of them, believing that the canal would work injury of the most serious character to the business of the transcontinental roads, have striven by every available means to prevent, or delay to the utmost, the legislation necessary to authorize its construction.

A Transportation Paradox. The controlling effect of waterways upon the rates of competing railways is conceded by every one who has given the slightest attention to the subject. This control arises from the fact that the carriage of freight by water costs so much less than carriage by rail—the average rate per ton-mile on the Great Lakes, for instance, being about one-tenth of the corresponding rate on the railways of the United States. As the Isthmian canal would affect a greater volume of railway traffic than any other waterway every constructed or proposed—with the possible exception of a ship canal from the Great Lakes to the Hudson River—it becomes a matter of the utmost importance to determine, so far as this can be done beforehand, just what effect will be produced thereby. While the controlling effect of competing waterways on railway rates has been generally recognized, another effect, of equal or greater importance, has been almost completely overlooked. For, paradoxical as it seems, waterways are not only the most powerful possible regulators of railway rates, but are also the most powerful possible promoters of the prosperity of railways with which they compete.

The best thing that could happen to every railway in the United States—or elsewhere, for that matter—would be to have a waterway paralleling every mile of its track, and the deeper the waterway, within reasonable limits, the greater would be the benefit derived by the railway. If the managers of the transcontinental American railways were really awake to their own interests, instead of opposing an Isthmian canal they would use all their influence in its favor. Nay more; if Congress should fail to act, the capitalists who control the transcontinental railway lines ought to underwrite a sufficient amount of bonds to secure the construction of an Isthmian canal, and to get it built at the earliest possible date, and this not as a matter of sentiment or patriotism, but as a cold-blooded business proposition. This opinion is based upon the fact that many instances can be shown in which the construction or improvement of a waterway has resulted in great benefit to competing railways, while not a single instance has come to my knowledge, in the course of a study of the subject covering many years, in which the result has been otherwise than beneficial. But as the unsupported opinion can have little or no weight, it will be in order to offer the incredulous reader a few of the facts upon which it is based.

Some Suggestive Figures. During the fifteen years in which improvements were being made on the River Elbe, in Bohemia, the river traffic, as a natural result of the deepening of its channels, increased five-fold. But the traffic on the competing railways increased still more largely, and the dividends on the main line, from Teplitz to Aussig, rose to 16 per cent. per annum. I know holders of American railway stocks who would be glad of a dividend half as great as that. A mere coincidence, say you? Well, possibly. But if it be, I have a fine lot of striking coincidences to submit for your consideration.

A report of a committee of the Senate of France shows that out of 196 waterways enumerated in the statistics of inland navigation, only

73 had, in 1887, a traffic of more than 70,000 mile-tons, and every one of these was in close proximity to railroads, while the Northern Railway Company, whose system traverses a region containing 43 per cent. of the boating capacity of France, was the only one that was not obliged to call upon the government to pay the interest guaranteed upon its stock.

"Made in Germany." Equally interesting and conclusive are some illustrations taken from the experience of Germany. The canalization of the River Main from Mayence to Frankfort was completed in the latter part of the year 1886. As a result of this improvement, which gave a channel vastly better and deeper than was before available, the river traffic showed an increase of 64 per cent. in 1887 and a further gain of 42 per cent. in 1888.

Frankfort is abundantly supplied with railroads, having among others an independent line on each bank of the Main all the way to Mayence. Did these roads go into bankruptcy or suffer a serious falling off in their traffic? On the contrary, their business increased 36 per cent. in 1887 and an additional 58 per cent. in 1888. Two years constitute rather a short time from which to judge of the permanent effect of this improvement, but fortunately Consul General Mason, from whose report the above figures were taken, submitted another report under date of December 10, 1897, from which it appears that the river traffic, which amounted to only 150,000 tons annually before the improvements were made, had increased to 700,000 tons in 1891, and to 1,693,112 tons in 1896, while the traffic by rail, which amounted to 930,000 tons in 1886, had risen to 1,400,000 tons in 1891, and to 1,639,229 tons in 1896, *being nearly double what it was ten years before, when the railways had a practical monopoly of the freight business of Frankfort.*

The greatest railway mileage in the world under one management is to be found in Germany, unless some of the recent "community-of-interest" arrangements in the United States are to be interpreted as constituting common ownership. On July 1, 1888, out of a total of 16,281 miles of road, 14,665 belonged to the German Government. Yet the Reichstag, in 1887, passed an act providing for the completion of nearly 1,500 miles of canals and canalized rivers, although there were then finished and in use 1,289 miles of canals and 4,925 miles of canalized rivers. Other improvements have been authorized and completed since the date named, until today Germany has over 9,000 miles of canals and navigable rivers, and there are nearly 18,000 miles of state-owned railways in Prussia alone. Does any one believe that the German Government would expend millions of marks out of the national treasury for the construction and improvement of waterways, if the result would be to lessen the national revenues by reducing the traffic on the national railways? Or is it possible that the German Government does not know what it is about? Let us see. To quote from Consul-General Mason:

> "If further testimony on this general topic were needed, it would be found in the steady, growing prosperity of the railways of Prussia, which from their location are brought into the most direct competition with the principal waterways. During the fiscal year 1896-97 the Prussian railroads earned $247,381,970, and the budget estimate, always conservative, for the present year (1897-98) is $264,000,000 from the same source. This is considerably more than half the entire income of the Prussian Government, and after deducting all expenses of operation, repairs, construction, new equipment, interest on bonds, etc., *leaves a net revenue of* $52,122,000 *to be turned into the treasury of the State*."
>
> "That a portion of this surplus should be devoted each year to extending the canal and navigable river system is in furtherance of a policy the wisdom of which time and experience have fully confirmed."

At Home and Abroad. The Manchester canal has hardly begun to pay its fixed charges as yet, but it has caused such a tremendous development of the trade and commerce of that city that new buildings have been erected by thousands upon thousands, and every railroad has been compelled to enlarge greatly its terminal facilities.

For a number of years the United States Government has been improving the navigation of the Great Kanawha River by a system of locks and movable dams. Two railroads run along the banks of this river, the Chesapeake & Ohio and the Kanawha & Michigan. The following table shows that the shipments of coal by rail have increased even more rapidly than the shipments by river. The figures show shipments in bushels from points below Kanawha Falls for fiscal years ending June 30:

YEAR.	RIVER.	RAIL.
1881	9,628,696	6,631,660
1886	17,861,613	13,958,747
1891	25,761,346	28,668,025
1892	26,787,888	30,844,100

No official record has been kept of the rail shipments since 1892. but a note from the resident engineer states that they have largely increased since that date.

The great cities of the United States are all situated on waterways, and the greater cities are without exception on the deeper waterways. The New York Central and its western connections, considered as one system, is paralleled by a waterway almost every mile of the distance from New York to Chicago; and where else in the United States can be found such a succession of prosperous towns and cities, almost within sight of one another all the way, as along the railway system named? Instances could be multiplied without limit, but those given must suffice, and it is now in order to consider the reason for the results which have been shown.

The Reason Why. Speaking of the German transportation system, Consul-General Mason, from whom quotation has already been made, says:

> German statesmanship was among the first to foresee that the time would come when, railways having reached their maximum extension and efficiency, there would remain a vast surplus of coarse, raw materials—coal, ores, timber, stone and crude metals—which could be economically carried long distances only by water transportation, and that in a fully developed national system the proper *rôle* of railroads would be to carry passengers, and the higher classes of merchandise manufactured from the raw staples which the waterways had brought to their doors."

To the same effect are the words of M. de Freycinet and the French legislative committee to which I have also referred:

> "It is conceded that waterways and railways are destined not to supplant but to supplement each other. Between the two there is a natural division of traffic. To the railroad goes the least burdensome traffic, which demands regularity and quick transit; to the waterways gravitate the heavy freights of small value, which can only be transported where freights are low."
>
> "Waterways, by increasing traffic, are rather the auxiliaries than the competitors of railroads. In procuring for manufacture cheap transportation for coal and raw materials, *they create freights whose subsequent transportation gives profit to the railroads.*"

A study of the statistics of the St. Mary's Falls canal shows that fully nine-tenths of all the traffic to and from Lake Superior consists of raw materials,.and the figures for other waterways show practically the same result.

The debates in the Senate of France in 1863-'65 resulted in the declaration that it is to the interest of the State to foster both railways and waterways. This principle was reaffirmed in 1872, again in 1878, and still again in 1889, when it was stated that experience had fully confirmed the predictions which had been made. They have certainly had wide experience with waterways in France, for they began building canals in that country more than a hundred years before Christ was born—and they have not stopped yet. The legislators of France have shown their faith by their works, for in that land, which is so much smaller than the single State of Texas, there has been spent since 1814 out of the national treasury more than $750,000,000 on waterways and harbors, more than $700,000,000 on railways and more than $650,000,000 on wagon roads. Within the past few weeks the House of Deputies has passed a bill appropriating no less than $132,-500,000 for the construction of canals and the improvement of rivers and harbors. And it may be remarked in passing that the people of France are quite as well informed as to the value of waterways as are their legislators, for when a *plebiscite* was taken some years ago to learn the popular feeling as to a proposed canal from Paris to Rouen, at an estimated cost of about $40,000,000, out of 345,000 votes cast only 13 were in the negative! It would seem to have been in order for some one to move to make it unanimous.

A Transportation Trinity. The truth is that there are three agencies of transportation, each of which has a fundamentally different function to perform in the commerce of the world, all of which are as essential as are the three sides of a triangle, and none of which can reach its highest possible efficiency unless accompanied by a symmetrical development of the other two. This trinity of transportation agencies is made up of the wagonway, the railway, and the waterway.

Of these, the wagonway is commonly considered to be subsidiary to the other two—and so it is, in the same sense that a foundation is subsidiary to the superstructure. And the waterway is commonly thought to be antagonistic to the railways—and so it is in a sense and to a certain degree. For the three parts are not separated one from another and hemmed in like lakes by rocky shores. Their fields of action overlap, and their elasticity is so great that they can readily conform to all the ever-changing conditions and needs of that complex thing called commerce. The wagonway, however, is essentially local, the railway continental, and the waterway world-wide, in its sphere of action, while the distinguishing characteristic of the wagonway may be called availability, as speed is undoubtedly the distinguishing characteristic of the railway and economy of the waterway. And in the last analysis these three will be found to be not competitors, but complements—not antagonists, but auxiliaries. No one thinks of hauling corn or wheat from Chicago to New York in a wagon, nor of building a railroad from the barn of every farmer to the nearest grain elevator; and it is in reality just as absurd and economically wrong for a railroad to haul low-grade raw materials where there is a deep waterway properly located and equipped to perform the service.

When traffic is carried by an expensive method when an economical method is available, it results in a loss not only to the community, but to the agency doing the carrying, the facilities of which ought rather to be employed in the transportation of goods of higher grade. Some years ago the directors of the Great Western Railway, of England, being dissatisfied with the returns arising from the operations of the road, made an investigation which showed that the manager, who was trying to drive a canal out of business, was using 58 per cent. of the total equipment in a traffic which produced only 14 per cent. of the total revenue.

Facilities Create Traffic. One-sided views are always wrong views, and the railway managers who look only at the traffic which would be taken away from their lines by a waterway, and not at all at that which would be brought to them by the waterway, are as wrong and short-sighted as the mobs that destroyed power looms or harvesting machinery with the idea that fewer men would be employed. The surface roads in New York city desperately opposed the elevated roads, fearing that their traffic would be ruined thereby. But the surface roads are more profitable than before the elevated lines were built, and the latter possess an enormous and profitable traffic which it would have been utterly impossible for the surface roads to develop. The tonnage which goes around the Cape of Good Hope is as large now as before the construction of the Suez Canal, which means that the traffic of 8,000,000 tons a year passing through that waterway has been created thereby.

Not a tithe of the truth is told by the figures which have been given showing the increased tonnage on the Mayence-Frankfort railways since the canalization of the River Main, because those figures do not show the fact that this tonnage is of a higher grade and pays a much higher freight rate, and make no mention of the greatly increased revenues from passengers, express matter, and mails.

The first locks at St. Mary's Falls were opened in 1855, in which year the registered tonnage was 106,296 tons. The half-million mark was reached in 1863, and the one-million-ton mark was passed in 1873. In 1881, exactly coincident with the opening of a much larger lock, the northwest began to grow by leaps and bounds and the tonnage of the canal rose from 2,000,000 tons in 1882 to 9,000,000 in 1890 and to 16,000,000 in 1896. During the past five years, two more enormous locks have been in operation, one of them on the Canadian side of the river, and in this short time the tonnage of the canal has leaped up to nearly 28,500,000 tons. This colossal tonnage is simply a manifestation of the development which has taken place in the northwest, along with which has come the building of thousands of miles of railroad, including two lines from the head of Lake Superior to the Pacific Coast. If by some cataclysm of nature the Great Lakes should be dried up, the enormous traffic now carried on their waters would not be divided among the railroads—it would simply cease to exist. The whole galaxy of cities from Buffalo to Chicago and Duluth would be overwhelmed in hopeless, irretrievable ruin, and the railroads could in no wise escape the general disaster.

A Glimpse Ahead. The development of the Northwest, which has come chiefly in consequence of the building of the locks at the outlet of Lake Superior, marvelous though it is, is but a faint and shadowy image of the development, similar, but multiplied a thousand fold, which will follow fast upon the completion of an Isthmian canal. Since it is "not mileage, but cost of transportation, that is the true commercial measure of distance," the continent will shrink until its eastern and western coasts are commercially but half as far apart, while yet no single acre of its wide expanse is lost. Manila, Yokohama, and Hong Kong will be brought close to New York, Boston, and New Orleans, while San Francisco, Portland, and Seattle will become neighbors of Liverpool, Antwerp, and Hamburg. Mines will be opened, deserts made to blossom as the rose beneath the magic touch of irrigation, towns and cities will spring up, and the western commonwealths grow populous and great, while the manufacturing cities of the eastern States, the cotton planters of the south, and the grain growers of the middle west, will find new and enlarged markets for their products. I can think of no portion of the United States which would not share in the benefits showered abroad by the construction of an Isthmian canal, but if I were asked to point out the interest which would receive the most abundant share of the benefits which would certainly accrue, I should, without an instant's hesitation, name—the railroads of the western States.

EDITORIAL COMMENT

THE conclusion of peace in South Africa was announced just as our June issue was published. It is peace upon terms the Boers could have secured at any time for months past, and doubtless would have accepted had the fighting burghers in the field been better advised—or less ill-advised—by the now entirely discredited representatives on the Continent. The end was inevitable, and to a certain extent was discounted long since by those immediately concerned in South African industrial development. But any condition of disturbance, and above all, disturbance of the peace, is paralyzing to developments dependent on sure and speedy communications, the employment of large bodies of workers, and the investment of great sums of capital in vulnerable machinery and equipment. The formal peace-agreement therefore means much for the industrial reorganization of the Transvaal.

Under equitable and enlightened rule, its future depends only upon its resources. It may be, as in the case of California, that agriculture will develop wealth in the colony beside which all the gold will seem a small sum. But for many years, at least, the gold mines will be the feature of commanding interest. Extreme importance therefore attaches to the *résumé* and forecast by Mr. John Hays Hammond, which leads this issue. No one has more thorough knowledge than he of every condition affecting the output of gold from the Rand mines. And never, probably, has so satisfactory a summary been presented of the history, economics, ore deposits, mining practice, and prospects of the Witwatersrand.

THE passage of the Spooner bill, putting the Senate squarely in favor of the Panama Canal, is a most encouraging evidence of the certain ascendancy of plain business sense over mere political partisanship. This is especially gratifying to THE ENGINEERING MAGAZINE, which has steadily, though at first in seemingly hopeless minority, advocated the Panama route as best from an engineering standpoint, and far the most useful to traffic when finished. It is curious that a struggle between two such motives should have been so hard a one in a country like the United States, which stands as the very type of hard-headed utilitarianism. The Panama route, clearly and vastly better than the other in point of length, of curvature, of lockage, of weather and rainfall conditions, of harbor facilities at both ends, of both certainty and facility of completion, of ease and cost of control and maintenance, of safety from volcanic and earthquake damage, of cost to build and of usefulness to commerce when built—this almost immeasurably better proposition has had to fight for its life against the witchery of a name—the sentiment of a misconceived idea. "Nicaraguan Canal" was so long used synonymously and interchangeably with "Isthmian Canal"—partly through misunderstanding and indifference and partly through clever promotion by an interested clique (since departed), that it seemed impossible for many earnest minds to comprehend the real facts. Every demonstration of the commanding merits of Panama drew forth fierce mouthings against that "sink of corruption." Some mysterious contagion of evil infested the enterprise, by which the country would be diseased. It calls to mind the remark of an old servant, who was told to prepare the guest room for a visitor—a lady whose house, as Bridget knew, had shortly before been robbed. "Sure, ma'am," said she, "ye wouldn't be havin' her sleepin' here? She has burglars!"

If indeed the microbe of mismanagement lurks in every fair prospect wrecked by weak or dishonest hands, the United States has done ill to adopt the cause of Cuba or to enter the Philippines. Americanism has been the great cry of the Nicaraguan party—the only response to reason or argument. The most un-American of all acts would be to buy and install a far inferior tool, and leave the better one for a possible competitor. And that the Panama route is immensely superior for actual service of commerce is practically the unanimous verdict of practical men. To be more precise, it has the unqualified endorsement of the Isthmian Canal Commission, and the emphatic preference of every mariner to whom the question has been submitted.

Many of the worthy Senators seem to have quite overlooked the fact that the function of a ship canal is not merely to be constructed, nor even to have the American flag flying over its waters, but to give safe, economical, and speedy passage to shipping. Usefulness, sufficiency to traffic needs when built, should be the qualities most sought. Grant that the construction of the Nicaraguan Canal is "feasible"—the point on which many of them insisted. The fact that it would be nearly three times as long, as tedious, and as hazardous in passage, should alone make it a last choice—a choice only if the safer, shorter, easier Panama route is wholly unobtainable.

Senator Morgan luridly described the Panama Canal as an undertaking in which "labor and death had joined hands." That they have not done so in Nicaragua is chiefly because labor has never been there. Panama paid the price that was paid by every like enterprise of the same period. Now the cutting of the most disease-infested surface soil has there been finished; conditions have been studied; sanitary working quarters have been established; hospitals have been built and equipped. A large part of the price need never be paid again—at Panama. Senator Morgan would throw this away, and begin anew the inevitable death tax of tropical excavation work, in a region in which, Dr. Soper says, natural hygienic conditions are even worse than at Panama.

There is strong belief that the same progress of reasonable conviction which has so changed the attitude of the Senate in a few months has also affected the House, and that the Spooner bill may prevail there also. It is sincerely to be hoped this may be true, and that a measure providing for actual construction of an Isthmian canal may go to the President before the close of the session. Of all the childish and stupid statements made during the heated debate, the most ridiculous was that "a vote for Panama meant a vote for no canal"—that those opposed to any waterway, and especially the Transcontinental railway interests, were opposing the Nicaraguan route. If the Pacific railways really are so shortsighted as to miss the perception so clearly put by Mr. Thompson in these pages—if mistakenly they believe the canal would diminish their traffic by the amount of tonnage it carried—they should by all means work for the route which, by its difficulties, dangers, and delays of navigation would handle the minimum of tonnage; and that route is by the proposed Nicaragua Canal.

REVIEW OF THE BRITISH PRESS

Economics and Engineering.

In the course of a recent editorial, *Engineering* strikes some fundamental facts in relation to the changes which modern engineering methods have wrought in the formerly accepted doctrines of economics, in a manner which will bear repetition and comment.

The old-time political economy of Adam Smith and his predecessors assumed a stable and lasting condition of social development upon which predictions could be based as in accordance with unchangeable laws. Much to the disgust of the professors and cabinet students of these important subjects, this comfortable state of affairs has been greatly upset, mainly by the action of engineers, an apparently irreverent and irresponsible set of interlopers, who ride rough-shod over ancient traditions in a manner altogether regardless of the fine old crusted traditions of their predecessors.

This action naturally extends over the entire world, but the industrial pre-eminence of Great Britain renders the effects more noticeable there than elsewhere. Says *Engineering:*

"The prospect is that in the future the efforts of the engineer will make the change more rapid, and will bring all the peoples of the world nearer and nearer together. If the alterations were to be all caused by British engineers and were to have their origin here, the future might be viewed with complacency. We should have first notice of the change, and should have time to adapt ourselves to it before other nations had clearly comprehended its significance. This is precisely what has occurred in the past. Speaking generally, all the great manufactures arose in this country, and although there were at times evils associated with them, as in the case of the factory system, from ignorance or want of forethought, yet on the whole the nation benefited immediately from the changes. "But the last few years have brought home to us the fact that we no longer have the complete pre-eminence we once had. Locomotives, steam engines, and machine tools come to us from America, electrical machinery from Belgium, chemicals from Germany, and so on. Our hands are not the only ones that grasp the rudder, and we have ceased to direct the course of nations exactly as we please. Other nations take a turn at the wheel at times, and we are carried on a course which is not of our own choosing. Change is always attended with inconveniences, even when it is directed by ourselves, but when forced upon us from without, and at inauspicious moments, it may be disastrous."

Since engineers have had such an important share in the modifications which have been made in practical economics, it has been urged that instruction in the science of economics should form a part of engineering education. Indeed it is this conclusion which forms the moral drawn in the editorial to which reference has been made above. At the same time it is evident that the most thorough training in the older schools of economics would have availed little in existing conditions, and it is altogether possible that an economic training based upon present conditions might be obsolete before the student had the opportunity to put it into practice.

The proper economic training for the engineer is not a logical system, entirely and rigidly correct in all its details, based upon premises of uncertain stability. Rather is it a full acquaintance with data and information concerning the industrial condition of the world at the moment, information available for prompt and powerful use upon demand and for practical ends.

"Economics involves the training of the judgment to grasp a great number of considerations of very diverse kinds and various values to set them in order, to calculate the chances of some of them being wrongly appraised, and finally to arrive at a decision which represents the resultant of them all. For such a decision a man cannot have too much knowledge. There are people who form judgments intuitively, and probably they are the safest guides. But they are fewer than the positions which need such qualities. Responsibilities are thrust upon men who are not prepared by Nature to meet them, and for such the aids of education are most important. For them history, logic, and statistics are the best aids; and at this period of our national life it is the duty of the ancient universities to do all that is possible to help them to bear their part in the coming industrial struggle. We are on the eve of a commercial war in which we shall need all the generalship which can be attained. It is useless for British engineers to brace themselves, to fling off their conservative habits, to improve their methods and appliances, if the commercial men who control the sinews of war cannot bear their part with credit. How far the men who are the heads of the great enterprises which have been lately launched in America are skilled in economics, we do not know, but it is certain that they have at their side assistants who have most carefully digested the immense stores of statistics the government provides, and have drawn from them a theory as to the constitution and movement of the industrial world during the next few years, which is of immense value to their chiefs."

While the above is doubtless in great part true, it must also be remembered that in many instances the combinations of financiers and engineers which have become so evident in industrial affairs of late, not only gather and digest information to guide them as to coming events, but they also in great measure control those events. The old laws of supply and demand included the idea of a freedom for the action of natural laws which at the present time is often absent. Forces do follow the lines of least resistance, but it is altogether possible to create and control artificial resistances which may materially change the direction of the currents. A man must not only have the knowledge and the data, but he must have the power and the ability to control them, and not merely glide with the current. Instead of drifting with the stream, contenting himself with a thorough knowledge of all its shoals and currents, he should correct its channel to suit his own purposes and then proceed to navigate it in a full-powered vessel, with his own hand on the wheel.

Compressed Coking Fuels.

Good coking fuels have never been very plentiful and they are continually becoming scarcer, and hence various methods have been proposed for enabling satisfactory coke to be made from inferior grades of fuels. The most promising of these is that in which the coal is heavily compressed before coking, and from a paper presented before the Iron and Steel Institute by Mr. John H. Darby we abstract some account of the process and its results.

The idea of compressing fuel for coking purposes originated on the Continent, where many of the coals coked so indifferently that it was of the greatest importance to adopt any method that gave a prospect of improving the quality of the resulting coke. It had been observed that the coke produced from the lower portions of retort ovens, compressed by the weight of the superincumbent fuel, was superior to that produced from the upper portions of the charge, and this led to experiments in compressing the fuel by various means: first, by stamping in the oven by hand, in other cases by weighting the charge; and from this the practice of compressing in a box outside the ovens was gradually evolved, the stamped cake being afterwards moved out of the box into the oven by mechanical means.

A number of samples taken from coking fuels in various parts of Great Britain were experimented with. The degree to which slack may be compressed varies with its character, state of division, contents of moisture, and other conditions; and generally speaking, it was found that the weight of a given bulk of compressed fuel in an oven was 50 per cent greater than fuel charged in the ordinary way through the holes in the upper portion of the oven and levelled by hand. Taking, however, the side clearance that has to be allowed in introducing a cake of fuel into an oven, the net gain in weight that a given oven capacity would hold varied from 25 to 30 per cent. in favour of compressed fuel. But it was found that the compressed fuel coked more slowly than the uncompressed, and the net gain in production of coke per oven finally amounted to between 10 and 12 per cent. in favour of the compressed charge.

To ascertain the difference in the character of the coke from compressed fuel compared with uncompressed, the weight of a cubic foot from a solid lump of coke was estimated, and it was found, in the case of three samples of fuel from Durham, that the average weight per cubic foot for uncompressed coke was 63.37 lb., and for compressed coke 80.88 lb.: for North Welsh uncompressed coke, average weight 56 lb. per cubic foot, compressed 60.57 lb.; South Yorkshire uncompressed coke 53.9 lb., compressed 57.9 lb.: West Lancashire uncompressed 58.0 lb., compressed 66.4 lb. It will be seen from the above figures that compressed coke is considerably denser, in addition to which other advantages were noted. These were (1) the breeze or small coke was very much reduced in quantity, the lumps of coke were larger and firmer, and in a marked degree bore handling without very much breakage; (2) the process of charging an oven by the mechanical means in use, where compression of fuel is adopted, occupies much less time than the old method of charging by hand through holes in the top of the oven; in fact, the time is reduced from 10 or 12 minutes to 3 or 4 minutes, so that the objectionable smoke is largely prevented, and the loss of by-products is less; in fact, in some cases the yield of ammonia has been increased 25 per cent.; (3) less hand labour is employed, and the laborious work of forcing the wet fuel out of the tubs into the ovens and leveling the charge in the ovens is entirely abolished, while the clearance between the cake of fuel and the side of the oven allows the free escape of the gases, and tends to prevent undue deterioration of the oven walls.

The process is especially intended to be used with retort ovens similar to the well-known Hoffman type, and the coal is compressed into large rectangular blocks about the height and width of the interior of the ovens, and slightly less in breadth. The slack coal is dumped into a framed box with hinged sides, and is rammed or stamped into it in layers about 18 inches deep, the stamping being performed by a rammer driven by an electric motor. When the box is filled with compressed slack the hinged sides are released by cams and the block, which is formed on edge, is pushed into the open oven by a ram, the operation being rapidly performed, and the oven quickly closed. The whole apparatus is mounted on a framework, carried on rails, so that it can travel along before the successive oven doors and charge them in order.

The process, as has already been noted, is especially intended for the preparation of inferior coals for coking, but it is also applicable to coals of good quality, the improvement being apparent in all cases. Even with the best coking fuels the results seem to justify the outlay in equipping a plant for compressed fuel, as well as the special case in which it is essential that the fuel should be compressed in order to produce a marketable coke.

By-Product Coke Ovens.

Among the papers presented at the recent meting of the Iron and Steel Institute attention may be called to that of Mr. J. Thiry upon the more recent improvements in the recovery of by-products in coke making.

The general features of the by-product oven, as distinguished from the common beehive oven are well known, consisting as they do in the coking of the coal in closed chambers, or retorts, and in delivering the distilled gases into coolers and condensers where the by-products are separated. The details of construction vary, mainly in connection with the heating of the air, the use of the gas as fuel, and the economical application of the heat. Much good pioneer work has been done in this line by Coppée, Simon, Otto, and others, and although there has always been a strong prejudice on the part of ironmasters against retort coke, this feeling is gradually giving way in the face of the evident advantages of the system.

Mr. Thiry describes as the latest type of by-product oven the Otto-Hilgenstock construction, in which the principal modifications over the Otto-Hoffman type appear in the method of using the gas as fuel.

The gas, after the by-products have been removed, is delivered back to the ovens and burned in Bunsen burners, the air supply being heated merely by passing through the flues beneath the ovens, thus dispensing with the necessity of employing any regenerator of the Siemens type. The hot products of combustion then pass to the steam boilers, where their heat is abstracted in making steam for the general purposes of the plant. The use of the Bunsen burners permits a very high temperature to be attained, an important requisite in the production of coke of high quality, the distribution of the heat being well under control, and the time required for coking being materially reduced.

The most important question in connection with by-product ovens is the market for sulphate of ammonia, since it is from the sale of this, the chief product, that the advantage of such ovens is mainly gained.

It has been urged as an objection to the adoption of by-product coke ovens that if such plants continued to be built in increasing numbers, the production of sulphate of ammonia would correspondingly increase, until the supply far exceeded the demand, thus rendering it difficult to find a market for the excess product. A general fall in price might then be anticipated, which would cut down any margin of profit, and makers of coke would then find themselves with an expensive plant left on their hands which could only be worked at a loss. With the object of ascertaining to what extent such apprehensions were justified, and being desirous of placing the true facts before the iron-makers, inquiries have been made, and an expression of opinion eventually elicited from the German Association for the sale of sulphate of ammonia as to the future prospects of the sulphate of ammonia industry, which may be regarded as quite trustworthy. According to this authority, the best evidence of the maintenance of prices in the future is afforded by a study of the published returns relating to the manufacture of sulphate of ammonia since 1895, and a comparison of the fluctuations in price corresponding to the state of the market for the same period. In the light of these facts it will, no doubt, be possible to refute, and, in fact, to dispel entirely, the groundless apprehensions entertained by those who are interested in this question. In Westphalia the production of sulphate of ammonia in 1895 was 10,043 tons, and it rose in the following year to 21,377 tons, with an average price of £7 18s. per ton. In 1897 the production was 32,418 tons, of the value of £7 13s. per ton. Throughout the succeeding years it continued to increase until, in 1900, it amounted to 49,223 tons, the price also gradually advancing until it reached £10 6s. per ton. Prior to the year 1895 the individual manufacturers sold their product independently, which renders it difficult to estimate the average value before that date. It may, however, be assumed that it fluctuated between £9 16s. and £10 6s.

On comparing the selling price of sulphate of ammonia with the quotations for Chili nitrates, it will be found that the former follows to a certain extent those of the latter, but the difference in the nitrogen contents of each—21.2 per cent. for sulphate of ammonia and 16.4 per cent. for Chili nitrates—must be taken into account. When it is further considered that about 1,300,000 tons of Chili nitrates are yearly produced and used, and, moreover, that sulphate of ammonia is a particularly suitable substitute for Chili nitrates as a fertiliser, for which purpose the latter is principally used, it is abundantly clear that only when the price of Chili nitrates is depressed will it be possible for a continuous backward tendency in the price of sulphate of ammonia to occur. The prices of Chili nitrates have, however, as a matter of fact, materially increased of late; and even if they decline, they can only fall in the most extreme case to level of £7 per ton, below which figure the production and preparation of nitrates would cease to be profitable. This would, however, be equivalent to a price of £9 5s. per ston for sulphate of ammonia, on taking into account the superior nitrogen contents of the latter. Further, it is possible that the nitrate fields will, according to the present available estimates, be completely exhausted in 23 years, provided the yearly production continues at the same level as in recent years—namely, 1,300,000 to 1,400,000 tons. Probably, therefore, the great need for nitrogen as a fertiliser will no longer be sufficiently met, as at present, by the use of nitrates, and it will become imperative to increase very largely the production of nitrogen—that is to say, ammonia—for the purpose of satisfying the demand.

At the present time in Germany nearly 160,000 tons of sulphate of ammonia are used annually for agricultural purposes. In addition to this, the imports of nitrates in 1900 amounted to 484,543 tons, and in 1901 to 529,568 tons, which in regard to nitrogen are equivalent to 363,300 tons and 397,200 tons of sulphate of ammonia respectively.

The Evolution of Smokeless Powder.

Recent military affairs in various parts of the world have drawn attention to the great advantages of smokeless powder in modern warfare, and hence an article in a recent issue of *Engineering,* upon the evolution of smokeless powder and other high explosives is of much general interest.

Common black powder, which is a mixture of nitre, sulphur, and charcoal, held its own against all other explosives as a propellant to be used in guns, and a bursting charge for shells, for several hundred years. It was simple, cheap, and easily made, and did not deteriorate with keeping, and it was quite strong enough for the guns which it was possible to make at that time. When black pawder is ignited, the oxygen which forms a part of the nitre becomes disassociated from the potash, and combines with both the sulphur and the charcoal. The sulphurous acid so formed in its turn combines with the potash which has been liberated, forming sulphate of potash, which appears in the air as a dense smoke.

When artillerists had arrived at the end of their tether, as far as black powder was concerned, they naturally sought something that would be stronger. Moreover, rapid-firing guns demanded that a powder should be found which was free from smoke. Gun-cotton in a compressed state, or in twisted cords, had been used to some extent, but had produced uneven results, and proved very unsatisfactory generally. However, a semi-smokeless powder was evolved which had gun-cotton for its basis, and which was extensively used in shot guns. This powder, however, was never very suitable for use in rifles.

When the Maxim gun first made its appearance, the amount of smoke which it evolved became very conspicuous. It was said at the time that one Maxim gun could pile up a cloud of smoke as big as St. Paul's in a few minutes. It therefore became obvious that if this gun were to go into use, it would be necessary to have something that would not produce this immense cloud of smoke, and very curiously the first smokeless powder suitable for use in rifles that seems to have been made was the result of experiments which were conducted for a totally different purpose.

The experiments of Maxim and MacRoberts, in 1885, upon a mixture of gun-cotton and nitro-glycerine, formed into cords, appears to have been the beginning of modern smokeless explosives, but the government prejudice against nitro-glycerine mixtures delayed the introduction of such combinations for military use. After various delays in litigation, however, the government modified its objections and the present explosive, well-known under the name of cordite, is admitted to be practically identical with the original powder made by Maxim and MacRoberts in 1886. The principal difficulty about such explosives, for there are several, differing mainly in the proportion of nitro-glycerine present, lies in the possible instability. The presence of too much nitro-glycerine prevents the powder from keeping, besides which it is apt to erode the bore of the guns with very great rapidity. The stability is improved by the use of a small quantity of vaseline, but the erosion produced is not diminished.

It soon appeared that the shape of the powder had an important influence upon its action.

When smokeless powder is employed in the form of a sphere or a cube, the cube burns smaller in all directions; consequently the surface on which the flame is operating is rapidly diminished in all directions. If, however, the powder is formed in long strips, the amount burning from the ends is immaterial; consequently the reduction only takes place in one direction—that is, in the diameter of the cord, and therefore the reduction of the burning surface is only half as rapid as it would be in cubes or spheres. When this same powder is spun into tubes or flat sheets, the burning surface practically remains constant from first to last. In the case of a tube, if we do not take into account the length, which is immaterial, we shall find that the powder is burning smaller from the outside and larger from the inside; consequently the approximate area on which the flame works is constant.

The latest development in explosives for military purposes is found in the use of picric acid compounds for bursting charges in shells. Picric acid, chemically known as tri-nitro-phenol, is in itself very insensitive, and can be burned in large quantities without danger of explosion, but if properly confined and set off with a strong detonator, it produces disruptive effects more powerful than those due to dynamite. Sudden heating will also cause it to explode, and the elevation of temperature at the moment of the striking of a shell against armour plate is sufficient to set off the contained charge. By the addition of a small percentage of dinitro-benzol, a substance very similar to picric acid, the melting point, upon which the control of the explosion depends, may be materially lowered, and by the addition of a little vaseline a very effective and safe bursting explosive for shells is obtained. This bears the name of lyddite in England and melinite in France, the two explosives being practically identical.

Shells loaded with lyddite are provided with fuzes having a delayed action, in order to permit the projectile to penetrate the plate a sufficient distance before explosion. The arrangement of fuze used for this purpose is that due to Sir Hiram Maxim, in 1885.

He used a very strong fulminating charge placed at a considerable distance to the rearward of the projectile, and inclosed in a strong tube forming part of the projectile. This charge was so far removed from the main bursting charge that a premature discharge ruptured the tube and went off harmlessly inside the gun chamber. However, when the projectile struck the target and was retarded, the detonating charge moved forward as relates to the projectile, not only giving perfect safety, but at the same time the necessary delayed action, which would admit of the projectile passing through the plate. It will be understood that when the projectile struck the target, the fulminating charge entered the base of the projectile, and was sufficiently strong to open a communication from the inner tube to the bursting charge, thus igniting the main charge. This arrangement seems to be the only one with which any degree of safety has ever been obtained.

The experience in recent warfare has demonstrated the absolute necessity of using smokeless powder, and both in South Africa and in the Spanish-American war the smoke-producing black powder showed its utter unfitness for modern conditions of fighting. In like manner the destruction wrought by shells carrying bursting charges of lyddite showed the tremendous advantage accruing to the force supplied with such ammunition. Whether such additions to the means of destruction will aid in the prevention of war can as yet hardly be predicted, however devoutly it may be hoped.

Relays for Submarine Cables,

One of the most useful details of the electric telegraph is the well-known relay, in which the comparatively feeble electrical impulses sent over long telegraph lines are used to make and break the contacts in a relay circuit, thus enabling a local battery of suitable strength to operate the local receiving instrument. If such instruments are necessary in land lines, how much more are they to be desired in connection with submarine telegraphy, in which the currents, themselves very feeble, are sent thousands of miles beneath the ocean? As is well-known, the receiving instrument for a submarine cable is either the mirror galvanometer, in which the swinging of a delicately suspended mirror moves a reflected spot of light to the right or left, giving substitutes for the dot and dash of the Morse code; or else the Thomson siphon recorder, in which the vibrations are converted into a sinuous line, traced on a moving band of paper. Until the present time these two instruments have been the only ones which could be depended upon to receive the very feeble signals of the ocean cables with any commercial degree of reliability.

Naturally there have been numerous attempts to devise a relay, by means of which the reinforcing action of a local battery could be called in to operate the receiving instruments, but the difficulties have been great. Any attempt to make a so-called "butt" contact good enough for the making of a relay circuit has been found to require more force than is practicable, while if a stronger relay current is tried the contact points are found to stick or cohere.

In view of these facts the paper recently presented before the Institution of Electrical Engineers by Mr. S. G. Brown, describing the achievement of this long sought feat, demands especial note and discussion.

Mr. Brown has brought to his aid a well-known fact in mechanics concerning the reduction of friction between two bodies when they are in motion. Thus a cylindrical rod, like a piston rod, fitted in a ring or collar, experiences a considerable frictional resistance to sliding motion endwise through the collar, starting from a condition of rest. If, however, the rod be given a rotating motion on its axis it is found that the frictional resistance to endlong motion is enormously reduced. Applying this principle to a cable relay, Mr. Brown makes his contact lever rest on a cylindrical drum, the surface of which is divided into three bands, the middle band being an insulator, and those on either side corresponding to the dot and dash contacts respectively. The drum is rotated at a speed of about 150 revolutions per minute, under which conditon it is found that a very small force is sufficient to swing the contact arm to one side or the other and throw the relay into action. Certain details are described by Mr. Brown, such as the introduction of condensers into the circuits, and the complete working instrument is shown and discussed at length.

The advantages of such an apparatus are self-evident. The usual methods employed on cables at the present time is to receive signals on a strip of paper, written by a siphon recorder, as a dotted ink line. The message at an intermediate station is then punched by hand on another strip of paper, which strip is passed through an automatic transmitter for re-transmission over the next line.

Sometimes, if the speed of signalling and the conditions of the circuit will allow of it, the message is read off the siphon recorder strip by the clerk directly as it flows from the instrument and sent on by a hand key, signal by signal. This latter system, called "human translation" is necessarily slow and laborious, and is permissible at but one station. By the introduction of a relay the human element is altogether removed, the messages being sent on automatically, whatever the speed of transmission may be.

Mr. Brown's system has been fitted to the cables of the Eastern Telegraph Company, and is in use at the station at Gibraltar for automatically transmitting messages over the cables between Porthcurnow, in England, and Alexandria, in Egypt.

In connection with this ingenious relay, Mr. Brown has also devised an apparatus which he terms an interpolator, and which is of great utility in increasing the transmitting capacity of submarine cables. This device is required when the highest possible speed is demanded, and as high speed is essential if the maximum amount of matter is to be transmitted, this has a vital commercial importance. When a cable is worked at high speed many of the originating impulses are obliterated from the received signals whenever successive impulses of the same polarity or sign occur. It is, therefore, evident that if the impulses sent by the relay apparatus into the second cable are to be identical with those of the first, it is necessary to restore the missing "beats." The instrument used for this purpose is called an "interpolator." Its action resembles that of the automatic transmitter at the originating station, with this difference, that the movements of its transmitting levers, instead of being governed by the perforations in the punched tape or strip, are governed by the motions of the relay tongue. The interpolator sends into the second cable impulses similar to those entering the first cable, and these may be either "curbed" or "plain" as required. To use this instrument to the best advantage, it is necessary that it should run in approximate synchronism with the automatic transmitter, and that the speed of the latter instrument should be nearly uniform.

It is admitted that these improvements of Mr. Brown's are the most important which have been made in cable telegraphy in the past thirty years, and the manner in which their presentation was received by such experts as Professor Ayrton, Mr. Mordey, and others, indicates the value which this contribution to the transmission of intelligence possesses.

Electric Power in South Wales.

Although the inauguration of electric power distribution has been retarded in Great Britain, it appears at last to have taken a definite start, and with the laying of the cornerstone of the station at Pontypridd by Sir Frederick Bramwell, the work may fairly be said to be begun. From an account in a recent issue of the *Colliery Guardian* we abstract some account of this work in its immediate plans as well as its proposed future development.

The South Wales Electrical Power Distribution Company Limited was registered in 1900, with a capital of £30,000, for the purpose of obtaining an Act of Parliament. That Act was obtained and the present company was incorporated under a similar title, with a capital of £750,000, with power to issue £250,000 debenture stock. The company will provide and distribute electric energy in the county of Glamorgan, and that portion of the county of Monmouth lying west of the River Usk, thus comprising the entire coalfield of South Wales. The importance of the scheme will be understood when it is stated that the above-named district has an area of 1,034 square miles, and contains a population of over 1,000,000. The industries carried on in it consist of collieries, steelworks, tinplate and copper works, stone quarries, railways, tramways, engineering and ship-repairing works, chemical works, and factories of all kinds. There are over 2,400 collieries and factories, &c., large and small, in the district, and electric tramways are now being constructed or promoted in many parts of the area. All these, it is believed, will sooner or later adopt the use of electric power.

While the growth of the plant must be gradual, it certainly is situated in an excellent field for rapid development.

The total steam power at present installed in the district is estimated at considerably over 500,000 indicated horse-power, of which probably one-third could be immediately and profitably made electric. In the Rhondda Valley, and within a radius of six miles of Pontypridd, it is estimated there is 65,000-horse-power; within a similar radius of the Neath station it is estimated there is 60,000-horse power, and these amounts are constantly increasing. The Act of Parliament of the company contemplates, as a preliminary only, the establishment of a total horse-power for the district of 30,000—to be generated at three centres, Neath, Pontypridd and Pontypool; but eventually the number of stations will be increased to five, ground having been acquired at Bridgend and Cwmbran. At Neath work has been commenced on the foundations, and at Pontypool and Cwmbran sites have been selected, while at Bridgend the first instalment of the plant has already been delivered. Other generating stations are also contemplated by the South Wales Company. The buildings at Pontypridd, of which Sir Frederick Bramwell laid the foundation, when completed will be only one-fifth of the station as designed. Fifteen housand horse-power in engines, dynamos and boilers are now being provided for, but the stations will contain when completed no less than 75,000-horse-power, and no one unit will be smaller than 3,000 indicated horse-power.

The erection of even this preliminary portion of the plant will necessarily occupy some time, and hence it has been decided to install a temporary plant for immediate use. This will consist of two large locomotive boilers, four direct-coupled engine generator sets of 240-horse-power each, together with the necessary switchboard, pumps, and other accessories.

The growth of development of this plant will be watched with great interest, consisting as it does, of one of the largest steam power electric supply companies in existence. The great electric companies of other countries are mainly hydro-electric plants, notably those in Switzerland and in America. It has been argued in many instances that properly installed steam plants would be as profitable as those depending upon water power, and when the plant of the South Wales Company is in full operation some instructive comparisons as to efficiency and cost may be made.

Liquid Fuel for Locomotives.

We have referred elsewhere to the development of the petroleum resources of the Dutch East Indies, while the great production of oil in South-eastern Russia is well known. In a recent issue of *Le Génie Civil* the use of petroleum residues as fuel for locomotives is discussed, with especial reference to these same districts, and some data as to practical results may be of interest.

The locomotives under consideration may be divided into two classes: those intended primarily for the combustion of coal, the liquid fuel being considered as an auxiliary, and those in which no provision is made for any but liquid fuel. The general arrangement of the engines of the first class is shown by the devices already well-known in England as in use on the engines of the Great Eastern Railway, designed by Mr. Holden. In these the liquid fuel is delivered through burners placed above the fire door the jets being annular in form, the liquid being pulverised by the action of steam jets while heated air is at the same time delivered in the centre of the burner. The air is drawn in by the suction of the jet, having previously passed through heaters placed in the smoke box. If liquid fuel is to be used exclustively the steam pressure must first be raised by a fire of wood or coal, and the grate covered with broken fire brick to receive and radiate the heat, but in general the burners are used in connection with coal firing on the grate. Usually the liquid fuel is light enough to be readily pulverised by the action of the steam jets, but when heavier fuel, such as coal tar, is used, it becomes necessary to employ steam coils in the supply tank to render it more liquid. In the later designs of Mr. Holden the preliminary heating of the fuel is effected by the exhaust steam from the air-brake pump, thus avoiding the necessity for employing live steam.

In the engines built by the Chemnitz Locomotive Works for the State Railways of Java the Holden system is practically adopted, a coal-burning grate being provided as well as burners for liquid fuel. Since these engines are to be used in a tropical climate, provision is made for the ventilation of the fuel reservoir to prevent overheating in case naphtha is employed, while heating coils are also added for use with tar. A fire-brick arch is provided to protect the crown sheet of the firebox from the intense heat of the petroleum burners. These engines are intended to use the liquid fuel only as an auxiliary to coal, especially on long grades, or on any occasion when the steam pressure has fallen because of heavy demands for power.

The use of liquid fuel on Russian railways, however, has so far passed the experimental stage that powerful engines are equipped with oil burners alone, no provision whatever being made for solid fuel. Thus a heavy compound locomotive on the Mallet system is shown equipped with a cylindrical furnace without any grate, the lower portion of the furnace being filled with fire brick arranged to form flues through which the air passes before it meets the burning oil. These engines, of 81½ tons weight, are intended for hauling heavy freight trains weighing 500 tons, on the Moscow-Kazan and the Trans-Siberian Railways. The average consumption of naphtha is given as 14⅓ litres er kilometre, or about 6.16 gallons per mile.

Another example of a Russian oil-fired engine is that of the compound express engines for the South-Eastern Railway of Russia, built at the Kolomna Iron Works, and intended to make a speed of 80 kilometres per hour (about 50 miles per hour). These engines, of a total weight of 63.2 tons, are two-cylinder compounds, with cylindrical fire box arranged for the burning of liquid fuel only, there being no grate. The experience which has been had in Southern Russia with petroleum and petroleum-residues as fuel has been so entirely satisfactory that there is now no hesitation in equipping engines for such fuel, without providing for grates in emergencies.

The Eastern Railway of France has introduced oil-burning engines in connection with solid fuel, the burners being intended for use in connection with the heavy grades between Paris and Belfort. Here the burners are introduced on each side of the fire box, the arrangement being that of MM. Vetillard & Scherding, in which the fuel, pulverised by a j t of steam, is delivered between two annular jets of air, thus insuring thorough mixture and complete combustion.

In view of the fact that liquid fuel can be so readily adapted for use with ordinary coal-burning locomotives, there seems to be no reason why such combinations should not be very generally supplied on railways where crude petroleum or petroleum residues are at all available, even though the entire change may not be contemplated. The consumption of fuel can be so perfectly regulated and accurately accounted for that there need be no reason for fearing waste, while at the same time such a reserve of firing capacity would enable lost time to be made up, or heavy grades to be ascended without the usual difficulties which are now encountered, when, for any reason, the steam pressure has been allowed to get low. The period of experiment is certainly past, and there is no apparent reason why such combinations should not become general.

The Düsseldorf Exposition.

We have already referred to the importance and interest of the Düsseldorf exposition, and now sufficient time has elapsed since the opening to permit some notice to be taken of the exhibits and their relation to mechanical progress. This is the more practicable since the exposition has distinguished itself from others by the remarkable feature of being ready at the appointed time, both as regards buildings and their contents. From interesting descriptions in the *Zeitschrift des Vereines deutscher Ingenieure* and in *Glasers Annalen* we abstract some notes concerning the exposition.

The grounds are situated on the banks of the Rhine, extending for about 1¼ miles north of the great bridge over the river, forming a strip a little less than ¼ mile wide, following the curve of the river. A large portion of the land has been reclaimed from what were formerly mud flats of the Rhine, and the whole has been improved and beautified in a very complete manner, the total area available being about 60 hectares (nearly 150 acres). On these grounds there have been erected 160 buildings, having a total value of about 10 million marks. Some of the structures are so constructed that they may be re-erected elsewhere for subsequent use, while the art building is intended to remain permanently.

Since the exposition is mainly representative of the industries of Rhenish Westphalia it is to be expected that the departments of mining and metallurgy should occupy a prominent position, and these, with the allied mechanical industries form the principal matters of interest. Besides the main buildings devoted to the departments there are special structures containing the exhibits of the larger establishments, such as Krupp, the Gutehoffnungshütte, the Hörde iron works, the Bochum works, and others.

Without attempting to discuss the entire exposition in anything but a most general way, the various technical journals are proceeding to take up various lines of exhibits and examine them in detail. First among such discussions naturally falls the subject of motive power, and in the *Zeitschrift des Vereines deutscher Ingenieure* we notice two articles by Herr Dubbel upon the boilers and engines at the exposition.

The steam generating department is a strong evidence of the popularity of the water-tube boiler, since eight out of the thirteen installations are of this type. The water-tube boilers are of well-known design, including the Babcock & Wilcox, Dürr, Gehre, Walther Steinmuller, and others. These call for little comment as to their construction, except as to the general adaptation of superheaters. A high degree of superheating, while now fully appreciated as a means toward better steam economy, can hardly be introduced at a general exposition, where the steam is to be used for various purposes, in engines of different designs, but such an extent of superheating as will effectually overcome the consequences of priming, may well be introduced, this permitting a high rate of evaporation to be attained without especial regard to the dryness of the steam, the superheater being relied on to evaporate the entrained moisture. Under such conditions the superheater should properly be regarded as a part of the boiler, its surface included in the total heating surface of the boiler, and the total efficiency taken as that of the apparatus as a whole.

As might be expected in an exposition devoted so largely to the iron and steel industries, the workmanship on the boilers is excellent, the plates being of mild steel, all rivet holes drilled, and rivetting performed by hydraulic pressure. The steam pressures are carried as high as 14 atmospheres, (about 200 pounds per square inch), and automatic stoking is shown in connection with some installations.

The steam engine exhibits show very clearly the reversion from multiple expansion to compounding, there being but one triple-expansion engine, the 3,500 h. p. vertical engine of the Gutehoffnungshütte, nearly all the others being compound horizontal engines, and most of these having the cylinders arranged tandem. The valve gears show a tendency to replace the Corliss with the poppett valve, although the former is still used on low-pressure cylinders in instances where it has been replaced on the high-pressure cylinders by the lift valve. These modifications all show the influence of the use of superheating upon engine design, this also being apparent in the provision made for free expension and contraction, the supporting of overhung cylinders upon spring bearings, and the avoidance of large masses of metal exposed to the heat of the steam.

So far as governing is concerned, the requirements of the electrical machinery have been taken into consideration, and inertia governors are very generally used, including those of the Proell, Doerfel, Stumpf, and similar types.

Coming so soon after the Paris exhibition of 1900, it is not to be expected that any great novelties in engine construction are to be seen at Düsseldorf. At the same time there is an excellent display of the latest type of steam generators and motors, and there is little doubt that the best work of German builders is shown in a manner more convenient for examination than at a larger exhibition.

The Cleaning of Boiler Tubes.

The extensive use of tubular boilers, especially those of the water-tube type, has rendered it necessary to provide some method for removing the scale and soot which accumulates, and much ingenuity has been given to the design of appliances for these purposes.

From a general review of the most effective methods and appliances, appearing in a recent issue of *Revue de Mécanique* we make some abstracts, which will give an idea of the present methods of dealing with the problem.

Various opinions have been expressed as to the effect of a deposit of scale upon the evaporative capacity of a steam boiler, and while the loss from this source is now believed to be less than was formerly supposed. it is still serious enough to demand attention, especially as the scale undoubtedly has an injurious effect upon the boiler. The extensive experiments of M. Cousté have shown that the conductivity of scale is about one-sixteenth that of iron, so that the influence upon the evaporative capacity of a boiler can be fairly well determined. The effect of deposits of soot is not so well ascertained, but it is believed by some engineers that it is even more injurious than hard scale. The fire side of tubes also become partially covered with fine dust and ash, which unless removed, seriously affects the value of the heating surface.

Prevention is always better than cure, and it is most desirable that scale should be avoided by the use of pure water and soot diminished by the use of smoke preventing furnaces, but in the great majority of instances some method of removing deposits is found necessary to maintain the performance of tubular boilers at their best efficiency.

For fire-tube boilers, in which the water is on the outside and the gases pass through the tubes, various forms of brushes have been devised for removing the soot, these being usually provided with steel or brass wires, and in some forms so arranged as to be expansible, pressing forcibly against the interior of the tube. For Serve tubes, provided with internal ribs for extending the area of heat-absorbing surface, special brushes are made, with spaces corresponding to the position of the ribs. Steam jets are also found effective for the removal of dust and ashes, but in most instances the soot is sufficiently adherent to require the employment of stiff brushing devices.

In the case of water-tube boilers the soot and ash is deposited on the outside of the tubes, and in general the use of steam jets is relied on to clean them, although some special forms of brushes have been made for the purpose. The tubes of economisers are fitted with scraping collars, either moved at intervals by hand, or kept in slow continuous motion by power.

It is the removal of hard scale, however, which gives the most trouble, and the practical difficulties only serve to emphasise the wisdom of preventing its formation whenever possible. Fire-tube boilers, in which the scale forms on the outside of the tubes, have the disadvantage of usually requiring the boiler to be entered to get at the tubes, but at the same time the deposit is more easily removed or broken away under these conditions than when, as inside of water tubes, a continuous arch ring is formed. The usual method is to enter the boiler and use picking tools and flexible band scrapers, operated by hand, but the inaccessibility of many of the tubes interferes much with the work.

The principal field of invention for tube cleaners is found in the water-tube boilers, in which straight tubes are used which can be opened at one or both ends, and into which a stout bar can be introduced to carry the tools or mechanism. The earlier devices for this purpose, operated by hand, consisted simply of various forms of scraping tools, some of them very ingenious, but all of them adapted for dealing with scale of moderate thickness and hardness only. The later appliances involve the use of power, an advance doubtless due to the ease with which portable electric motors can be attached and operated. With such cleaners a thick coating of scale can be removed in a few minutes, and with proper precautions, no injury to the tubes need be feared.

An ingenious combination of two functions for this work is found in the devices which use the power of water-pressure, or of compressed air, to operate the cleaning tools and at the same time drive out the loosened scale. These various devices are very effective, and by their use the interior of the tubes of water-tube boilers of the large-tube type may be kept free from scale to an extent dependent only upon the care and expense permissible.

It is a question whether the cost and labor involved in cleaning boilers would not, in nearly all instances be more effectively employed upon the purification of the feed water, than in removing the deposits resulting from the use of impure feed. Absolute purity is not required, and indeed corrosion would doubtless follow the use of perfectly pure water in steam boilers. At the same time it is possible to remove matter in suspension by adequate settling tanks, while the carbonates and sulphates may be precipitated by heat and separated by frequent blowing-off and straining in the purifying apparatus.

Boiler cleaning can take place only at intervals, and between these periods the evaporative efficiency of the boiler is steadily diminishing, and the fuel consumption increasing, and the loss from this cause should properly be included in the expense of cleaning if comparison is to be made between the cost of prevention and cure.

The Salvage of Wrecked Vessels.

A department of engineering work concerning which but little has been written is that relating to the appliances and methods for raising sunken vessels, or, when salvage is impossible, for the removal of the obstructions which the wrecks may offer to navigable channels. For this reason a paper recently presented before the Société des Ingénieurs Civils de France by M. Dibos and published in the *Mémoires* of the society, is found to contain much of interest.

M. Dibos divides the subject into two classes, the first relating to the raising of boats in canals and rivers, where the water is generally of moderate depth and comparatively smooth, and the second discussing the broader subject of the salvage of sea-going vessels on coasts and in harbors.

A source of danger in canals in which the barges leave but little clearance between their bottoms and the bed of the channel, is found in the projection of rocks or stones. A stone, washed into the channel and rolled along under the bottom of a deeply laden barge, may become imbedded in the sole of the canal very firmly and at the same time project sufficiently to tear a leak into the bottom of the next heavily laden boat which comes along. Such cases may be avoided by careful protection of the channel, and in any case the raising of boats in such shallow channels may generally be effected by stopping the leak temporarily by canvas on the outside, and by some form of coffer dam within, after which the water may be removed by pumping. In such instances difficulties sometimes arise from the nature of the cargo, sand or coal getting into the suction pipes and interfering with the pumps, and sugar forming a sticky mass, clogging the valves. Strainers will generally afford protection against solid matter, while sticky materials may be stirred and kept sufficiently dilute to avoid trouble. In some instances boats loaded with lime or plaster of Paris have been sunk, and in the latter case the swelling and hardening material renders the boat a complete wreck, besides forming a solid obstruction to navigation removable only by the use of explosives.

Where pumping, or the use of portable cranes or derricks, is found ineffective success is frequently attained by enclosing the sunken boat with a coffer dam of timber. A modification of this method is found in the use of a sheathing extending the bulwarks of the ship above the surface of the water, and then pumping the entire structure out, the leaks having been temporarily stopped as well as practicable by divers. This plan, when employed in harbours and similar locations is necessarily combined with the action of the tides, and in fact these latter afford most effective auxiliary power in many instances.

The use of air bags, submerged and attached to the hull in a state of collapse, and then inflated by means of air pumps, is a method which has been employed with some success, although their use is attended with difficulties when attempted on a large scale. An ingenious modification, used by M. Dibos, and on an improved system by M. Matignon, is the use of collapsed bags containing calcium carbide. When these are properly secured to the sunken hull, a small quantity of water is allowed to enter through suitable valves, and the large volume of acetylene gas thus produced inflates the bags and furnishes the required flotation.

Naturally the most important apparatus of the salvage engineer consists of the various forms of floating derricks and cranes of high power and stability, these having been built as large as 100 tons capacity, and mounted on pontoons capable of enabling them to be used with a high degree of stability, even with ample overhang. Air-tight caissons are also important accessories in working operations, while powerful pumps, capable of delivering large volumes of water form essential elements of equipment.

M. Dibos devotes a large portion of his paper to a description of difficult operations of actual experience in the salvage of wrecked vessels, showing the importance of the right application of engineering principles to the work. In fact, like all other branches of maritime work, this has become mainly a matter of judicious engineering, employing machinery of special design, and involving a high degree of engineering skill in its use.

Some interesting suggestions are given as to lines along which improvements may be expected in this especial line of work. Thus the peculiar transparency of sea water makes it possible to determine the location of sunken bodies when viewed under favorable conditions. An observer situated at a sufficient height above the water is able to distinguish the position of a submerged body when it would be unobserved if the eye were near the surface. Attempts have therefore been made, with some success, to us captive balloons to assist in the discovery of the correct position for the commencement of operations, and much valuable time in exploration by divers is thus saved.

The Elastic Deformation of Materials.

In computing the resistance of materials on construction it was formerly considered permissible to assume that the materials were practically rigid, and the distribution of stresses was based upon such an assumption, allowance being sometimes afterwards made for the yielding allowable within the limits of the arbitrarily selected factor of safety. It is now understood, however, that no material can be considered absolutely rigid, but that even the most resistent substances are elastic, and it is therefore required, not that no yielding should occur, but rather that such yielding should not produce stresses greater than the elastic limit, so that no permanent deformations may be produced.

At the same time it must be admitted that our knowledge of the elastic action of materials is yet very imperfect, and that the solution of practical problems becomes often difficult and uncertain.

This whole subject is discussed in an interesting manner in a paper by M. A. Mesnager, and published in the *Annales des Ponts et Chaussées,* from which we make some abstracts.

M. Mesnager first examines the principles upon which the elastic theory is based: namely, that the external forces or loads applied to a material are opposed by corresponding internal forces, and that the effects of these forces are independent in their action.

Taking these fundamental principles into account, M. Mesnager proceeds to deduce the conditions of internal equilibrium as well as the fundamental equations of elasticity. For this mathematical portion of the discussion the student must be referred to the original paper. For the present it may simply be stated that the theory shows that elastic deformations are directly proportional to the stresses, so long as the elastic limit is not passed, and that the deformations are independent of each other, even when the forces have not the same direction. It has also been shown, by M. Maurice Levy, that for problems in elasticity in two dimensions the internal efforts are independent of the co-efficients of elasticity, and hence independent of the nature of the material under consideration.

This last fact is of great importance, since it enables us to formulate general laws by experiments upon a limited number of substances; and it is to the portion of M. Mesnager's paper bearing upon this feature that especial attention is directed.

It is a well-known fact that when a piece of glass is examined by polarised light, using a pair of Nicol prisms as polariser and analyser, any internal stresses in the interior of the glass will appear as variations in the intensity and distribution of light transmitted. By arranging a pair of Nicol prisms so that their position at right angles is maintained while the glass under observation may be subjected to various stresses, the internal changes, due to changes in the action of external forces, may be studied. Taking these existing experiences, M. Mesnager has developed the apparatus, especially by the use of monochromatic light, so that it becomes an instrument clearly revealing the position and direction of the lines of force within the glass, thus enabling the theoretical conclusions to be tested experimentally in a very complete manner. Although the usual materials of construction differ from glass in many ways, the action of the forces is the same for all, and the manner of their distribution being definitely ascertained, their magnitude can readily be determined for any desired material.

A number of examples are examined and discussed in the paper, including such cases as those of beams uniformly loaded, and loaded at determinate points, also columns, and extended surfaces. For the details of the observations as well as the mathematical discussions showing their relation to the conditions of actual practice, the reader must be referred to the original paper. It is interesting to observe, however, that in nearly all instances the hypotheses upon which the elastic theory is based were confirmed. It appeared, however, that in many instances quantities which have been considered negligible should sometimes be taken into account, and that it is unsafe to assume that values which appear small in mathematical formulas may not, under certain conditions, become of much importance.

The data and results of M. Mesnager's investigations may well be made the basis for a revision of the existing formulas for the internal stresses in materials of construction, and also may serve to guide the constructor in the disposition of material and especially in the distribution and application of loads. Many formulas are based upon conditions of loading which rarely, if ever, are actually attained in practice. Thus, for example, the formulas for the strength of long columns are based upon the condition of axial loading, a state of affairs which is almost impossible of attainment in practice, and which is frequently altogether ignored by the attachment of brackets and flanges for the very purpose of enabling heavy eccentric and irregular loads to be applied. The study of the influence of such variations from assumed conditions becomes possible by the aid of some such optical method as that employed by M. Mesnager, and the possibilities which the method offers for the scientific study of the internal behavior of materials are almost unlimited.

Petroleum in Java.

The increasing importance of liquid fuel and the progress which has been made in methods for burning crude petroleum lends much interest to the development of petroleum fields in various parts of the world. In a paper recently presented before the Royal Institute of Engineers of Holland by Herr Lambrechtsen van Ritthem, and published in *De Ingenieur,* there is given a general review of the development of the petroleum industry in various parts of the world with some interesting account of the operations in the Dutch East Indies, especially in the residency of Rembang, Java.

Petroleum was known to exist in the Dutch West Indies as long ago as 1863, but the first borings were made in 1871, in the residency of Cheribon, but without much success. Borings in 1889, however, when carried to a depth of 121 metres, struck salt water, gas, and oil, the oil production reaching 34 litres per minute. Since 1890 the entire petroleum industry of the Dutch East Indies has been in the hands of the government company, and the development has been steadily pushed. In 1898 the output was 386,000 tons, or about one-twentieth that of the United States, and it has been increasing ever since.

Herr Lambrechtsen van Ritthem accompanies his paper with a number of photographs showing the spouting wells at Ledok, Semanggi, and elsewhere, and also the extensive refineries at Soerabaja, and these are ample evidence that the government is pushing the development of the industry most effectively. At the present time the commercial products of the Dutch colonies are composed mainly of coffee, sugar, and tobacco, but it is predicted, and with every evidence of truth, that petroleum will form a fourth, equal, if not superior in value to the others.

We have referred elsewhere in this issue to the use of petroleum as an auxiliary fuel on some of the recent locomotives of the State Railways of Java, but in view of the development of the Rembang oil fields, as well as the future possibilities of further discoveries in the Dutch East Indies, it is possible that the use of liquid fuel alone may become the practice in Java, as it already is emnloved on the railways of south-eastern Russia, and on the Black Sea steamers.

The Action of Pump Valves.

It has become well understood by hydraulic engineers that the principal difficulty involved in the operation of pumping machinery at high speeds and under heavy pressures lies in the prevention of shock, due to the inertia of the moving masses of water. The most satisfactory relief from such injurious action has been found in the mechanical operation of the water valves, the opening and closing being effected positively by mechanical appliances connected with the operative mechanism, instead of relying upon the action of the water. The mechanical operation permits high lifts and large openings with few large valves, instead of a number of small ones with small lift, while at the same time insuring prompt and quiet closing at such a timing as to produce the minimum variation in the momentum of the column of moving water.

Although the advantages are well known, and the method has been very successfully applied in practice, there has been a lack of definite information as to the exact behaviour of such valves. In a recent issue of the *Zeitschrift des Vereines deutscher Ingenieure* Herr Rudolph Schröder gives a very complete account of tests made upon certain pumping engines in which the valves were so arranged that they could be operated either mechanically or by the action of the water, and the result is the publication of definite quantitative data of much value and interest.

The investigations were made upon two different machines, one a vertical pumping engine at Rothenburgsort and the other a horizontal machine at Billwärder Insel, both in the vicinity of Hamburg. Both engines were crank-machines, arranged to be operated at speeds of 40 to 50 revolutions per minute, the water valves being operated by connections to eccentrics on the crank shaft. The Rothenburgsort engine was one of those furnishing the water supply to the city of Hamburg, and operated against a pressure of 43 metres while the engine at Billwärder Insel takes the water from the Elbe and delivers it into the settling basins against a head of only 4.3 metres, so that the two machines serve to illustrate very different conditions of operation.

In each case the valves were so arranged that they could be operated mechanically or allowed to be operated by the water against a spring resistance, and the successive observations were taken as closely together as possible, so that but little change in the operative conditions could occur. The investigations consisted in recording the exact lift of the valves upon indicator drums operated by the motion of the pump plunger, diagrams thus being obtained which showed the exact lift at every point of the stroke. In this way the timing of the valves was obtained as well as the absolute lift, and the relative action of the two methods of valve movement compared very precisely.

The motion for the indicator pencils was obtained by means of light rods, resting on the valves, the motion being transferred to the outside of the valve chamber through rocking spindles operating through stuffing boxes. Great care was taken to eliminate the effects of friction as far as possible, and the general characteristics of the diagrams show a consistency in results which confirms their reliability and value.

The results are given in a large number of diagrams which will reward careful study. The lift of the valves is given on a full scale, since the total amount of lift is within the range of the height of the indicator drum, while the stroke, while reduced, is given on a scale sufficiently large to permit the relation of valve-lift to plunger position to be accurately determined.

The performances can only be fully appreciated by a careful study of the respective diagrams, but the general characteristics may be readily described and discussed. In the main the mechanically operated valves show a decidedly earlier time of closing than those operated by the action of the water, although a fuller degree of opening was attained. This is what might be expected, since the movement of the water column must necessarily change itself before it can affect the valves. It is just this action, however, which determines the inertia effects in the operation, and which limits the speed at which the machinery can safely be run.

Apart from the more satisfactory action as regards lift and timing, the investigations show a material economy in power in operating the valves mechanically. In any case a certain amount of power is required, but under high pressures, and at high speeds much more is taken when the water acts as the moving agent than when a positive connection is employed. The experiments at Billwärder Insel show a gain of 15 to 20 per cent. by the use of the mechanical operation over the ordinary spring valves, and similar gain is shown at Rothenburgsort. The questions of wear and tear also enter, and it is evident that the reduction in shock, due to the smoother action, must produce corresponding economy in this respect.

The most advantageous arrangement appears to be that in which the valves are lifted by the action of the water, and closed by mechanical action, using some sort of positive connection with the mechanism of the pump. This permits very light and elastic springs to be used, and if the valves are made as light in weight as possible the delay in opening, in response to the action of the water will be inappreciable. The closing, being effected positively, will be always definitely accomplished as the gear may be set, and this can be done so that practically no shock will be produced, and the minimum of resistance encountered.

The investigations are probably but the first of many which will be undertaken in the same direction, and it will be of interest to observe the results obtained from some of the deep mine pumps fitted with Riedler and similar valve gears. There is no reason why the indicator should not produce as great an effect upon pump design as it has in the improvement of the steam engine, but it is probable that its most effective application will be in connection with valve diagrams, rather than with the record of the operations within the cylinder.

The Standardization of Engine Tests.

NEARLY all tests of materials or machines are made for purposes of comparison, and hence it is most desirable that tests of similar things should be made under comparable conditions. For this reason the report of the committee of the American Society of Mechanical Engineers upon the standardization of steam-engine tests is a document of immediate interest, especially in connection with the discussions which accompanied its presentation at the recent meeting of the Society in Boston. At the outset it must be distinctly understood that the Society in no case "adopts" any course of action as having its authorization, but receives the reports of its committees and makes them public as the expression of the opinions of those whose names they bear. Nevertheless the various reports which the committees of the society have made from time to time have met with wide acceptance from the engineering profession in all parts of the world, and in nearly all cases have crystallized into standard practice because of their inherent merits.

The code which is included in the report of the committee is far too long to be given here entire, but the general principles on which it is based may be indicated and some comments made, the interested reader being referred to the complete paper for details.

In the first place the performance of a steam engine is made on a heat unit basis. This is eminently wise, since it is the only true basis on which a heat engine can be scientifically examined.

This does not interfere with the time-honored term "horse power" since the relation between the two is definite and simple. It is only necessary to know whether the horse power is indicated or brake, and we can express the economy of a steam engine in terms of the number of heat units consumed per hour per horse power (brake or indicated), and obtain proper standards of comparison. There are naturally other ways of expressing engine performance, such as the hourly weights of coal, gas, oil, or other fuel, or the weight of steam consumed per horse-power-hour, but these are all convertible into their equivalent heat-unit values.

In the opinion of the committee the heat consumption of a steam engine should be ascertained by measuring the quantity of steam consumed by the plant and crediting the total heat of the entire quantity with that portion rejected by the engine which is utilized and returned to the boiler. In such determinations the committee includes the entire equipment of the steam plant which is concerned in the production of power in the term "engine," believing that the use of the heat-unit standard renders it obligatory that the engine should be charged with the steam used by all necessary auxiliaries. While this may be logically correct, it is not always possible to do so, nor it is usually commercially satisfactory, since the various auxiliaries, such as condensers, pumps, etc., are frequently furnished by other makers than the engine builders. It appears to be most desirable that the various auxiliaries be tested separately in such a manner that the results may be summed up in a total, and at the same time be capable of independent consideration. Especially is this the case in view of the introduction of the independent central condensing plant, in which a number of engines discharge into one general condenser, having its own air and circulating pumps and operating independently of any of the engines from which it receives steam. Such a condenser is as much an independent piece of apparatus as is the steam generating plant, the one forming a positive and the other a negative pressure reservoir, the engine being placed between.

In the rules for conducting the trials it is recognized that tests are made for various purposes, sometimes to determine the fulfilment of a contract guarantee, at other times to ascertain the working economy of the engine alone, and sometimes to determine the performance of the entire power plant, including the steam generating portion. The code for boiler testing, prepared by a committee of the society, provides fully for that portion of the latter test, and the present code completes the subject for formulating the rules for engine testing in a similar manner.

Without going too fully into details, we may comment upon some matters connected with engine testing which are suggested by the code. In the first place, the fundamental data depending upon the construction of the engine should be furnished by the maker when the engine is delivered to the purchaser, as some points can be determined far more readily during construction than afterwards. Thus the clearance is usually measured from the drawings, or by weighing the quantity of water required to fill the space when the piston is at the end of the stroke, either method being unsatisfactory. The water method, however, could readily and accurately be applied in the shop, and the true clearance at each end furnished to the purchaser for subsequent use at any time. A wire gauge showing the exact bore of the cylinder should also be furnished, and replaced by a new one should the cylinder at any time be re-bored. A correct indicator reducing motion should form a portion of every engine, being as necessary to a modern plant as any other part of the machine. A little forethought in providing valves and connections in the piping will enable the tightness, or otherwise, of the engine to be ascertained in a few minutes, when it might be necessary to perform much annoying work to determine the presence or absence of leaks under ordinary conditions. The present report will have done much to advance steam economy if it draws attention to the provision of proper testing facilities as a fundamental part of a steam plant, and renders frequent testing convenient and inexpensive.

While the report countenances the use of water meters, insisting only upon their proper calibration, the discussion showed that little reliance is placed upon meters as instruments of scientific precision. The only reliable method of measuring water for a test is that of weighing it; or, for very large volumes, the discharge of a properly calibrated orifice, under constant head, may be substituted.

Indicator diagrams should be taken very frequently, the instruments having been carefully calibrated, but it is not necessary that simultaneous diagrams should be taken from both ends of a cylinder since the law of averages provides fully for any slight variations, if enough diagrams are taken. Speeds are best taken by the readings of a counter during the entire test, the difference in readings divided by the number of minutes giving an average which is more reliable than any isolated counting.

An interesting question brought up in connection with the rating of steam engines is the proportion of overload which an engine should reasonably be expected to stand. It is undoubtedly true that a steam engine should have a certain reserve capacity, but too high an overload capacity renders an engine less economical than if it is proportioned more closely to its usual operating load. The committee recommends that when an engine is operating at its rated power at a given pressure there should be a sufficient reserve to allow a drop of at least 15 per cent. in the gauge pressure without a sensible reduction in the working speed, and to allow an overload at the stated pressure of 25 per cent. This matter, however, is one which can hardly be controlled, for mill owners are altogether too prone to throw on more and more load as business increases, and the overload limit gradually becomes encroached upon, and often attained as a constant working load.

Taken as a whole the report is an admirable one, and the weight of the names appended to it will assure for it an authoritative standing.

Steam Pipe Coverings.

The loss of heat by radiation from pipes through which steam is flowing on its way from the boilers to the engine or other point of useful application has long been considered by the engineer as a matter requiring consideration, and in nearly every modern steam plant some form of pipe covering is employed to diminish this loss.

A great variety of materials has been proposed for use in this connection, and pipe coverings form a regular article of commerce in most places wheres team is used

The relative value of the different materials which have been used for pipe coverings has been a fruitful subject for discussion, but since the investigations of Ordway, a number of years ago, there has been no scientific investigation of the matter until the recent experiments of Mr. George H. Barrus, the data and results of which were presented by him before the recent meeting of the American Society of Mechanical Engineers. The method employed in the tests was that of measuring the condensation of steam occurring in the pipes protected by the various coverings, in comparison with the condensation produced under similar and simultaneous conditions in uncovered pipes.

"The condensation test furnishes a method which is entirely satisfactory, not only in its practical aspects, but in its scientific bearings. The heat radiated from a steam pipe causes a portion of the enclosed steam to be condensed, and the quality of heat-radiated is exactly proportional to the weight of steam condensed, this being a well established scientific fact. It is a matter of extreme simplicity to ascertain the quantity of steam which is condensed, for it is merely a question of weighing the resulting water on ordinary weighing scales. The quantity of radiated heat which the condensation represents is determined with equal facility by reference to the well established tables of the properties of steam. It seems quite unnecessary, therefore, to consider any other method of testing radiation from steam pipes, when the condensation method is so readily and accurately used, and when its results are determined with such reliability as to leave nothing further to be desired. A matter, of the first importance, moreover, is that this method determines the exact thing for which non-conducting material is applied to steam pipes, which is, the quantity of condensation prevented, and the saving of fuel which covering the pipes secures.

"Condensation tests require, first, that the steam supplied to the pipes, which are subject to test, shall be at the outset free from condensation; in other words, dry steam. They require, second, that all the water condensed shall flow by the force of gravity to some low point from which it can be readily and completely drawn off for measurement. They require, third, that the surfaces of the pipe within shall be continuously supplied with steam, and that no air held in suspension by the steam shall collect at any point and prevent its contact with the surface. They require, fourth, that the water of condensation drawn off from the apparatus, which under the effect of the pressure of the steam in the pipe is at a temperature much above 212 degrees, shall be cooled on its escape to the weighing receptacle, so as to prevent loss of water by evaporation. The apparatus used on these tests was so arranged as to accomplish all the objects noted."

Previous tests which have been made for the measurement of the efficiency of pipe coverings have been upon a rather small scale and for short periods of time, but these tests included surfaces from 60 to 100 square feet in area, and extended over a month of time, during eight or nine hours each day, so that the results may fairly be considered as representative of actual working conditions.

In the first place the condensation occurring in the bare pipes furnishes some interesting information in a general way, showing as it does, the rate of transmission of heat which may be expected in pipes of 2 and 10 inches in diameter, exposed to the air. With a difference of about 300 degrees F. between the temperature of the steam and external air, the mean of the tests showed a transmission of about 3.2 British thermal units per square foot per hour per degree F. This determination alone is a valuable addition to the constants of steam engineering, especially as it has been obtained under conditions closely similar to those obtaining in the heating of air by steam pipes, and it will doubtless prove very useful in future computations for steam heating appliances.

The pipe coverings tested included those in extensive use in modern engineering practice, including asbestos, magnesia, different kinds of air-cell coverings, as well as asbestos hair-felt, and the results are given both in the form of tables and as graphical diagrams. The most interesting thing about this portion of the paper is the slight difference which appears in the value of the different coverings, all of them indicating the great value of some form of covering, and showing the small choice existing between those tested.

Mr. Barrus calls attention to the fact that it has long been known that the most efficient covering, as regards merely the non-ducting properties, is hair felt, and the tests showed that those coverings which approached the most closely to hair felt in physical characteristics gave the best results. The reason for the superiority of hair felt is the fact that this covering divides up and entraps the air which it contains in a better manner than any other material commonly used, and it is the non-conducting properties of confined air upon which the efficiency of the covering depends. The only reason for using other materials, therefore, is to obtain a higher degree of durability, and this, in connection with the cost, becomes the controlling factor in the choice of a covering.

Compared with the bare pipes, it appears that the efficiency of the various coverings tested was about 80 per cent., or in other words, the condensation of the steam in the covered pipes was only about one-fifth of that which took place in the bare pipes. Mr. Barrus gives some interesting computations as to the money value of the coverings, this manifestly being dependent to a certain extent upon the first cost of the covering and the life before renewal, but in all cases the gain due to the saving of steam is greatly in excess of the expenditure, and the showing is such as to convince any one of the great economy in providing the best possible covering for all exposed steam pipes.

Water-Tube Boilers.

Although it is admitted that the ideal design for a marine water-tube boiler has not yet been produced, the extent to which existing forms have entered into current practice is evidence of the merits of the system, broadly considered. In a careful review of the present types for marine service, compared with cylindrical boilers, by Mr. Ernest N. Janson, in a recent issue of the *Journal of the American Society of Naval Engineers,* the whole subject is treated systematically, and some interesting points developed.

As Mr. Janson well says, the present prominence of the subject is partially, if not largely due to the apparent failures of certain types, and hence a critical review of the details of construction of water-tube boilers is timely. In a water-tube boiler the methods of construction determine to a great extent the adaptability for marine service, since designs giving excellent primary results may be lacking in features necessary for useful life in service. There is no doubt that the present unsatisfactory condition of the water-tube boiler question in the British navy is largely due to the unsuitability of the type chosen for the first installations, and the lesson has been both expensive and annoying.

That the water-tube boiler is undoubtedly to be the accepted general type for naval service, is conceded, and the only points to be examined, therefore, are those which go to make up the most acceptable design, indicating the lines along which development and improvement may be expected.

The advantages of water-tube boilers over those of the shell of cylindrical type are distinct and undoubted. In comparison of the two types the difference between the items of weight, space, steam pressure, economy, and facilities for installation appear most notable. In regard to weight and space the water-tube type shows a notable advantage. As regards pressure, the limit in cylindrical boilers appears to be reached at about 210 pounds per square inch, although as high as 225 is being used. The water-tube boiler, on the contrary, has a very wide margin, and pressures can be carried with safety far beyond the requirements of the present style of marine engines.

The cylindrical boiler is generally credited with possessing a higher degree of economy than the water-tube type, but this is not altogether warranted. There is no reason why the water-tube boiler should not be fully as economical as the cylindrical boiler, and when such results are not attained it can usually be traced to some defect in the installation or operation. The water-tube type permits of the use of ample furnace space, and the employment of heated air supply is readily accomplished. Proper baffling will keep the temperature of uptake gases down to an economic limit, and with proper construction and care the loss from air leaks into the casing can be practically prevented.

Mr. Janson reviews in detail the construction of the principal water-tube boilers in the market, showing their merits and defects for naval use, and emphasises the importance of simplicity in construction, and convenience for repair and cleaning on shipboard, away from the shop or navy yard.

In the earlier history of the introduction of water-tube boilers into naval service, the natural conservatism of naval engineers led to the use of both water-tube and cylindrical boilers in the same vessel, the latter being employed for cruising and port service, and the former held in reserve for sudden demands for speed in action.

At the present time, however, there appears a tendency in the equipment of new naval ships, to install water-tube boilers to the entire exclusion of the ordinary cylindrical boiler. This is well shown by the progressive practice in the German navy, a service which has always been most cautious and conservative as regards changes in important details. At first the proportion installed was about 35 per cent. of water-tube boilers and the balance of the cylindrical type, while in the two latest German battle ships the water-tube boilers form 70 per cent. of the whole, and the last contemplated cruisers are planned for water-tube boilers throughout.

For cruisers and battle ships the large-tube type of boiler has been generally installed, although there have been numerous appeals in favor of the small-tube express types for this service.

Each type, however, appears to be adapted for a special service. The small diameter bent-tube boiler is considerably lighter in weight so long as it is arranged for service in torpedo boats, because the tubes, on the whole are made much lighter, as they can well afford to be, on account of the more limited service to be expected from this class of boats. The heating surface is also provided in more liberal proportions, owing to a possibly excessive amount of forcing; this, however, cannot be had without occupying additional space. This extra space is easily provided for in the class of boats mentioned, due to the usual arrangement of the boilers, they never being placed side by side. Should this class of boilers be chosen for large ships, their weights at once increase on account of the heavier tubes and larger drums required, and become almost as high as any type of large-tube boilers. Excessive forcing cannot be permitted in such service, and hence still more space will be required.

In addition to these disabilities, arising as soon as this type of boilers is made to fit the conditions to be met when used in large installations, the question of cleaning the boilers becomes of great importance. Every two or three days some of the boilers require to be laid up for this purpose, with attending inconveniences in the cruising routine.

The boiler for continuous working, with provisions for keeping it in an efficient state and with the least liability of being thrown out of commission on account of the failure of some of its more or less important appurtenances, is the type to be first considered, and these requirements can, apparently, better be met in types containing comparatively large and straight tubes. The matter of first cost should always be considered in connection with other important points, such as life of boiler, repairs likely to be required, and the economic results while in actual service, but if any one boiler possesses a decided advantage over another in these latter points it should be adopted without regard to its possibly extra cost.

Education and Engineering.

ENGINEERING education is a subject which has been thrashed out so many times that it seems as if little more could be presented at this time, but the subject of the presidential address of Mr. Robert Moore at the recent convention of the American Society of Civil Engineers consisted of a different phase of the question. That is to say, he emphasized the importance and even the necessity that the engineer of the twentieth century should be a man of broad general education as well as one well trained in his specialized profession.

"Until very recent years the engineer, as a man of learning, even in his own profession, has not been the peer of the clergyman, the teacher, the lawyer or the physician. In fact, speaking broadly, engineering has not been one of the learned professions. And for this the reasons are not far to seek. As a distinct profession, that of the engineer is much younger than those just mentioned, and, what is even more to the point, the sciences which set forth the laws that govern the materials and forces of nature and underlie engineering works, are all of recent development."

Naturally the earliest engineers were the priests, following whom came the builders of the mediaeval cathredals, bridges, and castles, but in all these instances the engineering was a minor part of the knowledge of the individual. As time passed on the field expanded and the work became specialized, so that the engineer, as a rule, found that it required all his time to acquire his professional experience, and general education became a secondary consideration.

"The structures which the first engineers were called to build, while they demanded skill and courage and judgment, called for little of the learning found in books. Some practical skill in arithmetic and geometry, and, possibly trigonometry was the limit of the scientific knowledge required. Engineering was an art, and not a science, and the engineer was little more than a highly skilled workman. As in all the arts, the standard method of instruction was that of apprenticeship, in which by word and by example the master slowly transmitted to his pupil the art and mystery of his craft. James Brindley, builder of the first important English canal, was a cotter's son and served seven years as a wheelwright's apprentice. George Stephenson, builder of the first successful locomotive and railway, was eighteen years of age before he learned to read. Thomas Telford, builder of roads and bridges, and first President of the Institution of Civil Engineers, was the orphaned son of a shepherd, and served a seven years' apprenticeship as a stonemason. Smeaton and Watt were mathematical instrument makers, and both men of considerable training, but as engineers they were almost wholly self-taught."

With the development of scientific research and the applications of scientific methods to engineering the engineer must have a scientific training, and the growth of the modern engineering school is witness to the extent to which that side of the question has been developed. This is the branch which is fully and widely understood by the term engineering education. Beyond this, however, there is needed for the proper equipment of the engineer a broad training in the other departments of human knowledge.

"For we cannot know anything correctly except as we know its limits and its place in the general system of things. Even the place where we stand on the earth cannot be accurately located except by its co-ordinates of latitude and longitude, which define its position with reference to the whole globe. Every well trained professional man, therefore, must have, as part of his equipment, the broad outlines of general knowledge. He must know something of language and literature, of political science and of history, something of what the world's workers have done and of what its thinkers have thought, in order that he may correctly understand and evaluate the knowledge peculiar to his own calling. To know every thing about something, which is his business as a professional man, he must also know something about everything.

"A broad basis of general knowledge such as shall put the man in touch with all times and with all men must, therefore, precede the special knowledge of the technical school. Otherwise there may be much mastery of detail, a microscopic thoroughness, but not the firm grasp and clear insight which the broader training gives. In fact, if a choice must be made, it is better to shorten, or even to omit, the training of the technical school, leaving the man to supply this deficiency for himself, rather than to sacrifice the broader outlook and the wider sympathy which is given by the more diversified training in the outlines of general knowledge.

"It is safe to say, therefore, that in the new century he who aims at the highest success as an engineer must be a more learned man than his predecessor of the last century. He must be master of the strictly engineering sciences and as a basis and introduction to these he must have the wider training of the preparatory school and the college.

"For it must never be forgotten that for real success in any calling, be it that of the professional man or the man in political or commercial life, there is needed something which neither books nor schools alone can teach, something which is partly the result of inherited qualities and partly the result of our daily contact with men and things, something which is the resultant of the reaction of our inheritance upon our environment, and which we sum up in the word character. Before there can be real power in any walk in life there must, in addition to technical training, be energy, veracity, self-respect, courage and address. That is to say, before we can have the able engineer, or the worthy exemplar of any profession we must, first of all, and more than all, have a strong and worthy man."

Electricity in Naval Service.

THE paper of Mr. Walter M. McFarland, presented before the American Institute of Electrical Engineers, upon electricity in the navy, is of much value for many reasons, but space will permit an abstract of but one portion of the subject at the present time.

Mr. McFarland drew attention to the fact that under the present rulings the naval authorities in charge of electric apparatus still limit all electric machinery on shipboard to that operated by direct current. This practice he believes to be a mistaken one, and he emphasised the great advantages of alternating current apparatus on shipboard. These advantages are based upon the simplicity of the apparatus, and its ability to stand the difficult usage of naval practice.

From the very nature of things the electric apparatus is to a considerable extent handled by men without a great deal of skill, the chief of the Bureau of equipment having called attention to this fact in his recent reports. Now the induction motor, with its extreme simplicity and ability to stand abuse and neglect, seems much better adapted to the general run of conditions on board ship than the more delicate direct-current motor. With its ability to stand a tremendous overload and even temporary stoppage, it would answer for driving capstans and even steering gear, from which the direct-current motors have thus far been barred out. It would also seem admirably adapted for such work as driving the forced draft blowers for the fire rooms, which are usually located in almost inaccessible places and where the steam engines now used to drive them rarely receive adequate attention when the blowers are driven at full power.

The demand for direct current for search lights and similar special service could readily be supplied by a separate generator, but as this has been decided in any case, there can be no difficulty of that score.

Although induction motors are as yet barred from use on shipboard, there have been numerous successful installations of them on shore in naval stations. Thus at the ordnance proving grounds and powder factory at Indian Head, Md., induction motors have been used for about three years with entire success, their especial advantage in that connection being their freedom from sparking. At the Brooklyn Navy Yard alternating current generators are used with induction motors for the tools, the whole plant being an excellent illustration of the most advanced practice in the powering of a modern engine-building plant.

With these examples before the continual observation of naval officers, there is every reason to believe that the entire practicability of the induction motor will be demonstrated for use on shipboard as well as on shore, and it is the opinion of Mr. McFarland that the permission to use alternating current on the vessels of the United States navy would result in the installation of a greatly increased number of motors.

Liquid Fuel Combustion.

THE advantages of liquid fuel have been appreciated for many years, but the practical difficulties connected with its complete and economical combustion have delayed its use in many instances.

The usual methods of burning oil is to employ compressed air or superheated steam to pulverize the liquid and deliver it into the furnace in the form of an atomized mixture of oil, steam, and air.

During the past few years, Mr. Charles E. Lucke has conducted some very interesting experimental work at Columbia University, and a paper containing his results was presented by Mr. R. H. Fernald at the recent meeting of the American Society of Mechanical Engineers.

The paper relates the details of a number of experimental methods which are interesting mainly in that they lead up to the very simple and effective apparatus which was finally adopted. Instead of vaporising or spraying the oil by any mechanical means, Mr. Lucke delivers the liquid fuel directly into the mass of a body of broken rock, this rock having already been raised to a red heat by means of a gas flame. The hot rocks vaporize the oil, which burns as a gas, the heat produced sufficing to maintain the temperature of the rocks necessary to vaporize the oil thereafter.

In describing the action of this method, Mr. Lucke says:

"The air and oil impinge together on the hot mass, spreading out in constant velocity surfaces; the combustion takes place on that surface where the velocity is equal to the rate of propagation and in the passage the oil automatically vaporizes by contact with the same rocks which make the explosive fire possible, and all this happens without diffusion with the products of previous combustion. Thus the function of the rocks becomes complicated; first, starting with gas the explosive fire is made possible by their presence, and the result is the heating of the entire mass from top to bottom, the mass thus heated is a perfect vaporizer for the oil, which, fed with its air makes an explosive mixture and maintains the temperature of the rocks, the whole interrelated series of actions and reactions producing what I have named the 'explosive oil fire.'

"Were the proportions not explosive the interior of the mass would chill and the vaporization would stop. It is a very striking experiment to withdraw the nozzle from the intensely glowing mass of rock, of a properly working fire, and note the oil drip, drop by drop, giving off each time a dull red flash and a cloud of smoke, while the whole rock mass cools down; a re-insertion of the nozzle causes at once a resumption of the intense rapid high temperature combustion. And, secondly, by a simple change of proportion observe an instant cessation of the action, producing first smoke and then total extinction.

"It need only be remarked that with every oil tried the action was the same; and three fires side by side, burning respectively kerosene, cylinder oil, and linseed oil, showed no difference in action. The so-called residue oils leave no residue this way. The experiment of feeding the several oils successively through the same fire without interruption resulted in no apparent change of action."

In the original experiments fire brick was used, but the intense heat of the fire was sufficient to fuse the fragments together, and better results were obtained with magnesite.

This method of burning liquid fuel permits results practically similar to gas firing to be obtained under steam boilers, and in all kinds of furnaces, but the principal application which the designer had in mind was the direct combustion of for the construction of an internal-combustion engine working by increase of volume at constant pressure. In this connection it is interesting to call attention to the early experiments of Brayton along similar lines about thirty years ago. There seems to be little doubt that an efficient internal-combustion engine of the Brayton type may be made in the light of the experiments of Mr. Lucke, and the ability of such a motor to burn almost any kind of liquid fuel would be not the least of its advantages.

By adopting this method of burning liquid fuel it becomes practicable to maintain combustion in a closed vessel continuously, the air being supplied with the liquid fuel under pressure and the products of combustion, greatly augmented in volume, delivered into another chamber, from which they proceed to the motor. The pressure of air and fuel can be maintained by a pump driven by the motor, precisely as was done by Brayton, the pressure of compression being somewhat higher than the resulting pressure of combustion, this maintaining the flow of air and fuel.

The resultant products of combustion might be delivered to a double-acting cylinder engine, similar to an ordinary steam engine, or probably to better advantage they might be permitted to impinge upon the blades of a gas turbine of the de Laval type, this having the advantage of avoiding the use of a water jacket, and probably permitting a high degree of efficiency to be obtained. Many similar applications will doubtless suggest themselves, and future experiments will decide the details of construction.

THE ENGINEERING INDEX

"THE ENGINEERING INDEX IS THE KEYSTONE OF APPLIED SCIENCE"

The following pages form a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world,—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

We supply the articles themselves, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

CIVIL ENGINEERING

BRIDGES.

Arch.

Design of a Concrete-Steel Arch Bridge. Daniel B. Luten. Explains in detail a method used by the writer during the past year in erecting 16 bridges, which is thought to eliminate some of the doubtful factors. 5600 w. Eng News—May 8, 1902. No. 48026.

Basel.

The Competition for the Middle Bridge over the Rhine at Basel, Switzerland (Der Wettbemberb um den Neubau der Mittlern Rheinbrücke zu Basel). Carl Bernhard. A well illustrated review of the design which received the second prize, a steel cantilever with a single architectural pier in the center of the river. 2000 w. Zeitschr d Ver Deutscher Ing—April 19, 1902. No. 48227 D.

Bridge Moving.

Moving the Ft. Wayne Bridge at Pittsburg. Illustrates and describes a movement made necessary by the necessity of erecting a new bridge of greater strength. 1800 w. Ry & Engng Rev—May 3, 1902. No. 47963.

Dams.

See Civil Engineering, Construction.

Loadings.

Specified Loadings for Railroad Bridges. Ward Baldwin. A list of loadings specified in 1901 by the railroads more than 100 miles long, in the United States, Canada and Mexico, and comparison with those specified in 1893. 2000 w. R R Gaz—May 2, 1902. No. 47943.

Luxemburg.

The Great Luxemburg Arch. Illustrates and describes this great arch now in course of construction. It has a span of 277 ft. 1500 w. Engr, Lond—May 2, 1902. No. 48057 A.

The Luxemburg Bridge from the View Point of an American Designer of Masonry Arch Bridges. Albert W. Buel. An illustrated article discussing features of the design and construction. 3700 w. Eng News—May 8, 1902. No. 48023.

Plate Girder.

Single-Track Plate Girder Railroad Bridges at Richmond, Ind. Illustrated description of the details of erection of some large plate-girder spans. 2200 w. Eng Rec—May 17, 1902. No. 48130.

Quebec.

The Quebec Bridge. E. A. Hoare. An illustrated description of the new cantilever bridge over the St. Lawrence near Quebec. 2800 w. Can Engr—May, 1902. No. 47915.

Skew Bridge.

A Heavy Double-Track Skew Bridge. Illustrated description of a 237-ft. truss bridge with solid floor. 1700 w. Eng Rec—May 10, 1902. No. 47998.

Suspension Bridge.

Cable-Making on the New East River Bridge, New York. A description of the method of laying the wires for a suspension bridge with cables 2,985 ft. long. 2200 w. Eng Rec—May 3, 1902. No. 47860.

Cable Making on the New East River Bridge. An illustrated description of this interesting work. Each cable will be composed of 7696 wires, and have a strength of 200,000 lbs. per sectional square inch. Describes the process of cable making, the changes introduced, and the system of anchoring the cables. 1400 w. Ir Age—May 8, 1902. No. 47965.

Thusis, Switzerland.

The Rhine Bridge of the Albula Railway at Thusis, Switzerland (Die Rheinbrücke der Albulabahn bei Thusis). A well illustrated account of a steel deck bridge, 269 ft. span, in Eastern Switzerland. Serial. 2 Parts. 3000 w. Schweiz Bauzeitung—April 12 and 19, 1902. No. 48272 each B.

CANALS, RIVERS AND HARBORS.

Breakwater.

The New Breakwater at Port Colborne, Ontario; Welland Canal Entrance. Describes extensive improvements being made by the Canadian government at the point where the Welland Canal leaves Lake Erie. Also gives briefly the history of the canal, with report of its traffic and existing works. Ill. 4500 w. Eng News—May 15, 1902. No. 48108.

Canals.

Canal Improvements in France. A project for internal improvement now being discussed, which may cost $193,000,000. 600 w. U S Cons Repts, No. 1337—May 9, 1902. No. 47991 D.

Canal Traction.

See Electrical Engineering, Power Applications.

Docks.

Floating Docks. Illustrates and dscribes details of the Bermuda dock and the Algiers dock. 1000 w. Engng—May 2, 1902. No. 48063 A.

Dredge.

Sea-Going Bucket Dredge "Hephaestos" with Floating Pipe Line (Seetüchtiger Eimerbagger "Hephaestos" mit Schwimmender Rohrleitung). E. Kleinrath. A well illustrated description of a dredge built by Smulders for service in China, with a pipe line for discharging the dredged material supported on iron casks. 1 Plate. 3000 w. Zeitschr d Ver Deutscher Ing—April 19, 1902. No. 48226 D.

Dry Docks.

Reconstruction of the Pontanion Dry Docks at the Brest Arsenal (Reconstruction des Formes de Radoub de Pontanion dans l'Arsenal de Brest par M. Adrian Hallier). G. Richou. An illustrated account of the work of enlarging and modernizing dry docks for large naval vessels. 1 Plate. 5000 w. Mem Soc Ing Civils de France—Feb., 1902. No. 48409 G.

Reconstruction of the Pontanion Dry Docks at the Brest Arsenal, France (Reconstruction des Formes de Radoub de Pontanion dans l'Arsenal de Brest). G. Richou. Illustrated description of enlargement and modernization of old dry docks for battleships and cruisers. 1 Plate. 3500 w. Génie Civil—May 3, 1902. No. 48287 D.

Floods.

General Discussion on the Discharge of Streams. On the influence of floods and protection from them. 4700 w. Pro Engrs' Club of Phila—April, 1902. No. 47845 D.

Isthmian Canal.

The Choice of Isthmian Canal Routes. John T. Morgan. Presents the advantages of the Nicaragua route, and disadvantages of the Panama route. 5600 w. N Am Rev—May, 1902. No. 47834 D.

The Conditions Governing the Panama and the Nicaragua Canal Routes. George S. Morison. An address before the Massachusettts Reform Club. States the advantages of the two routes in a general way, but favors the Panama route. Also discusses the reasons why a canal should be built. 6000 w. R R Gaz—May 9, 1902. No. 47967.

The Isthmian Canal. Briefly reviews the suggested routes, especially discussing the Panama and the Nicaragua routes, and the problems in connection with each. 5800 w. Locomotive—March, 1902. No. 48083.

The Proposed Inter-Oceanic Canal. The first of a series of articles discussing the present outlook of this project, the routes favored, causes of delay, and matters of interest connected with the undertaking. Sections of the Nicaragua route are given. 2500 w. Engr, Lond—May 2, 1902. Serial. 1st part. No. 48056 A.

River Improvement.

Improvement of the Black Warrior, Warrior and Tombigbee Rivers, in Alabama. R. C. McCalla. An illustrated article giving detailed description of work to cost about $5,000,000. 11500 w. Pro Am Soc Civ Engrs—April, 1902. No. 47826 E.

The Improvement of the Channels of the Delaware and Schuylkill Rivers by the City of Philadelphia. An illustrated article stating the projects, giving details of the work and of the methods and machinery used. Also discussion. 9800 w. Pro Engrs Club of Phila—April, 1902. No. 47844 D.

Spillways.

The New Spillways of the Pribram Reservoirs (Die Neuen Ueberlaufgerinne der Pribramer Hauptteiche). Julius Divis. An illustrated account of improvements to safeguard the dams and reservoirs at a large Bohemian silver and lead works and mines. 2000 w. Oesterr Zeitschr f Berg u Hüttenwesen—May 10, 1902. No. 48268 B.

Stream Gauging.

The Figdor Indicator for Measuring the Velocity of Water (Der Wassergeschwindigkeits-Indicator System Wilhelm Figdor). Illustrated description of apparatus for measuring the velocity of flow in streams. An electric circuit is closed at every revolution of the vane, and a train of wheels set in motion. A recording apparatus is also shown. 1500 w. Oesterr Wochenschr f d Oeffent Baudienst—May 3, 1902. No. 48220 B.

CONSTRUCTION.

Building Construction.

Erection of the New York Stock Exchange Building. Illustrated description of the method of building a steel frame so heavy that bridge erection methods had to be adopted. 2300 w. Eng Rec—May 24, 1902. No. 48193.

Setting Heavy Columns in the Hall of Records, New York. Describes the method of handling granite columns 4½ feet in diameter and 36 ft. long. 900 w. Eng Rec —May 10, 1902. No. 48005.

The New York Stock Exchange Building. Illustrated description of the heavy steel-work in a 150 x 150 ft. building having an unusual arrangement of rooms. 2600 w. Eng Rec—May 17, 1902. No. 48-135.

Coal Pocket.

Steel and Concrete Coal Storage Plant. Franklin M. Bowman. The Lowell Gas Light Company's coal pocket is described in detail. It is fireproof. Ill. 2000 w. Trans Am Soc Mech Engrs, No. 0950—May, 1902. No. 47987.

Cofferdams.

Interlocking Steel Sheeting in Cofferdam Construction. Illustrates and briefly describes a new method of interest being employed in the construction of the substructure of the Randolph St. bridge in Chicago. 500 w. Ry Age—May 2, 1902. No. 47960.

Dams.

A Proposed New Type of Masonry Dam. George L. Dillman. States the definite requirements of masonry dams, and suggests a new type, according to these requirements, which will contain less masonry, for the same factor of safety, than any of the recognized "standard types." 2000 w. Pro Am Soc of Civ Engrs—April, 1902. No. 47825 E.

Description of a Dam and Accompanying Works Built for the Water Commissioners, London, Ont., at Springbank. J. A. Heaman. Description and drawings showing the nature of the works, which consist of a concrete dam, retaining walls, etc. 2500 w. Can Soc of Civ Engrs, Adv. Proof —April 24, 1902. No. 47832 D.

The Bohio Dam. Continued discussion of paper on this subject, by George S. Morison. Ill. 10300 w. Pro Am Soc of Civ Engrs—April, 1902. No. 47827 E.

Fire-Resisting.

Fire-Resisting Construction. R. Clarence Backhouse. Read before the Inst. of Archt's., N. S. W. Discusses methods of construction, especially aiming to find something inexpensive but effective. 3600 w. Aust Min Stand—April 3, 1902. No. 48160 B.

Foundations.

A Foundation Failure and its Reconstruction. Illustrated description of interesting work acomplished under difficulties. 1700 w. Eng News—May 1, 1902. No. 47940.

Some Observations on the Deep Pneumatic Work of the New East River Bridge Foundations. Edwin Duryea, Jr. A general description of special features of the work; the compressed air conditions, caisson sinking, material encountered, temperatures, etc. 4500 w. Eng News—May 1, 1902. No. 47941.

Undermining the Decker Building, New York. Illustrates and describes the method used in carrying long sections of wall, 185 ft. high and weighing 12000 tons, by means of unusually heavy beams and shores. 2500 w. Eng News—May 10, 1902. No. 48002.

Masonry.

Graphical Design of Retaining Walls, Dams, Abutments and Bridge Piers with Plane and Curved Surfaces (Graphostatische Verfahren zur Directen Dimensionirung von Stütz und Staumauern, Widerlagern und Brückeupfeilern mit Ebenen und Gekrümunten Begreuzungsflächen). Josef Schreier. Grapical methods for masonry structures, with formulae and diagrams. 6000 w. Zeitschr d Oesterr Ing u Arch Ver—April 25, 1902. No. 48222 B.

Roads.

Highway Construction. E. R. Buckley. Discusses principally the character of the pavement to be constructed and the methods employed, but also considers other matters related to this subject. 7000 w. Jour Assn of Engng Socs—April, 1902. No. 48086 C.

Some Observations upon the Binding of Sand by Stone Dust. Halbert Powers Gillette. Outlines a theory that if correct would make it possible to bind clean sand with fine stone dust forming a macadam, and aims to show that such a phenomenon occurs. 1100 w. Eng News—May 15, 1902. No. 48115.

Streets and Roads. James H. McDonald. Shows the severe usage of the city pavements of the present, discussing the six pavements now generally adopted in large cities, and their construction. General discussion follows. 9500 w. Jour Assn of Engng Soc's—April, 1902. No. 48085 C.

The Selection of Materials for Macadam Roads. Extracts from a report by Logan Waller Page on the properties of road materials suitable for different classes of traffic. 3100 w. Eng. Rec—May 17, 1902. No. 48132.

Simplon Tunnel.

The Construction of the Simplon Tunnel (Der Bau des Simplon-Tunnels). Hr. Molsen. A paper before the Hamburg branch of the Verein deutscher Ingenieure, givin a general account of this great Swiss-Italian tunnel and its construction. 3000 w. Zeitschr d Ver Deutscher Ing—May 3, 1902. No. 48237 D.

Tunneling.

Construction of the Metropolitan Railway, Paris. Illustrated description of tunneling operations with and without shields, sometimes along the route of large sewers. 3400 w. Eng Rec—May 24, 1902. No. 48191.

MATERIALS.

Brickwork.

Experiments with a Division Wall (Versuch bezuglich der Standfestigkeit einer Scheidemauer). Karl Stigler. Illustrated description of experiments with a brick wall, where part was removed and part remained in place. 600 w. Zeitschr d Oesterr Ing u Arch Ver—May 2, 1902. No. 48225 B.

Cement.

The New Swiss Standards for Hydraulic Cements (Die Neuen Schweiz, Normen für Hydraulische Bindemittel). A comparison of the old standards for cement and cement testing and those recently adopted by the Swiss Cement Manufacturers' Association and Swiss Engineers and Architects Society. 2000 w. Schweiz Bauzeitung—April 10. 1902. No. 48274 B.

The Portland Cement Industry in Michigan. Its history as given by Prof. Israel C. Russell in the Annual Report of the U. S. Geol. Survey. 1200 w. Sci Am Sup—May 17, 1902. No. 48105.

Columns.

Resistance of Materials. The Stability of Loaded Columns (Résistance des Matériaux Etude sur la Stabilité des Pièces Chargées Debout). Gus L. Gérard. A mathematical discussion of the theory of long straight pieces under compression. Diagrams. 10,000 w. Rev Univ d Mines—March, 1902. No. 48418 H.

Exhibition.

Stone at the Royal Exchange Colonial Exhibition. Describes some of the noteworthy exhibits from various localities. 5400 w. Quarry—May 1, 1902. No. 48-070 A.

Fireproofing.

Different Building Materials Considered as to Their Adaptation for Fireproofing and Fire Retarding Purposes. Adler Muller. Considers brick, terra cotta, concrete, cast iron, wrought iron and steel, stone, timber and wired glass. 3500 w. Ins Engng—April, 1902. Serial. 1st part. No. 47830 C.

Georgia.

The Mineral Resources of Georgia. Extract from a paper by Prof. S. W. McCallie giving information concerning the development of the quarrying industry, the valuable marbles, granites, etc.; the road building material is also reported. 3300 w. Stone—March, 1892. No. 48021 C.

Marble.

An experimental investigation into the Flow of Marble. Frank D. Adams. An illustrated article indicating the methods employed in the investigation and the results attained. 2800 w. Can Engr—May, 1902. No. 47917.

Reinforced Concrete.

Canal Lining of Reinforced Concrete (Revétement en Beton de Ciment Armé un Plafond de Canal). An illustrated description of a lining for the bottom and sides of a canal at Epinal, France. 800 w. Génie Civil—April 26, 1902. No. 48286 D.

Computing the Strength of Concrete Steel Beams. Louis F. Brayton. Table for the moment of resistance of reinforced concrete computed according to theory "B" presented by Prof. Hatt, with explanatory notes. 500 w. Eng News—May 15, 1902. No. 48112.

The Boussiron System of Reinforced Concrete (Note sur les Constructions en Cement Armé Systéme Boussiron). J. Boussiron. An extended illustrated account of a reinforced concrete system using straight, round, rough iron rods. Serial. 1st part. 6000 w. Revue Technique—May 10, 1902. No. 48400 D.

Theory of the Strength of Beams of Reinforced Concrete. W. Kendrick Hatt. Abstract of a paper read before the Indiana Engng Soc. An illustrated article explaining different theories of the strength of concrete steel construction and comparing the results of computations from the same data following these different theories. 2500 w. Eng Rec—May 10, 1902. No. 47996.

Resistance of Materials.

New Methods in the Study of the Resistance of Materials (Neuere Methoden der Festigkeitslehre). S. Rappaport. A mathematical discussion of the resistance of materials and framework calculations, with diagrams. Serial. 1st part. 1500 w. Schweiz Bauzeitung—May 10, 1902. No. 48277 B.

Timber.

The Timber Resources of the Australian Commonwealth. Edward T. Scammell. Showing the claims of Australian timber to the favorable consideration of municipal, railway and marine engineers, architects, builders, and cabinet and art-workers. Also discussion. 14000 w. Jour Soc of Arts—May 2, 1902. No. 48073 A.

MEASUREMENT.

Loads.

Maximum Moments and Wheel Loads. Mathematical demonstration of problems in which combined loading is used. 1000 w. R R Gaz—May 23, 1902. No. 48323.

Surveying.

Mine Surveying. Paper presented at meeting of the Assn. of Ontario Land Survs. by Messrs De Morex and Silvester. Methods of obtaining accurate underground surveys and plans are considered. 2700 w. Can Engr—May, 1902. No. 47918.

Range Pole Surveying. H. F. Wilson, Jr. Abstract of a paper read before the Engng. Assn. of the South. Describes a rapid method of approximate surveying for a railway in Alabama. 1400 w. Eng Rec—May 17, 1902. No. 48131.

Transit.

Some Hints on Specifications for an Engineer's Transit. Prof. L. S. Smith. An illustrated article discussing the deficiencies of this instrument and the proper remedies. 3700 w. Wis Engr—April, 1902. No. 47821 D.

MUNICIPAL.

Paving Brick.

Comparison of Brick Tests and Street Wear. Charles Carroll Brown. A report of tests and trials of a number of brands of paving brick made in Detroit in 1898. Also tests of paving materials in Maryland. 1900 w. Munic Engng—May, 1902. No. 47835 C.

Pavements.

The New Specifications for Asphalt Pavements in New York. Extracts from specifications intended to allow free competition while restricting the choice of materials to those suitable for such work. 2400 w. Eng Rec—May 17, 1902. No. 48129.

Sewage Disposal.

Electric Sewage Pumps, Septic Tanks and Contact Beds at Fond du Lac, Wis. George S. Pierson. Gives general information regarding the city and its sewerage system, with illustrated description of the fine plant recently put in operation. 3000 w. Eng News—May 22, 1902. No. 48311.

Pittsfield Sewage Disposal Plant. Illustrates and describes the new system on the plan of intermittent filtration. 1300 w. Fire & Water—May 3, 1902. No. 47899.

Sewage Disposal at Collingswood, N. J. G. Everett Hill. Illustrates and describes a plant with a septic tank and four coke filters. 2200 w. Engng Rec—May 3, 1902. No. 47859.

Sewage Disposal at Fond du Lac, Wisconsin. Irvine Watson. An illustrated detailed description of a septic tank installation. 1700 w. Munic Engng—May, 1902. No. 47836 C.

The Action of the Septic Tank on Acid Sewage. A review of the experiments for 15 months made by Leonard P. Kinnicutt and Harrison P. Eddy on the work actually done by a closed tank, on sewage containing an unusual amount of iron salts. 3800 w. Eng Rec—May 10, 1902. No. 48003.

The Intermittent Sewage Filters at Pittsfield, Mass. Illustrated description of a system of storage tanks, electric pumps and intermittent filters of 25 acres extent. 1300 w. Eng Rec—May 10, 1902. No. 48000.

See Electrical Engineering, Power Applications.

Street Cleaner.

New System of Street Cleaning. Illustrated description of a sanitary machine now in use in New York. 400 w. Sci Am —May 10, 1902. No. 48027.

WATER SUPPLY.

Filtration.

Filtration of River Water. Alfred J. Jenkins. Extracts from a paper read before the Assn. of Munic. & Co. Engrs. at Birmingham. Considers means adopted for treatment. Discussion. 5800 w. Jour Gas Lgt—April 29, 1902. No. 48079 A.

Reservoirs.

Automatic Regulation of Discharge from a Reservoir. F. Rigaud. Gives solutions of the question, with mathematical development of formula. 1000 w. Min & Sci Pr—May 10, 1902. No. 48098.

Stand-Pipes.

Wind Damage to Water Works Stand-Pipe at Lincoln, Neb. An illustrated account of the accident. 600 w. Eng News —May 15, 1902. No. 48111.

See also Civil Engineering, Miscellany.

Stream Gauging.

See Civil Engineering, Canals, Rivers and Harbors.

Wachusett Reservoir.

The North Dike of the Wachusett Reservoir, Metropolitan Water Works. Frederic P. Stearns. Reprinted from the *Pro. Am. Soc. of Civ. Engrs.*, from the discussion on the Bohio Dam. Description of the design and construction. 7800 w. Eng News—May 8, 1902. No. 48025.

Water Purification.

The Iron Coagulant Process at Lorain. Describes the method of preparing sulphate of iron for use as a coagulant with rapid filters. 1200 w. Eng Rec—May 10, 1902. No. 48001.

Water Softening.

The Kennicott Water Softening System. Illustrated detailed description. It consists in the addition of soda and lime solutions, supplemented by the sedimentation of the treated water. 2000 w. Eng News—May 15, 1902. No. 48109.

Water-Works.

The utility of subsiding Basins. Review of a monograph by W. Kiersted, giving the results of experiments on the classification of Missouri River water by sedimentation and coagulation. 2500 w. Eng Rec—May 17, 1902. No. 48134.

Wells.

Artesian Water Supply and Irrigation. W. Gibbons Cox. An account of the extent to which underground water has been utilized in the past, and suggestions for the fuller application. 2000 w. · Engr, Lond—April 25, 1902. Serial. 1st part. No. 47886 A.

Well Driving. A. H. Eldredge. Considers the method of driving wells and connecting the pump suction. Ill. 1300 w. Mach, N Y—May, 1902. No. 47913.

MISCELLANY.

Cuba.

Engineering in Cuba. C. J. Carlson. An extract from a field order, dealing with the water and sewage systems of the army camp at Quemador, Cuba. Ill. 2000 w. Wis Engr—April, 1902. No. 47820 D.

Education.

The Engineer of the Twentieth Century. Robert Moore. Presidential address before the Am. Soc. of C. E. concerning the requirements for successful engineering practice. 3100 w. Eng Rec—May 24, 1902. No. 48188.

Engineering Society.

The First Fifty years of the American Society of Civil Engineers. Charles Warren Hunt. Briefly reviews the growth in members, character of papers, library, etc. 2900 w. Eng Rec—May 24, 1902. No. 48189.

Irrigation.

Irrigation in Roumania and Bulgaria (Bewässerung der Rustikalgründe in Rumänien und Bulgarien). Jan Blauth. An illustrated description of irrigating and rather primitive water-raising methods. 1 plate. 700 w. Oesterr Wochenschr f d Oeffent Baudienst—April 19, 1902. No. 48217 B.

Wind Pressure.

Competition for a Wind-Pressure Recorder (Vorschriften für den Wettbewerb zur Erlangung einer Vorrichtung zum Messen des Winddruckes). The terms of a competition for a wind-pressure measurer and recorder, held by the German Ministry of Public Works, and which closes April 1, 1903, at the "Deutsche Seewarte," Hamburg. 500 w. Technologist—April, 1902. No. 48414.

The Wind Pressure on Upright Cylindrical Tanks (Berechnung von Behältern auf Winddruck). Prof. Philipp Forchheimer. The mathematical design of standpipes with particular reference to wind pressures. Diagrams and formulae. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—May 2, 1902. No. 48224 B.

COMMUNICATION.

Cables.

Automatic Relay Translation for Long Submarine Cables. S. G. Brown. Read before the Inst. of Elec. Engrs. Illustrated description of a system in use on some of the lines of the largest cable companies. 3200 w. Elect'n, Lond—May 16, 1902. Serial. 1st part. No. 48352 A.

Submarine Telephone Cable with Increased Self-Induction (Unterseeische Fernsprechkabel mit Erhöhter Selbstinduktion). C. E. Krarup. An account of measurements of experimental telephone cables having iron ribbon and iron wire wound about the copper conductor. 1800 w. Elektrotech Zeitschr—April 17, 1902. No. 48202 B.

Fire Alarm.

The Vienna Fire Alarm System (Die Organisation des Nachrichtendienstes der Wiener Feuerwehr). W. Chitil. An illustrated general review of the telegraphic, telephonic and automatic fire-alarm service of Vienna. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—May 9, 1902. No. 48245 B.

Space Telegraphy.

Fessenden System of Wireless Telegraphy. Report of the testing of this system at Roanoke Island, N. C., by the U. S. Weather Bureau. It differs materially from the Marconi system, especially in employing no coherer. 1500 w. Elec Wld & Engr—May 3, 1902. No. 47925.

The Genesis of Wireless Telegraphy. A. Frederick Collins. A record of the efforts and facts that are responsible for the spark-gap and coherer system of wireless telegraphy. Ill. 3800 w. Elec Wld & Engr—May 10, 1902. No. 48039.

The Scientific Basis of Spark Telegraphy. Abstract of a paper by Dr. A. Slaby, in the *Elektrotechnische Zeitschrift.* An account of the scientific basis of the writer's method of wireless telegraphy. 2000 w. Elect'n, Lond—April 25, 1902. Serial. 1st part. No. 47879 A.

Wireless Telegraphy Invention. A summary by Prof. Sylvanus P. Thompson published in the London *Saturday Review.* Also editorial. 1900 w. Elec Rev, N Y—May 10, 1902. No. 48037.

Telegraphy.

An Electric Picture Telegraph. Describes an improved electrograph instrument, giving illustration and sample of work, and explaining its operation. 1300 w. Eng News—May 1, 1902. No. 47939.

The Buckingham Long-Distance Page-Printing Telegraph. William Maver, Jr. An illustrated description of a system operating at a high rate of speed on the longest circuits, in which the messages are received on the ordinary telegraph blank, or on large sheets if desired. 6000 w. Elec Wld & Engr—May 24, 1902. No. 48373.

The Telegraph of To-day. J. C. Barclay. A letter favoring manual rather than automatic telegraphy except for emergency service. 1000 w. Elec Wld & Engr—May 24, 1902. No. 48374.

Telephone Switch.

Telephone Switch for the Moldau-Elbe Canal System (Telephon-Umschalter für die Fernsprechanlage der Moldau-Elbe-Canalisierung). Hans Mattausch. An illustrated description of the telephone system of the Moldau-Elbe canalization works particularly of a switching arrangement designed by the author. 1 plate. 4500 w. Oesterr Wochenschr f d Oeffent Baudienst —April 26, 1902. No. 48218 B.

Telephony.

Party Lines. Oscar M. Leich. Considers the difficulties encountered on party lines and describes the signaling systems used. 3000 w. Wis Engr—April, 1902. No. 47819 D.

DISTRIBUTION.

Alternating Current.

A Résumé of the Alternating-Current System. H. G. Reist. Considers the generators, motors, distribution, etc. 2500 w. Am Elect'n—June, 1902. No. 48305.

Blasting.

See Mining and Metallurgy, Mining.

Cable Tests.

See Electrical Engineering, Measurement.

Fuses.

Safety Fuses in Branched Circuits (Ueber Sicherungen in Vergweigten Leitungsanlagen). Prof. A. Sengel. A discussion of the proper placing of fuses in branch circuits which have more than one connection with main circuits. Diagrams. 1600 w. Elektrotech Zeitschr—May 1, 1902. No. 48207 B.

Graphical Calculations.

Some Constructions for the Graphical Calculation of Conducting Networks (Einige Konstruktionen zur Graphischen Berechnung von Leitungsnetzen). Bruno Soschinski. An extension and completion of some graphical constructions due to C. Hochenegg, with diagrams. 1200 w. Elektrotech Zeitschr—April 24, 1902. No. 48204 B.

Polyphase.

Practical Polyphase Working. Dr. Louis Bell. Deals with the installation and operation of polyphase stations, with special reference to the power transmission work for which such apparatus is used. 3000 w. Am Elect'n—June, 1902. No. 48307.

Railway Feeders.

The Calculation of Feeders for Electric Railway Distribution Systems (Beitrag zur Berechnung von Speiseleitungen Elektrischer Bahnanlagen). Prof. A. Sengel. A determination of the most economical cross-section of feeding conductors, with formulæ and diagrams. 2000 w. Elektrotech Zeitschr—April 17, 1902. No. 48200 B.

Voltage Control.

The Synchronous Converter as Voltage Controller. M. Seidner. Shows by graphical treatment how these machines may be employed for indirectly regulating the voltage by changing the field of the converter. 2200 w. Elec Wld & Engr—May 3, 1902. No. 47923.

Wattless Currents.

Wattless Currents (Ueber Wattlose Ströme). C. P. Feldmann. A paper before the Electrotechnical Society of Cologne, discussing various phenomena of alternating current circuits having capacity and inductance. 4000 w. Elektrotech Zeitschr—April 24, 1902. No. 48206 B.

ELECTRO-CHEMISTRY.

Electro-Metallurgy.

Electrolytic Production of Metals, with Special Reference to Copper and Nickel. William Koehler. An interesting discussion of this subject, explaining the method of working, the reactions and the different processes in use. 4000 w. Can Min Rev—April 30, 1902. No. 47908 B.

The English Electro-Metallurgical Company, Limited. An illustrated account of the new works of a newly organized company, and their equipment, the methods employed, etc. 2000 w. Engng—May 16, 1902. No. 48358 A.

Treatment of Auriferous Ores. C. A. Mulholland. Read at meeting Sydney Tech. Col. Min. & Met. Soc. Discusses apparatus where the electro-solution and electro-deposition of the gold are effected in one operation. 2800 w. Aust Min Stand—April 10, 1902. Serial. 1st part. No. 48159 B.

Electromotive Force.

Researches on Electromotive Forces (Recherches sur les Forces Electromotrices). M. Berthelot. A theoretical discussion of chemical action and electromotive force, and comparison of calculated and experimental results with various combinations of materials. 4000 w. Comptes Rendus—April 14, 1902. No. 48423 D.

Storage Battery.

Design for a High-Capacity Storage Battery. J. C. Brocksmith. Working drawings with descriptions of details. 3000 w. Am Elect'n—June, 1902. No. 48309.

Water Electrolysis.

The Technical Electrolysis of Water (Die Technische Elektrolyse des Wassers). Victor Engelhardt. An illustrated historical and general review of processes for the electrolysis of water and the resulting production of oxygen and hydrogen. 6500 w. Zeitschr d Oesterr Ing u Arch Ver—May 9, 1902. No. 48244 B.

ELECTRO-PHYSICS.

Coherers.

The Mode of Action of Coherers and Auto-Decoherers (Remarques sur le Fonctionnement des Choéreurs et des Auto-Décohéreurs). O. Rochefort. A record of observation leading to the opinion that auto-decoherers can be made ordinary coherers by diminishing the pressure of the imperfect contacts. 400 w. Comptes Rendus—April 14, 1902. No. 48428 D.

Constants.

Physical Constants. C. I. T. Haussen. A simplified system of dynamic, caloric, electric, magnetic and other physical and chemical constants and calculations. Mathematical demonstration. 1500 w. Engng—May 9, 1902. No. 48184 A.

Duddell Arc.

The Theory of the Duddell Singing Arc (Quelques Remarques sur la Théorie de l'Arc Chantant de Duddell). Paul Janet. A mathematical discussion, with suggestion for obtaining alternating from continuous current by means of this arc. 300 w. Comptes Rendus—April 14, 1902. No. 48425 D.

Low Temperatures.

Electrical Phenomena at Low Temperatures (Les Phénomènes Electriques aux Basses Températures). M. d'Arsonval. An illustrated account of the liquefaction of gases, and electric, magnetic and other phenomena at very low temperatures. 8000 w. Bull Soc Internationale d Electriciens—March, 1902. No. 48403 E.

Radiography.

Walter's Rontgen Ray Apparatus. An illustrated description of the practical construction and method of working the apparatus devised by Dr. Walter, of Hamburg. 1700 w. Elec Rev, Lond—May 9, 1902. No. 48166 A.

Spark Spectra.

Variations of the Spectrum of Electric Snarks (Variations du Spectre des Etincelles). B. Eginitis. An account of experiments, which show that with electrodes remaining the same, the spectrum of the electric discharge between them varies with the self-induction of the circuit. 600 w. Comptes Rendus—April 14, 1902. No. 48426 D.

GENERATING STATIONS.

Austria-Hungary.

Electricity in Austria-Hungary. Felix Horschitz. Describes important and interesting plants, showing what has been accomplished. Ill. 2200 w. Elec Wld & Engr—May 3, 1902. No. 47922.

Buenos Aires.

The Buenos Aires Electric Station of the German Transmarine Electric Company (Das Elektricitätswerk der Deutsch-Ueberseeischen Elektricitäts-Gesellschaft in Buenos Aires). H. Baehcker. An illustrated description of a large station for light and power, on the Rio de la Plata, Argentina. 2000 w. Elektrotech Zeitschr—May 8, 1902. No. 48212 B.

California.

S. K. C. Apparatus at Colgate. Edw. Heitmann and William Currie. Illustrated description of the principal electrical features of this power house, especially the generators. 6000 w. Jour of Elec—April, 1902. No. 48146 C.

Discussion.

The Isolated Plant versus the Central Station—Discussion at the Chicago Electrical Association. Report of a very interesting discussion on the comparative advantages of the two systems. 3200 w. Elec Wld & Engr—May 10, 1902. No. 48041.

Generator Sets.

Some Details of Direct-Connected Generator Sets. William H. Bryan. The usual division of responsibilities between engine and generator builders in the construction of direct-connected sets, is outlined. 2500 w. Trans Am Soc of Mech Engrs, No. 0951—May, 1902. No. 47988.

Hagneck.

The Hydro-Electric Station at Hagneck, Switzerland (Usine Hydro-Eléctrique de Hagneck, Suisse). Henry Martin. A well illustrated, comprehensive account of this large plant and the electric distribution system. 1 plate. 4500 w. Génie Civil—April 12, 1902. No. 48280 D.

Heating.

Central Station Heating. D. F. McGee. Read before the Iowa State Elec. Lgt. Assn. A description of the plant at Red Oak, Iowa, with discussion of points of importance to obtain success. 3000 w. Am Gas Lgt Jour—May 12, 1902. No. 48051.

Magnetic Reaction.

On Magnetic Reactions in Dynamos (Sur la Reaction Magnetique de l'Induit des Dynamos). N. Vasilesco-Karpen. A mathematical discussion of the effect of the induced currents in armature and armature windings. 600 w. Comptes Rendus—April 14, 1902. No. 48427 D.

Paris.

The Electric Station of the Eastern Paris Lighting Company (Installations Electriques de la Cie. Est-Lumiére). Henry Martin. A well illustrated description of a central station, sub-station and electric distribution system in the east suburbs of Paris. 1 plate. 4000 w. Génie Civil—May 10, 1902. No. 48288 D.

Recent Construction.

Recent Construction at the Atlantic Avenue Station of the Edison Electric Illuminating Company of Boston. I. E. Moultrop and R. E. Curtis. An account of some of the new features introduced and of the conditions under which they were developed. Ill. 7200 w. Trans Am Soc of Mech Engrs, No. 0944—May, 1902. No. 47982.

Rheostat.

See Electrical Engineering, Measurement.

Shawinigan Falls.

Water Power Development at Shawinigan Falls. Wallace C. Johnson. Abstract of a lecture before the Canadian Soc. of Civ. Engrs. Describes the work of development. 4200 w. Can Engr—May, 1902. No. 47916.

South Wales.

Electric Power Supply Scheme for South Wales. An account of the engineering features of a scheme for supplying electric energy over an area of about 1,034 square miles. 1600 w. Ir & Coal Trds Rev—May 2, 1902. No. 48068 A.

Spain.

Hydro-Electric Station near Madrid (Proyectos de Santillana). A comprehensive, illustrated review of a 2000 H. P. hydro-electric plant which will transmit energy to Madrid and other places in the vicinity; projected by the Marquis de Santillana. 18000 w. Madrid Cientificos Supplement—April, 1902. No. 48299 D.

Speed Regulation.

See Mechanical Engineering, Steam Engineering.

Switzerland.

Some Statistics of Swiss Electric Stations (Einige Zahlen betreffend die Schweizerischen Elektricitätswerke). Prof.

W. Wyssling. A statistical review of Swiss electric stations of all kinds, principally driven by water power. Serial. 1st part. 1000 w. Schweiz Bauzeitung—May 10, 1902. No. 48276 B.

Transformers.

Transformer Testing by Central Station Companies. R. F. Schuchardt. Practical information of testing methods which are rapid and sufficiently accurate. Gives a table of average results from transformers. Ill. 2300 w. Elec Wld & Engr—May 17, 1902. No. 48149.

Wales.

Electrical Enterprise in Wales. Describes the plant of the South Wales Electrical Distribution Company, summarized from an article in the South Wales *Daily News*. 1500 w. U S Cons Repts, No. 1344—May 17, 1902. No. 48084 D.

Whitehall, Ill.

A Progressive and Profitable Small Central Station. J. R. Cravath. An illustrated detailed description of the plant of the Whitehall (Ill.) Electric Co. 3400 w. Am Elect'n—June, 1902. No. 48303.

LIGHTING.

Arc Lamp.

A New Type of Continuous Current Arc Lamp. Frank Lewis. Illustrated description of the lamp and its action. 900 w. Elec Rev, Lond—May 2, 1902. No. 48081 A.

Cincinnati.

The Cincinnati Gas and Electric Company. Illustrated detailed description of the generating station and its equipment, the territory supplied, lamps, etc. 5200 w. Elec Wld & Engr—May 17, 1902. No. 48147.

The System of the Cincinnati Gas and Electric Company. L. G. Lilley. Illustrated description of a fine modern electric lighting system. 3000 w. Elec Rev, N Y—May 17, 1902. No. 48143.

Incandescent Lamps.

The Birth of a Glow Lamp. An illustrated description of the processes involved in the manufacture. 3200 w. Elec Times—April 24. 1902. No. 47868 A.

The Incandescent Electric Lamp—How Manufactured and Tested. William A. Del Mar. An illustrated description of the processes employed by a large European manufacturer. Also gives variations of the process introduced by other makers. 2700 w. Sci Am Sup—May 24, 1902. No. 48301.

The Manufacture of Glow Lamps. An illustrated detailed description of their manufacture and testing. 1800 w. Elec Rev, Lond—May 9, 1902. Serial. 1st part. No. 48167 A.

An Incandescent Lamp Test. J. D. Nies. A report of tests covering six makes of lamps. Diagrams. 500 w. Cent Sta—May, 1902. No. 47969.

Municipal Lighting.

Municipal Electric Lighting in Chicago. I. Report of Haskins and Sells, the result of an investigation into the finances of the plant. II. Economic and Social Factors in Chicago Municipal Lighting. John R. Commons. The general conclusions favor the municipal plant. 7000 w. Munic Af—March, 1902. No. 47893 D.

Nernst Lamp.

Tests on the Nernst Lamp. R. P. Hulse. Paper read at Birmingham, Eng., March 19, 1902. Describes the tests made of the 1902 model, giving diagrams. 1800 w. Elec Rev, Lond—April 18, 1902. Serial. 1st part. No. 47877 A.

The Nernst Lamp. Murray C. Beebe. Abstract of a paper read before the New England Cotton Mfrs. Assn. Describes the commercial and automatic lamp as recently developed. 1200 w. Ir Age—May 29, 1902. No. 48375.

Rates.

The Flat Rate Nuisance. Thomas D. Miller. Read at meeting of the Southwestern Gas, Electric and Street Railway Assn. Condemning flat rates as applied to the lighting business. 1600 w. Am Gas Lgt Jour—May 12, 1902. No. 48050.

Suburban.

A successful Suburban System. Alton D. Adams. Describes the territory served by the Malden Electric Company, near Boston, the plant, etc., the number of incandescent street lamps supplied being larger than any other plant in the state. 2000 w. Elec Wld & Engr—May 17, 1902. No. 48148.

The Bergen County, N. J. Lighting System. W. J. Jones. Illustrated description of a system furnishing current for street-lighting, commercial lighting and power to thirty-eight municipalities, which comprise about fifty different towns and boroughs, covering about 160 sq. miles. 1400 w. Elec Wld & Engr—May 24, 1902. No. 48372.

Supply.

Electric Lighting by Street Railway systems. Alton D. Adams. Discusses the movement looking to the supply of electric light from street railway stations, showing its desirability from the standpoint of the general public. 1700 w. St Ry Rev—May 20, 1902. No. 48340 C.

Western Plants.

Some Typical Western Electric Lighting Plants. Brief Illustrated descriptions of interesting details in what may be regarded as typical installations. 1200 w. Elec Rev, N Y—May 24, 1902. No. 48336.

MEASUREMENT.

Cable Tests.

The Testing of Electric Cables (Note sur les Essais des Cables Electriques). P. Charpentier. A paper on the testing of heavy current and high tension cables. 10000 w. Bull Soc Internationale d'Electriciens—March, 1902. No. 48404 E.

Compensated Meters.

Magnetically Compensated Ampere- and Voltmeters (Nouveaux Ampèremètres et Voltmètres Indépendants de leur Aimant). An illustrated description of continuous-current meters, which are compensated for variations in their permanent magnets by a small piece of soft iron inside their coil. 2500 w. Bull Soc Internationale d Electriciens—April, 1902. No. 48405 E.

Current Density.

The Current Density in Resistance Wires (Ueber die Stromdichte in Widerstände). Georg J. Erlacher. A record of experiments for determining the rise in temperature and allowable current density in nickelin wires. Tables. 1600 w. Electrotech Zeitschr—May 8, 1902. No. 48211 B.

Electrometer.

The Use of the Electrometer for the Direct Measurement of the Energy, Current Strength and Phase Angle of Alternating Currents (Anwendung des Elektrometers bei Weckselstrom zur Direkten Messung des Effektes, des Stromes und des Phasenwinkels). Karl Hohage. A description of method with diagram of connections. 400 w. Electrotech Zeitschr—April 24, 1902. No. 48205 B.

Electro-Tellurograph.

Earth Currents and the Electro-Tellurograph. E. Guarini. Illustrated description of this apparatus for the study of earth currents. 800 w. Elec Rev. Lond—May 16, 1902. No. 48350 A.

Hot Wire Meters.

Hot-Wire Electric Meters (Ueber Hitzdrahtstrommesser). Prof. Kollert. The theory and design of electric meters which operate by the heating of wires by the electric current. Diagrams and formulæ. 1800 w. Elektrotceh Zeitschr—May 1, 1902. No. 48209 B.

Hysteresis.

The Ballistic Measurement of Hysteresis. G. F. C. Searle. A connected account of the principles involved in the ballistic method of hysteresis measurement, together with a description of the practical details of the method. 3600 w. Elect'n, Lond—May 9, 1902. Serial. 1st part. No. 48165 A.

Magnetic Testing.

A Null Method of Magnetic Measurements. Rudolf Goldsmidt. From the *Electrotechnische Zeitschrift*. Illustrated description of method determining the magnetic force of given windings which gives fairly accurate results. 900 w. Elect'n, Lond—May 2, 1902. No. 48080 A.

Industrial Tests of the Magnetic Properties of Iron (Rapport sur les Travaux de la Sixième Commission: Les Essais Magnetiques des Fers dans l'Industrie). M. Armagnat. A report of a committee of the Société Internationale des Slectriciens on the advisability of making magnetic tests in commercial and practical work, with list of questions sent to manufacturers. 1500 w. Bull Soc Internationale d Elect—March, 1902. No. 48402 E.

The Measurement of Magnetic Induction. C. W. Burrows. Experimental investigations with description and illustrations of instrument used. 1500 w. Horseless Age—May 21, 1902. No. 48-318.

Regulations.

Regulations for the Construction and Testing of Apparatus and Materials (Vorschriften für die Konstruktion und Prüfung von Installationsmaterial). Regulations and specifications for electrical apparatus and materials, proposed by a committee of the Verband Deutscher Elektrotechniker. 1500 w. Elektrotech Zeitschr—May 8, 1902. No. 48213 B.

Rheostat.

Determination of the Regulating Resistance of Self-Exciting Shunt Generators (Bestimmung der Stufen und Stufung des Regulirwiderstandes von Nebenschlussgeneratoren mit Selbsterregung). Rudolf Krause. An illustrated discussion of the design of rheostats for regulating dynamos. 800 w. Elektrotech Zeitschr—May 1, 1902. No. 48208 B.

Wattmeters.

The Measurement of Electrical Energy (Ueber Messungen Elektrischer Effekte). J. Görner. A discussion of the measurement of the energy of alternating and polyphase currents of various wave forms, and descriptions of wattmeters which fulfil all requirements. Diagrams and illustrations. Serial. 2 parts. 4500 w. Elektrotech Zeitschr—April 17, 24, 1902. No. 48201 each B.

POWER APPLICATIONS.

Electric Driving.

Electric Power Installations at the Ongrée Works, Belgium. Illustrates and describes the leading features of an installation for electric power and light in large mechanical works. 3200 w. Ir & Coal Trds Rev—May 16, 1902. No. 48370 A.

Power Generating Equipment of a Spice Factory. Illustrated detailed description of a plant at Charlestown, Mass. 1800 w. Am Elect'n—May, 1902. No. 47947.

Power Plant of the Otis Elevator Co., Yonkers, N. Y. Arthur L. Rice. Illustrated detailed description. 2200 w. Engr, U S A—May 1, 1902. No. 47959.

Elevators.

The Electric Elevator. H. D. James. Illustrates and describes the mechanism and the operation. 3000 w. Am Elect'n—May, 1902. No. 47948.

Induction Motors.

An Important Polyphase Motor Decision. Judge Brown's decision in the suit of the Westinghouse Electric and Manufacturing Co. vs. the Royal Weaving Co. for infringement of the Tesla patents for polyphase motors. 2500 w. Elec Rev, N Y—May 24, 1902. No. 48337.

The Single-Phase Induction Motor. A. S. M'Allister. An outline of the characteristic features of the single-phase induction motor, showing the similarities and differences between the performance of a single-phase and a polyphase machine and investigating the methods by which the single-phase motor may be operated under various conditions. 2800 w. Am Elect'n—June, 1902. No. 48304.

Mill Driving.

Electricity in Cotton Mills. W. B. Smith Whaley. An account of the installation of an electric plant, tests, comparisons, etc. 2500 w. Trans Am Soc of Mech Engrs, No. 0942—May, 1902. No. 47980.

Motor Testing.

How to Test Electric Motors. A practical talk on methods of testing, explaining the principles upon which the test depends. 3000 w. Steam Engng—May 15, 1902. No. 48329.

Sewage Disposal.

Electro-Pneumatic Control of the Moon Island Sewage Reservoir. Gives a resume of the sewage systems of Boston with an illustrated description of the appliances now in use. 2500 w. Ry & Engng Rev—May 17, 1902. No. 48145.

Synchronous Motors.

Synchronous Motor Calculations. F. G. Baum. Gives a method for solving synchronous motor problems which is as simple as the solving of problems concerning a generator. 3200 w. Elec Wld & Engr—May 17, 1902. No. 48151.

Telpherage.

The Telpherage System of Electric Traction. Illustrates and describes this system for the transportation of material, and its applications and merits. 1000 w. Sci Am Sup—May 17, 1902. No. 48106.

Testing Tank.

The Electrical Equipment of the Experimental Model Basin at Washington Navy Yard. J. Adger McCrary. An illustrated detailed description of the machinery and apparatus employed; particularly the electrical devices used. 1500 w. Elec Wld & Engr—May 10, 1902. No. 48038.

Turntable.

An Electrically Operated Turntable (Ueber einen Neuen Elektrischen Antrieb von Drehscheiben). E. Block. An illustrated description of a Westinghouse electric motor which runs on the circular track under the table and pulls the latter around. 1200 w. Glasers Annalen—May 1, 1902. No. 48243 D.

MISCELLANY.

Düsseldorf Exposition.

See Industrial Economy.

Electric Accidents.

Electric Accidents and the Means of Preventing Them. L. W. de Grave. Abstract of a paper read before the Chesterfield and Midland Co.'s Inst. of Engrs. Considers accidents due to shock and to fire. 2000 w. Quarry—May 1, 1902. No. 48071 A.

Kelvin.

Lord Kelvin, His Work and Influence. F. B. Crocker. A comprehensive examination of the effect of the work of Lord Kelvin upon the development of electrical engineering. 2000 w. Engineering Magazine—June, 1902. No. 48391 B.

Magnetic Separator.

See Mining and Metallurgy, Iron and Steel.

Model Contracts.

The Institution and Its Proposed Model Contracts. Gives the more important of the draft clauses of the proposed form for use in connection with contracts for plant, mains, and apparatus for electricity works, with comments. 6000 w. Elect'n, Lond—April 25, 1902. No. 47880 A.

Report.

General Electric Report. Report for the year ending Jan. 31, 1902, containing much information of interest. 4000 w. Elec Wld & Engr—May 3, 1902. No. 47924.

Tariff.

The Influence of Tariffs on Electricity Supply. J. R. Dick. Critical reply to articles by C. Ashmore Baker on this subject. 1400 w. Elec Rev, Lond—April 25, 1902. No. 47875 A.

Winding.

Formers and Former-Winding. F. W. Davies. On the construction and use of formers, giving a general classification of the principal types, method of winding, etc. 2000 w. Elec Engr, Lond—May 9, 1902. Serial. 1st part. No. 48164 A.

GAS WORKS ENGINEERING

Address.

President's Address before the Institution of Gas Engineers in London. Thomas Holgate. Gives a sketch of ideal gas works, discussing details, and giving interesting statements in regard to incandescent lighting. Ill. 8700 w. Gas Wld—May 3, 1902. No. 48121 A.

Analysis.

The Analysis of Blast Furnace and Producer Gas (Analyse der Hochofen und Generatorgase). A. Wencelius. An illustrated account of apparatus, methods and results. 2000 w. Stahl u Eisen—May 1, 1902. No. 48251 D.

Carbonizing.

A Suggestion for Unification in the Methods of Stating the Items Comprising the Carbonizing Costs in Gasworks. W. R. Herring. Read before the Inst. of Gas Engrs. On the value of statistical research, and uniformity in reporting statements. 3500 w. Gas Wld—May 3, 1902. No. 48124 A.

Condensation.

Coal Gas Condensation: A Theory. A. F. Browne. Discusses the question of the position of the condenser with regard to the exhauster, the effect of expansion, etc. General discussion. 11300 w. Gas Wld—May 3, 1902. No. 48125 A.

Depreciation.

Depreciation in Gas Plants. R. W. Prosser. A discussion of this subject, and explanation of methods of calculating the yearly sum charged to depreciation in gas works. 2200 w. Am Gas Lgt Jour—May 26, 1902. No. 48328.

Distribution.

• Distribution—Developments to Meet Rapidly Increasing Consumption. A. B. Walker. Read before the North of England Gas Mgrs. Assn. A record of developments carried out in the last six years. Also discussion. 5000 w. Jour Gas Lgt—April 29, 1902. No. 48074 A.

Explosions.

Gas Explosions in Electric Supply Conduits. This first article gives an account of a case in the English courts. 2000 w. Elec Rev, Lond—April 25, 1902. Serial. 1st part. No. 47876 A.

Future Gas.

The Illuminating Power of the Gas of the Future. Harry Edward Jones. Read before the Inst. of Gas Engrs. Discusses how an illuminating gas of 10 or 12 candles may best be produced, the subject of fuel gas for power, and other matters of related interest. General discussion. 11500 w. Gas Wld—May 3, 1902. No. 48123 A.

Gasholders.

A Talk on the Development of the Gasholder. George Livesey. Sketches the gradual growth in size and construction and gives interesting information. Ill. Discussion. 7200 w. Gas Wld—May 3, 1902. No. 48127 A.

Governors.

Governors on Service Pipes and Burners. Summary of a report by F. Pennertz, in the *Journal für Gasbeleuchtung,* of the results of a study made on the action of governors. 1200 w. Jour Gas Lgt—April 29, 1902. No. 48077 A.

High Pressure.

The Cost of High-Pressure Gas-Lighting. Statement of J. G. Newbigging, giving details of expense connected with a Welsbach high-pressure installation for twelve months. 600 w. Jour Gas Lgt—April 29, 1902. No. 48078 A.

Incandescence.

Experience in Incandescent Gas Lighting at the Antipodes. An account of incandescent gas affairs in Australasia. 3300 w. Jour Gas Lgt—April 22, 1902. No. 47848 A.

Inverted Incandescent Gas Lamps. Illustrated description summarized from the *Journal für Gasbeleuchtung.* 1100 w. Gas Wld—May 3, 1902. No. 48120 A.

Oil Gas and Oil Incandescent Lighting. Slightly condensed lecture of Vivian B. Lewes, before the Petroleum Inst. Considers methods of production, cost, processes and results, mantles, lamps, etc. 7500 w. Jour Gas Lgt—April 22, 1902. No. 47849 A.

The Incandescent Mantle Trade. Concerning the agreements and negotiations concerning the Welsbach mantles, as settled in the British Law Courts. 2400 w. Gas Wld—April 26, 1902. No. 47872 A.

Mains.

The Relative Advantages of Cast Iron and Wrought Iron Gas Mains. Godfrey L. Cabot. Gives evidence in favor of wrought iron. 1600 w. Am Gas Lgt Jour—May 12, 1902. No. 48049.

Naphthalene.

The Solubility of Naphthaline. P. F. Smith. Read before the Inst. of Gas Engrs. Gives results of laboratory work in determining the value of various solvents when employed for clearing mains

We supply copies of these articles. See page 651.

and service pipes. Discussion. 3900 w. Gas Wld—May 3, 1902. No. 48126 A.

Producer.

Gas Producer with Suction Down Draft (Gazogène à Combustion Renversée par Aspiration). J. Deschamps. An illustrated description of a gas generator of the Loomis type, using all kinds of fuels rich in volatile products. 1800 w. Génie Civil —April 25, 1902. No. 48285 D.

Purifiers.

Construction of Purifiers. Ed. Jaeger. From *Journal für Gasbeleuchtung.* Illustrates and describes a construction that has been found very satisfactory. 1000 w. Gas Wld—May 10, 1902. No. 48163 A.

Subway.

A Short Account of the Construction of a Subway for a Gas-main Under Queen's Dock Basin, Hull, England. F. J. Bancroft. Read before the North of England Gas Mgrs. Assn. Ill. 1800 w. Jour Gas Lgt—April 29, 1902. No. 48075 A.

Tar and Ammonia.

Progress in the Production of Tar and Ammonia from the Gases of Blast Furnaces and Producers (Fortschritte in der Gewunnung von Theer und Ammoniak aus den Gasen der Hochöfen und Generatoren). A review of methods and results in gaining these by-products. 4500 w. Stahl u Eisen—May 1, 1902. No. 48252 D.

Wood Gas.

A New Riché Combustion Gas Generator (Nouveau Gazogène à Combustion de la Compagnie du Gaz Riché). G. Briand. An illustrated description of a gas generator using either wood or coal fuel, with table of tests. 800 w. Génie Civil—April 12, 1902. No. 48281 D.

On the Use of Wood Gas in the Manufacture of Iron and Steel. Dr. James Douglas. An illustrated article on the gasification of wood for gas engine purposes. 1800 w. Can Min Rev—April 30, 1902. No. 47904 B.

INDUSTRIAL ECONOMY

Competitions.

Principles for the Government of Competitions (Grundsätzen für Preisbewerbungen). A report of a committee of the Oesterr Ing. und Arch. Verein on the principles which should govern architectural and engineering competition. 5500 w. Supplement to Zeitscher d Oesterr Ing u Arch Ver—May 9, 1902. No. 48246 B.

Cost-Keeping.

Co-operation and Mechanical Aids to Work-Shop Cost-Keeping. R. P. Link. Read before the Northeast Coast Inst. of Engrs & Shipbuilders. Aims to show the superiority of the machine control system over the board system. 4000 w. Mech Engr—April 26, 1902. No. 47870 A.

Dusseldorf Exposition.

The Building of the Düsseldorf Exposition (Die Industrie und Gewerbeausstellung in Düsseldorf 1902. Bemerkenswerte Bauwerke). O. Leitholf. A well illustrated review of the principal buildings of this large German exposition and their details of construction. Serial. 1st part. 1 plate. 2500 w. Zeitschr d Ver Deutscher Ing—May 3, 1902. No. 48233 D.

The Düsseldorf Exposition of 1902 (Die Industrie-Gewerbe-und Kunstausstellung in Düsseldorf 1902). O. Lietholf. A general review of this industrial and art exposition of the Westphalian and Rhineland provinces, with illustrations and plans. 2500 w. Zeitschr d Ver Deutscher Ing—May 3, 1902. No. 48231 D.

The Düsseldorf Exposition (Die Industrie-,Gewerbe-und Kunstausstelling 1902 in Düsseldorf). A. Seyfferth. An illustrated review of this large German exposition, particularly of the electric and steam plants. Serial. 2 parts. 8000 w. Elektrotech Zeitschr—May 8 and 15, 1902. No. 48210 each B.

The Düsseldorf Exposition of 1902 (Die Düsseldorfer Ausstelling 1902). An illustrated general review of this large German exposition. Serial. 1st part. 1500 w. Glasers Annalen—May 1, 1902. No. 48242 D.

The Düsseldorf Exposition of 1902 (Exposition Industrielle de Düsseldorf en 1902). Alex. Gouvy. A general review of the exposition, with plan, and statistics of the Rhenish-Westphalian district and its industries, particularly coal and iron. 1 plate. 5000 w. Mem Soc Ing Civils de France—Feb., 1902. No. 48407 G.

The Rhenish-Westphalian Industrial Exposition (Rheinisch-Westfälische industrie Ansstellung). An illustrated general review of the engineering features of this large German exposition. 4000 w. Stahl u Eisen—May 1, 1902. No. 48274 D.

See also Mechanical Engineering; Mining and Metallurgy.

Economics.

The Study of Economics. Editorial

discussing the value of this study, its relation to the engineer, etc. 3000 w. Engng—May 9, 1902. No. 48183 A.

Engineering Societies.

The Engineering Societies of Great Britain and Germany (Développement des Associations d'Ingénieurs en Angleterre et en Allemagne). M. Alby. A review of the principal engineering associations of Great Britain and Germany, their organization, objects, numbers, property, work, etc., with diagrams. 8000 w. Bull Soc d'Encouragement—April, 1902. No. 48290 G.

Factory Office.

The Factory Office as a Productive Department. Kenneth Falconer. Mr. Falconer's third paper discusses the relations of the factory office to the stock room and shipping department. 3000 w. Engineering Magazine—June, 1902. No. 48396 B.

French Coal Miners.

Labor Conditions at the Coal Mines of Northern France (Arbeiterverhältnisse und Arbeiter-Wohlfahrtseinrichtungen im Steinkohlenbezirk der Departments Nord und Pas-de-Calais in Nordfrankreich). Hr. Tittler. A review of the coal miners' work, social conditions, benevolent associations, etc., and illustrations of workmen's dwellings. 1 plate. 5500 w. Glückauf—May 10, 1902. No. 48260 B.

Labor.

The Labor Question in Providence. Substance of the form of agreement presented by the employees for the acceptance of the United Traction & Electric Co., with the reply of the Company. 2000 w. St Ry Rev—May 20, 1902. No. 48341 C.

The Relative Position of Employer and Employed. Edward B. Gilmour. Arguments showing the interests are co-equal. 1100 w. Jour Am Found Assn—May, 1902. No. 47921.

Municipal Undertakings.

Municipal Socialism in Great Britain. Discussing the ownership and operation of certain undertakings and enterprises by the municipality, supposedly for the public good, and the increasing development of such enterprises in Great Britain. 4200 w. U. S. Cons Repts, No. 1345—May 19, 1902. No. 48136 D.

Profit-Sharing

A Dividend to Labor. J. Holliday. Read before the North of England Gas Mgrs. Assn. A few ideas on the subject of profit-sharing as related particularly to gas undertakings. 2500 w. Jour Gas Lgt—April 29, 1902. No. 48076 A.

Shipping Combination.

The American Shipping Combine. Editorial discussion of the proposed arrangement for the control of the Atlantic shipping trade. 3500 w. Engng—May 2, 1902. No. 48065 A.

The Atlantic Shipping Combination. Editorial discussion of the schemes of J. Pierpont Morgan in this field. 1200 w. Engr, Lond—May 2, 1902. No. 48058 A.

The Shipping Combine. Editorial discussion of the recent arrangements under the leadership of Mr. J. P. Morgan, and the effect on British trade. 3000 w. Engng—May 16, 1902. No. 48363 A.

United States.

Some Great Things Which Make Our Country Great. John Birkinbine. Reviews the resources of the country, the industries, engineering works and wealth, in a general way. 2400 w. Pro Engrs Club of Phila—April, 1902. No. 47842 D.

Works Management.

Money-Making Management for Workshop and Factory. C. U. Carpenter. Mr. Carpenter''s fifth paper discusses the operation of a complete system of stock tracing, and inspection. 5000 w. Engineering Magazine—June, 1902. No. 48398 B.

MARINE AND NAVAL ENGINEERING

Armament.

The Admiralty Policy as to Armament. Editorial discussing the need of rearmament of the British fleet. 1500 w. Engng—May 16, 1902. No. 48364 A.

Barkentine.

The Steam Barkentine Gauss of the German Antartic Expedition. George Crouse Cook. Illustrated description of this vessel for special service built at Kiel, Germany. 1300 w. Marine Engng—May, 1902. No. 47930 C.

Battleship.

The New French Battleship Suffren. Illustrations with description. 1000 w. Engr, Lond—May 9, 1902. No. 48187 A.

Boats.

Boats and Boat Building in the Malay Peninsula. H. Warington Smythe. An illustrated article describing the types of boats and the conditions they were to meet, methods of building, etc., with list of boats and tabulated information. Also discussion. 9600 w. Jour Soc of Arts—May 16, 1902. No. 48342 A.

Conveying.

Handling Material in Shipyards. Waldon Fawcett. Some of the recent devices for expeditiously and economically handling heavy material are illustrated and described. 1200 w. Sci Am—May 24, 1902. No. 48300.

Economy.

The Growth of Economy in Marine Engineering. W. M. McFarland. Mr. McFarland's concluding paner discusses the improvements which have particularly affected the performance of naval engines. 5000 w. Engineering Magazine—June, 1902. No. 48397 B.

Explosion.

The Explosion of H. M. S. "Mars." A statement of the facts so far as known, and explanation of the cause. 1400 w. Engng—April 25, 1902. No. 47884 A.

Liner.

New Orient Liner Orontes. Describes a new twin-screw steamer intended for the Australian trade. Ill. 1000 w. Engr, Lond—May 16, 1902. No. 48369 A.

Motor Launches.

Motive Powers for the Modern Launch. E. W. Roberts. A fully illustrated study of the marine applications of electrical, gasoline, and oil motors, especially for the propulsion of launches and small boats. 5000 w. Engineering Magazine—June, 1902. No. 48392 B.

Refrigeration.

Refrigeration on Shipboard. E. N. Percy. The first of a series of articles written to urge the use of a higher standard of refrigerating machinery for marine service, its inspection, etc. 1800 w. Ill. Marine Engng—May, 1902. Serial. 1st part. No. 47929E C.

Ship Resistance.

The Resistance Due to Accompanying Waves (Résistance Due aux Vagues Satellites). M. de Bussy. A mathematical discussion of ship resistance due to the accompanying waves. 1500 w. Comptes Rendus—April 14, 1902. No. 48424 D.

Ship Yards.

Organization of Ship Yards. Theodore Lucas. Considers points relating to the organization to adapt it to its natural run of business. 2000 w. Naut Gaz—May 8, 1902. No. 48031.

Steamships.

Pacific Mail Steamships Korea and Siberia, built by the Newport News Shinbuilding and Dry Dock Co. Illustrated detailed description of the largest ships yet built in America. 4800 w. Marine Engng—May, 1902. No. 47928 C.

The Growth of the Trans-Atlantic Steamship. Interesting diagrams, with notes on the development. 2000 w. Sci Am—May 3, 1902. No. 47853.

Testing Tank.

See Electrical Engineering, Power Applications.

Warships.

Warships (La Marine Militaire). Hector Pouleur. An illustrated general review of naval architecture, warship construction and armament, types of warships, and also brief account of latest ocean liners. 2 plates. 14000 w. Rev Univ d Mines—Feb., 1902. No. 48415 H.

Wrecking.

The Salving and Floating of Wrecked Vessels (Sauvetages et Renflouages des Navires Neufragés). M. Dibos. A general review of methods of wrecking and raising sunken boats and ships. 10000 w. Mem Soc Ing Civils de France—March, 1902. No. 48411 G.

MECHANICAL ENGINEERING

AUTOMOBILES.

Accumulators.

Some Modern Automobile Accumulators. Illustrations and descriptions of typical battery cells used in the electric vehicles at the present time. 1500 w. Sci Am—May 17, 1902. No. 48101.

Automobiles.

Automobiles. Hiram Percy Maxim. Discusses four classes of city transportation where motor vehicles should prove more satisfactory than the horse. Also general discussion. 12400 w. Ill. Pro Engrs' Soc of W Penn—April, 1902. No. 47890 D.

Condensers.

Steam Condensers. Arthur L. Stevens. Considers the application to automobiles, the advantages and disadvantages. 1000 w. Horseless Age—May 14, 1902. No. 48091.

Daimler Motor.

King Edward's Daimler. A. F. Sinclair. A brief account of Coventry, England, with history of the Daimler Company, and illustrated descriptions of cars made for King Edward VII. 4000 w. Auto Mag—May, 1902. No. 47829 C.

Endurance Run.

Long Island's Century. Francis P. Prial. An illustrated account. 1700 w. Auto Mag—June, 1902. No. 48354 C.

Long Island Endurance Contest. An illustrated report of the contest, the vehicles entered and their performance, etc. 22500 w. Horseless Age—April 30, 1902. No. 47946.

The Long Island Contest from the Standpoint of a Steam Carriage User.

Ernest Duval. Remarks on the contest and vehicles tested. 1500 w. Horseless Age—May 7, 1902. No. 48017.

Exhibitions.

Lamps, Burners and Heating Apparatus at the Paris Alcohol Exposition. Illustrated description of exhibits. 3200 w. Sci Am Sup—May 17, 1902. No. 48104.

Motor Car Exhibition at Islington. Report of a very successful exhibition, with illustrated descriptions of exhibits. 3500 w. Engr, Lond—April 25, 1902. Serial. 1st part. No. 47887 A.

The Motor-Car Exhibition. A brief account of some of the exhibits at Islington, England, where an exhibition has recently been held. Also editorial. 5200 w. Engng—April 25, 1902. No. 47883 A.

Ignition.

Early Electric Ignition. Douglas Leechman. Gives brief extracts from early patents showing electric ignition for internal combustion motors to be nearly fifty years old. 1000 w. Autocar—April 26, 1902. No. 47867 A.

Lurry.

A. Napier Lurry. Illustrates and describes the construction of a patrol lurry. 1800 w. Auto Jour—May 17, 1902. No. 48347 A.

Mechanical Traction.

Mechanical Road Traction. A. E. A. Edwards. Abstract of a paper read before the Birmingham Assn. of Mech. Engrs. Briefly reviews the history and considers present problems under heads of (1) Resistances to motion; (2) motive power; (3) cost of running; (4) future developments. 3700 w. Mech Engr—May 3, 1902. No. 48069 A.

Motor Car.

The 40 H. P. Mercedes-Simplex. An illustrated description of the general arrangement of the car, mentioning the special features. 2000 w. Autocar—May 10, 1902. Serial. 1st part. No. 48161 A.

The Gillet-Forest Car. An illustrated description of one of the most interesting of recent French cars. The framework is built entirely of tubes. 2000 w. Auto Jour—May 10, 1902. No. 48162 A.

Motor Car Trials.

Industrial Motor Car Trials in France. Begins a report of the trial from Paris to Monte Carlo, a distance of about 700 miles to be covered in 11 days. Illustrates and describes the vehicles entered and reports their performance. 2200 w. Engr, Lond—May 2, 1902. Serial. 1st part. No. 48055 A.

Speed.

How to Estimate the Speed of an Automobile. A. L. Clough. Gives a table corresponding to the time required to cover a mile, and considers methods of determining speed. 800 w. Horseless Age—May 7, 1902. No. 48018.

Stability.

The Conditions of Stability for Automobiles on Curves (Sur les Conditions de Stabilité des Automobiles dans les Courbes). A. Petot. A mathematical discussion, with suggestions of causes of accidents to automobiles on curves. 600 w. Comptes Rendus—April 7, 1902. No. 48422 D.

Steam Carriage.

The First Road Engine. Angus Sinclair. Illustrated description of Cugnot's engine built in the 18th century. 800 w. Auto Mag—June, 1902. No. 48355 C.

The Hyler White Carriage. J. S. V. Bickford. General high praise of the design with criticism of a few details. 1600 w. Horseless Age—May 14, 1902. No. 48089.

Steering.

Improved Link Details of Locked Wheel Steering Devices. Hugh D. Meier. Illustrates and describes several devices that embody resilient members, discussing their advantages. 1000 w. Horseless Age —May 14, 1902. No. 48090.

Tests.

A. C. A.'s Official Stopping Tests. An illustrated account of tests made on Riverside Drive, New York, by the Automobile Club of America. 2500 w. Auto Topics —May 10, 1902. No. 47992.

Trial Runs.

Paris to Monte Carlo. An illustrated account of this 700 miles run, giving the performances of the industrial motor vehicles. 2200 w. Autocar—May 3, 1902. Serial. 1st part. No. 48072 A.

The Glasgow to London Non-Stop Trial. An account of the run, with some amusing incidents included. 3500 w. Auto Jour—April 26, 1902. No. 47869 A.

Trials.

Hill-Climbing and Consumption Trials. An illustrated account of the Automobile Club tests on the London-Oxford road and the scalings of Dashwood Hill, giving descriptions of vehicles. 4500 w. Autocar —May 17. 1902. No. 48344 A.

The Automobile Consumption and Hill Climbing Trials. An illustrated account of the performance of the vehicles, with tabulated results. 2400 w. Auto Jour— May 17, 1902. No. 48345 A.

Wolseley Works.

The Wolseley Works and Cars. An illustrated description of works for motor carriage building and some of the latest types of vehicles. 3500 w. Auto Jour— May 17, 1902. Serial. 1st part. No. 48346 A.

HYDRAULICS.

Centrifugal Pumps.

The Schabaver Centrifugal Pump (Pompe Centrifuge Schabaver). Gérard Lavergne. An illustrated description of pumps for lifting water to great heights, with account of tests. 2400 w. Génie Civil —April 19, 1902. No. 48283 D.

Plumbing.

Details of New York School Plumbing. Illustrated description of standard details for shower baths, drinking fountains, drains and laboratory fittings. 2300 w. Eng. Rec—May 3, 1902. No. 47862.

Pumping Engine.

A New High-Duty Pumping Engine of the Compensating Type. Illustrated description of a pumping engine in which the end stroke of one piston rod is reinforced from the other rod by means of a connecting link. 1100 w. Eng Rec—May 10, 1902. No. 47999.

Pumps.

Hydraulically Balanced Ashley Pump. Illustrated description of a new system of hydraulically balancing the load on the engine with the result that however the water level in the well may vary, the engine does exactly the same amount of work on successive up and down strokes. 2000 w. Engng—May 16, 1902. No. 48362 A.

Pump Valves.

Tests of the Relative Efficiency of Mechanically Operated and Automatic Spring Valves for Pumps (Versuche zur Ermittlung der Bawegungen und Widerstandsunterschiede Grosser Gestewerter und Selbstthätiger Federbelasteter Pumpen—Ringventile). Rud. Schröder. An exhaustive series of tests, showing the advantages of mechanically-operated pump-valves, of the Riedler type, with illustrations and many diagrams. 5 plates. 5000 w. Zeitschr d Ver Deutscher Ing—May 10, 1902. No. 48238 D.

Rams.

The Determination of the Efficiency of Hydraulic Rams. A. J. Wood, with discussion. A condensed study of the subject with discussions by William Kent, and by Prof. Theo. Woolsey Johnson. Ill. 6400 w. Stevens Ind—April, 1902. No. 47840 D.

MACHINE WORKS AND FOUNDRIES.

Annealing.

The Effect of Annealing Shot or Chilled Iron in the Determination of Phosphorus by the Permanganate Alkali Method. Charles E. Manby. Gives the method of analysis in detail. 1200 w. Pro Engrs' Soc of W Penn—April, 1902. No. 47891 D.

Boring.

Deep Hole Drilling in Gun Construction. J. M. B. Scheele. Describes the general features, giving sketches and engravings of the boring, turning and reaming operations on a 16-inch breech loading rifle built in the shops of the Government Army Gun Factory at Watervliet Arsenal, N. Y. 2200 w. Mach, N Y—May, 1902. No. 47909.

Chains.

The Spuhl New Chain Making Machine. Illustrated description of a machine, which will bend and weld effectively with report of tests as to the tensile strength of chains made. 1200 w. Ir Age—May 22, 1902. No. 48195.

Cranes.

See Electrical Engineering, Power Applications.

Cylinders.

Repairing a Broken Cylinder. H. M. Lane. An illustrated description of the work. 1000 w. Trans Am Soc of Mech Engrs, No. 0940—May, 1902. No. 47979.

Dies.

Artistic Die-Making. Joseph V. Woodworth. Illustrates and describes dies made in a small Brooklyn shop, and shows examples of work. 1200 w. Am Mach—May 15, 1902. No. 48094.

Cold Working Sheet Metal in Dies. John D. Riggs. Dies operated by presses are described and information concerning their use and economy given. Ill. 3000 w. Trans Am Soc of Mech Engrs, No. 0939—May, 1902. No. 47978.

Gain by Changing a Punching and Forming Operation. William H. Brooks. Illustrates a case of sheet metal stamping and the economy realized by a change in the method of production. 800 w. Am Mach—May 15, 1902. No. 48096.

Dividing.

A Scheme for Making the Universal Dividing Head Universal. W. A. Warman. Sketches and description of a device that gives accuracy. 600 w. Am Mach —May 15, 1902. No. 48095.

Engine Works.

Messrs. David Rowan and Co.'s Works, Glasgow. An illustrated detailed description of these fine works, with discussion of the engineering economy in the management of such works. 5400 w. Engng—May 9, 1902. No. 48179 A.

Grinding.

A Novel Tool-Grinding Attachment. Illustrates and describes a tool-grinding attachment designed by Prof. C. V. Boys for accurately grinding lathe and planing tools. 1000 w. Sci Am—May 24, 1902. No. 48198.

Heating.

Hot-Water Heating in a Hartford Residence. Illustrated description of the low-pressure gravity hot-water system in a 3-story, 72x48 ft. house, explaining some methods of calculating the sizes of different parts of the plant. 1200 w. Eng Rec—May 24, 1902. No. 48194.

Lathe.

Ring Turret Lathe. Illustrated description of a turret lathe having a number of novel features, the most interesting one being the turret which is made in the form of a ring and encircles the bed. 1500 w. Am Mach—May 22, 1902. No. 48197.

Mixing Iron.

Economy of Mixing Iron by Chemical Process and Removal of Barriers to Its Adoption. Thomas D. West. Discusses the benefits of mixing by chemical analysis and movement to decrease the cost. 1400 w. Foundry—May, 1902. No. 47838.

Pattern Work.

Stopping Off and Saving Pattern Work. John M. Richardson. Illustrates and describes cases where great expense is saved by this process. 1000 w. Am Mach—May 1, 1902. No. 47935.

Planing.

Circular Planing Attachment. Illustrated description showing how the steam chest of a laundry mangle was machined to fit the ironing roller. 600 w. Am Mach—May 22, 1902. No. 48196.

Records.

Workshop Records in Cards and Files. George Parker. Read before the North-east Coast Inst. of Engrs. & Shipbuilders (Great Britain). Describes applications of cards for various purposes, and gives the origin of the system. 7700 w. Ir Trd Rev—May 1, 1902. No. 47926.

Screw-Threads.

A Proposed Standard for Machine Screw Thread Sizes. Charles C. Tyler. Attention is called to the inconvenience resulting from the variation in size and a standard is proposed having an angle of 60 degrees and a flat at the top of the thread equal to 1/8 of the pitch. Ill. 3500 w. Trans Am Soc of Mech Engrs, No. 0931—May, 1902. No. 47970 C.

Shear.

The Flying Shear. V. E. Edwards. Photographs and sectional drawings of the different styles of shears are given with description of operation and work accomplished. 1600 w. Trans Am Soc of Mech Engrs, No. 0936—May, 1902. No. 47975.

Shop Methods.

The National Cash Register Co., of Dayton, O., and Its Manufacturing and Cost-Keeping Methods. An illustrated article explaining the system adopted and its success. 8500 w. Ir Trd Rev—May 1, 1902. No. 47927.

Specifications.

Specifications for Steel Forgings, Steel Castings and Steel Boiler Plates. William R. Webster. The standard specifications of the American section of the International Assn. for Testing Materials are presented for discussion. 2500 w. Trans Am Soc of Mech Engrs, No. 0948—May, 1902. No. 47986.

Springs.

Construction of Elliptical Springs. Charles A. Lindstrom. Calls attention to the methods that should be followed in the calculations of elliptical and semi-elliptical springs so as to guard against an excessive deflection. Also discussion. Ill. 7600 w. Pro W Ry Club—April 18, 1902. No. 47944 C.

Hardening and Tempering Coil Springs. E. R. Markham. Suggestions helpful in securing success. 1300 w. Mach, N Y—May, 1902. No. 47910.

Tool Steel.

Points of Heat Treatment of Tool Steel. C. P. Crowe in the *American Blacksmith*. Gives suggestions and tables to serve as guides in hardening and tempering. 2000 w. Ir Trd Rev—May 8, 1902. No. 48032.

Wire.

The Diamond in Wire Drawing. S. Barnett. Information of interest concerning the selection of the stones and the drawing of copper and steel wire. 3200 w. Ir Age—May 29, 1902. No. 48376.

MATERIALS OF CONSTRUCTION.

Alloys.

A Useful Alloy of Copper, Zinc and Aluminum for Sand Casting. Erwin S. Sperry, in *Aluminum World*. Describes an alloy known as "aluminum silver," noting the characteristics, good qualities, uses, etc. 3000 w. Foundry—May, 1902. No. 47837.

Corrugated Metal.

The Moments of Inertia and of Resistance of Corrugated Sheet Metal (Zur Berechnung der Trägheits und Widerstandsmomente von Wellblechen). Leopold Pfeffer. Article with diagrams and tables founded on formulæ due to the late Prof. R. F. Mayer, of Vienna. 1500 w. Oesterr Wochenschr f d Oeffent Baudienst—April 12, 1902. No. 48215 B.

Leather.

Tests of Leather (Essais du Cuir dans ses Applications Industrielles). Henri Boulanger. A well illustrated account of an extensive series of tensile tests of leather prepared in various ways for industrial purposes, with tables and diagrams. Serial. 1st part. 9000 w. Bull Soc d'Encouragement—April, 1902. No. 48291 G.

MEASUREMENT.

Drafting.

Proportions and Spacing of Roman Letters. William Welch. An analysis of a number of the best Roman alphabets and their spacing, with rules for laying off such lettering. 3000 w. Eng Rec—May 17, 1902. No. 48133.

Extensometer.

A Roller Extensometer. Gus C. Henning. Describes the new type of instrument and its working. Ill. 2200 w. Trans Am Soc of Mech Engrs, No. 0945—May, 1902. No. 47983.

Metric System.

The National Bureau of Standards. S. W. Stratton. Shows the condition of affairs that led the U. S. Congress to establish the National Bureau of Standards, describing the work belonging to it, and showing the need of the adoption of uniform and correct standards, especially between nations, and urging the adoption of the metric system. Also discussion. 7700 w. Pro Engrs Club of Phila—April, 1902. No. 47843 D.

POWER AND TRANSMISSION.

Belting.

Belting for Power Transmission (Organes de la Transmission: Notes sur la Courroie). L. Tourneux. A discussion of belts and belting for the transmission of motion and power, with table of best speeds and horse-power. 2500 w. Revue Technique—May 10, 1902. No. 48401 D.

Chain Gear.

The Renold Silent Chain Gear. J. O. Nixon. An illustrated detailed discussion of a gear that may be run at high speeds, with no noise, for the transmission of any amount of power. 3500 w. Jour Fr Inst—May, 1902. No. 47994 D.

Compressed Air.

A New Means of Using Compressed Air in the Manufacture of Glassware. Illustrated description of a process invented by Paul T. Sievert, which bids fair to overcome the difficulties which have hitherto baffled the glass manufacturers. 1500 w. Sci Am—May 10, 1902. No. 48028.

Compressed Air. W. L. Saunders. Discusses the subject of compression, cooling, oil, etc., and concludes with a number of "Dont's," bearing on this subject. 3000 w. Can Min Rev—April 30, 1902. No. 47-903 B.

Conveyor.

A Cableway for Conveying Waste Material to the Dump Pile (Ueber die Aufstellung eines Seilbahnkrahnes zum Transporte des Tauben Materiales auf die Holde). Hans Haberfelner. An illustrated description of a Brown conveying plant at the surface of a brown coal mine at Fohnsdorf, Austria. 1 plate. 4000 w. Oesterr Zeitschr f Berg u Hüttenwesen—May 3, 1902. No. 48267 B.

Cranes.

New Cranes in German Dockyards. Illustrates and describes recent equipments of these yards for handling large and heavy weights. 1300 w. Engr, Lond—April 25, 1902. No. 47888 A.

Crank.

A Three Headed, or Triangular Crank (Biellé à Trois Têtes on Bielles Triangulaires). M. Chaud. An illustrated description of transmitting mechanism in which, besides the cranks on the two working shafts, there is a crank on an idle shaft, the three being connected by a three-armed rigid piece. 600 w. Revue Technique—April 25, 1902. No. 48298 D.

Elevators.

Elevator Safeties. Charles R. Pratt. The defects of old-style safety devices are pointed out, and a new type is described. Ill. 2000 w. Trans Am Soc of Mech Engrs, No. 0946—May, 1902. No. 47984.

Industrial Plant.

The Oxford Paper Mills. Illustrated description of a mill for manufacturing daily 225 tons of soda and sulphite fiber and 200 tons of paper. The hydraulic and steam power plants are described, the various processes of making pulp and paper are explained, and the plant for the purpose is illustrated. 5900 w. Eng Rec—May 3, 1902. No. 47857.

Mechanical Power.

Shop Transportation. Cloyd Marshall. Illustrates and describes some mechanical appliances for the transportation of heavy materials. 2000 w. Engr, U S A—May 15, 1902. No. 48153.

Power Plant.

The Billancourt Compressed Air Plant, Paris. Illustrated description of plant of 7000 H. P. for furnishing compressed air at 1,140 lbs. for the use of cars operated by compressed air. 1400 w. Eng Rec—Mav 3, 1902. No. 47858.

Worm Gear.

Globoid Worm Gear (Globoid-schnecken). Prof. Georg Lindner. A well illustrated description of the globoid (or Hindley) worm gears, as modified by Lorenz, of Ettlingen, Baden, with account of tests. 2000 w. Zeitschr d Ver Deutscher Ing—May 3, 1902. No. 48235 D.

SPECIAL MOTORS.

Blast Furnace Gas.

Blast Furnace Gas and the Thwaite-

Gardner Blowing Engine (L'Utilisation des Gaz de Hauts Fournaux. Machine Soufflante Thwaite-Gardner). Jules Deschamps. A discussion of the utilization of blast-furnace gas, and an illustrated description of the Thwaite-Gardner blowing engine of the Otto type. 2500 w. Rev de Mecanique—April, 1902. No. 48294 E+F.

Engines.

Steam, Gas and Oil Engines: Cost of Fuel per Brake Horse-Power per Hour and Their Heat Efficiencies. Bryan Donkin. Paper prepared for meeting of Inst. of Gas Engrs. Discusses the fuel required to produce power by means of these various engines. 2200 w. Gas Wld—May 3, 1902. No. 48122 A.

Exhaust Gases.

A Method of Determining the Temperature of Exhaust Gases in Combustion Engines. H. Fernald. Describes the forms of exhaust chamber which were tried, and a record of the experiments made is given. Ill. 3200 w. Trans Am Soc of Mech Engrs. No. 0932—May, 1902. No. 47971 C.

Gas Engines.

The Heat Balance of Gas Engines (Beitrag zur Wärmebilanz des Gasmotors). A. Staus. A discussion of the balance of the energy input and output of gas engines, with an illustrated description of a calorimeter for measuring the energy in the exhaust gas due to its heat and velocity of efflux. 1000 w. Zeitschr d Ver Deutscher Ing—May 3, 1902. No. 48236 D.

Working Details of a Gas Engine Test. R. H. Fernald. A complete system for testing gas engines is given, with the details of taking observations, making records and working up results, together with a blank for the recording of data and the complete log of two tests made. 14500 w. Trans Am Soc of Mech Mgrs, No. 0933—May, 1902. No. 47972 D.

Ignition.

Ignition and Ignition Gears for Internal Combustion Engines. Holberry Mensforth. Lecture delivered before the Sheffield Soc. of Engrs. and Metallurgists. A review of ignition gears up to the present, and a discussion of points showing the effects of a variation in the time and point og ignition. 5000 w. Mech Engr—May 10, 1902. No. 48154 A.

The Sparking Coil. E. J. Stoddard. Considers the working of ordinary coils, and gives facts obtained from experiments and actual trials. 3000 w. Horseless Age —May 21, 1902. No. 48317.

Internal Combustion Engines.

The Calculation of the Principal Dimensions of the Internal Combustion Engines (Berechnung der Hauptmasse der Verbrennungsmotoren). Hugo Güldner. An article on the design of these engines, with formulæ for the stroke, piston diameter, and number of revolutions, and also table of fuel data. 3000 w. Zeitschr d Ver Deutscher Ing—April 26, 1902. No. 48230 D.

STEAM ENGINEERING.

Balanced Engine.

The Wizzell Balanced Engine. R. J. Isaacson. Illustrated description with statement of advantages claimed. 2300 w. Mech Engr—April 26, 1902. No. 47871 A.

Blowing Engine.

See Mining and Metallurgy, Iron and Steel.

Boilers.

Another Scamped Boiler Job. An illustrated article discussing errors of construction. 1700 w. Locomotive—March, 1902. No. 48082.

Economy in Boiler Room. Paul McIntire. Briefly considers the conditions regulating boiler capacity, relation of grate surface to various fuels, scale and unclean boilers, etc. 1500 w. Ice & Refrig—May, 1902. No. 47896 C.

Leaky Boilers. Editorial discussion of the sources of weakness that cause these leaks. 1000 w. Loc Engng—May, 1902. No. 47961 C.

Boiler Cleaners.

Methods and Apparatus for Cleaning Boiler Tubes (Procédés et Appareils de Nettoyage des Chaudières Tubulaires). Illustrated description of all kinds of brushes and scrapers for cleaning the inside and outside of boiler tubes. 3500 w. Rev de Mecanique—April, 1902. No. 48293 E+F.

Objections to Water-Tube Boilers. W. H. Wakeman. Gives reasons for disapproving of this type of generator. 1700 w. Elec, N Y—May 14, 1902. No. 48030.

The Construction and Inspection of Steam Boilers; with Especial Reference to the "City of Trenton" Disaster. Discussion with illustrations. 5700 w. Jour Fr Inst—May, 1902. Serial. 1st part. No. 47993 D.

Boiler Trials.

Comparative Boiler Trials in Italy. Concerning the experiments recently made by the Italian Government on three large and precisely similar warships to determine the relative values of boilers of different types. Ill. 3000 w. Engng—May 16, 1902. No. 48-359 A.

Condensing.

Condensing vs. Non-Condensing. Charles L. Hubbard. A discussion of this subject showing that the value of a condenser depends entirely upon existing conditions, and to a great extent upon the relative cost of water and coal. 2000 w. Am Elect'n—June, 1902. No. 48310.

Steam Condensers. Charles L. Hubbard. Presents the fundamental principles upon which a condenser operates, and gives descriptions of some of the standard types in use. Ill. 2000 w. Am Elect'n —May, 1902. No. 47949.

Dusseldorf Exposition.

Steam Engines at the Düsseldorf Exposition (Die Industrie und Gewerbeausstellung in Düsseldorf 1902. Die Dampfmaschinen). H. Dubbel. A well illustrated and comprehensive review of the steam engines exhibited at this large German exposition. Serial. Part 1. 1 plate. 3000 w. Zeitschr d Ver Deutscher Ing—May 3, 1902. No. 48232 D.

The Boilers at the Düsseldorf Exposition of 1902 (Die Industrie und Gewerbeausstellung in Düsseldorf 1902. Die Dampfkessel). H. Dubbel. A well illustrated, comprehensive review of the boilers and accessories exhibited at this large German exposition. Serial. 1st part. 4000 w. Zeitschr d Ver Deutscher Ing—May 3, 1902. No. 48234 D.

Engines.

An American Poppet-Valve Engine. Illustrated description of an engine of special interest from the fact that it is practically the first designed and built in the United States for electric station work with poppet valves. 4000 w. Power—May, 1902. No. 47931 C.

Final Report of the Committee Appointed to Standardize a System of Testing Steam Engines. The final revision of the report made after embodying the discussions. 25000 w. Trans Am Soc of Mech Engrs, No. 0943—May, 1902. No. 47981 D.

500 Horse-Power Tandem Engine and Alternator. An illustrated description of an exhibit at the Düsseldorf Exhibition 600 w. Engng—May 16, 1902. No. 48360 A.

Rolling Mill Engine. Illustrates and describes the compound engines at the Wardsend Steel Works, Sheffield, Eng. Ropes are used for driving, one of the drives having extraordinary length, but giving satisfactory results. 600 w. Engr, Lond—May 2, 1902. No. 48059 A.

The Tosi Engines. Illustrated description of horizontal tandem engines made in Italy for the Milan-Verese Electric Railway. 1000 w. Elec Engr, Lond—April 25, 1902. No. 47878 A.

Vertical Compound Engine for Cape Town. Illustrated description of Ferranti engine for the new supply station, calling attention to interesting features. 1800 w. Engr, Lond—May 9, 1902. No. 48186 A.

Hoisting Engines.

See Mining and Metallurgy, Mining.

Horse-Power.

A Horse-Power Chart. A. G. Holman. Gives chart and explanation of its use. 1000 w. Power—May, 1902. No. 47932 C.

Indicator.

The Rosenkranz Indicator with Cold Spring (Ueber einen Neuen Indikator mit Kaltfeder). An illustrated description of an indicator with an uncovered spring, which thus keeps cool and retains its accuracy. With diagrams of tests. 1 plate. 400 w. Glückauf—April 19, 1902. No. 48256 B.

Indicator Cock.

Improved Indicator Cock for Engines. Albert K. Mansfield. Illustrated description of a four-way cock to allow of taking a card from the steam chest or exhaust pipe in order to determine whether the piping between boiler and engine, or between engine and exhaust opening has been properly installed. 700 w. Trans Am Soc of Mech Engrs, No. 0938—May, 1902. No. 47977.

Joints.

A Swivelling Joint for a Sixteen-Inch High Pressure Steam Main. R. E. Curtis. The swivel joints described are used to connect two 16-inch steam mains, at points where the expansion is such as to make some flexible arrangement imperative. Ill. 600 w. Trans Am Soc of Mech Engrs, No. 0937—May, 1902. No. 47976.

Liquid Fuel.

Fuel Oil. W. W. Reed. Read at meeting of the Southwestern Gas, Electric and Street Railway Assn. Discusses the commercial side of the question, and the utilization of oil as fuel for steam purposes. 2600 w. Am Gas Lgt Jour—May 12, 1902. No. 48052.

Liquid Fuel Combustion. Charles E. Lucke. The difficulties are described and methods classified. An illustrated account is given of a series of experiments which were carried on to find a satisfactory burner, and the burner which proved successful. 8700 w. Trans Am Soc of Mech Engrs, No. 0934—May, 1902. No. 47973 C.

Liquid Fuel—Its Application, Past and Present. R. G. Paddock. Considers methods of application, devices used, experimental tests, etc. 7500 w. Jour Assn of Engng Soc's—April, 1902. No. 48087 C.

See also Railway Engineering, Motive Power and Equipment.

Pipe Coverings.

Tests of Steam Pipe Coverings. George H. Barrus. An account of tests made on a large scale and in most careful manner, with conclusions. Ill. 12600 w. Trans Am Soc of Mech Engrs, No. 0952—May, 1902. No. 47989 D.

The Loss of Heat from Covered Steam Pipes. Charles P. Paulding. Considers the tests of Peclet, Barrus and others, analyzing the results and giving applications of the theory. 5000 w. Stevens Ind —April, 1902. No. 47839 D.

Piping.

A Comparison of the Steam Piping Systems of the Four Large Electrical Stations of New York. C. G. Robbins. Presents, in a manner for easy comparison, the steam plants of the N. Y. Edison Co. (Waterside), the Manhattan El. Ry. Co., the Third Ave. St. Ry. Co., and the Metropolitan St. Ry. Co. Ill. 3700 w. Am Elect'n—June, 1902. No. 48306.

Steam Fitting. Warren E. Willis. Notes and suggestions upon erecting piping. 1800 w. Mach, N Y—May, 1902. No. 47912.

Pistons.

A Graphical Determination of Piston Acceleration. J. N. Le Conte. Presents a method for finding the acceleration of the cross-head for any given angular position of the crank. 1000 w. Trans Am Soc of Mech Engrs, No. 0953—May, 1902. No. 47990.

The Strength of Pistons of Steam Engines (Contribution à l'Etude de la Resistance des Pistons des Machines à Vapeur). Hector Pouleur. A mathematical discussion of the forces acting on pistons and their resistance. 7000 w. Rev Univ d Mines—April, 1902. No. 48421 H.

Speed Regulation.

Speed Regulators for Steam Engines (Etude des Regulateurs de Vitesse des Moteurs à Vapeur). The program of a section of the Société Internationale des Electriciens, a paper by C. F. Guilbert, on driving alternators in parallel, and notes by various other members. Diagrams. 13000 w. Bull Soc Internationale d Electriciens—April, 1902. No. 48406 E.

Steam Turbines.

The Coming of the Steam Turbine. Editorial reviewing the development. 1400 w. Loc Engng—May, 1902. No. 47962 C.

The Steam Turbine Generator of the Hartford Electric Light Company. An illustrated description of the largest turbine generating apparatus in the United States. 1800 w. Elec Rev, N Y—May 17, 1902. No. 48142.

Superheated Steam.

The Use of Superheated Steam. W. H. Wakeman. Considers some points that are disadvantages in the use of superheated steam. 1500 w. Elec, N Y—May 21, 1902. No. 48152.

Superheater.

The Cruse Patent Controllable Superheater. Illustrated description of an improved form. 1300 w. Prac Engr—May 16, 1902. No. 48343 A.

Thermodynamics.

Analysis of the Steam-Engine Cycle. R. H. Thurston. A study in thermodynamics. Discusses Rankine's formula. 1600 w. Sib Jour of Engng—April, 1902. No. 47828 C.

Valves.

Modern Practice in Rocking Valves and Valve Gears. H. F. Schmidt. Considers some of the different types of valves and valve gears employed in modern steam engine practice, with reasons for the modifications of the original Corliss type. Ill. 6500 w. Am Elect'n—June, 1902. No. 48-308.

The Phoenix Steam-Pressure Regulating and Automatic Cut Off Valves. Descriptive account with illustrations. 1200 w. Engng—April 25, 1902. No. 47882 A.

MISCELLANY.

Aeronautics.

Aerial Navigation (Ueber die Frage der Luftschiffahrt). Prof. Georg Wellner. An illustrated review of navigable balloons and flying machines, with a plea for machines driven upward by a propeller with vertical shaft. Also illustrations of apparatus for showing stream lines in air. 6000 w. Zeitschr d Oesterr Ing u Arch Ver—May 2, 1902. No. 48223 B.

New Airships Under Construction for the British War Office. Illustration and description of Dr. Barton's aeroplane airship. 1300 w. Sci Am—May 3, 1902. No. 47852.

Exhibition.

The Düsseldorf Exhibition. Illustrated detailed descriptions of the more striking industrial products exhibited, showing the great progress in the German industries. 1500 w. Engng—May 9, 1902. No. 48181 A.

The Düsseldorf Exhibition. A descriptive account of interesting exhibits, especially in metallurgy and mechanics. 3000 w. Engng—May 16, 1902. No. 48365 A.

Explosives.

The Evolution of Smokeless Powder and Other High Explosives. A review of the development, discussing the shape of the powder, bursting charges, etc. 5200 w. Engng—May 2, 1902. No. 48061 A.

The Manufacture of Gun-Cotton Charges. Illustrates and describes a new method of compressing gun-cotton for charges of locomotive torpedoes, shells, submarine mines, etc. 2700 w. Engng—May 9, 1902. No. 48182 A.

Gun.

The New 15-Pounder Quick-Firing Field Artillery Gun. Full description with detail drawings and illustrations of the new German quick-firing field artillery gun of 3 in. calibre, together with its carriage. After a series of exhaustive trials this gun has been adopted for service in the British army. 3000 w. Engr, Lond—May 16, 1902. No. 48366 A.

Heating.

Hot-Water Heating from a Central Steam Plant. Illustrated description of a system employed to utilize old hot-water heating installations by warming the water in special heaters connecting with a central plant. 1000 w. Eng Rec—May 10, 1902. No. 48004.

Index.

Technical Index and File. R. H. Soule. An illustrated description of the system used is given. 1200 w. Trans Am Soc of Mech Engrs, No. 0947—May, 1902. No. 47985.

Laboratory.

A New Government Laboratory and Its Work. George Steiger and E. T. Allen. Illustrated description of these new laboratories and their equipment. 2000 w. Eng & Min Jour—May 10, 1902. No. 48034.

Mechanical Plant.

The Mechanical Plant in the University Club, New York City. Illustrated description of the plant for heating, ventilation, electric light and elevator service in a leading New York club-house. 2300 w. Eng Rec—May 3, 1902. No. 47861.

The Mechanical Plant of the Frick Building, Pittsburg. Illustrated description of the installation in a 20-story office building, embracing 1200-h.p. in water-tube boilers, four 150-KW. generating units, 11 long travel hydraulic elevators, a refrigerating plant and a special system of electric wiring. 3100 w. Eng Rec—May 17, 1902. No. 48128.

Refrigeration.

Analyzing the Compressor. Gardner T. Voorhees. Begins an investigation into the economical action of the compression refrigerating machine. 1100 w. Ice & Refrig—May, 1902. Serial. 1st part. No. 47897 C.

Refrigerating Plant in Berlin. R. Stetefeld. An illustrated description of a modern municipal cold storage and ice-making plant in Germany. 4700 w. Ice & Refrig —May, 1902. No. 47895 C.

Sand Blast.

The Sand Blast (Die Sandstrahlgebläse). Ernst Schulz. An illustrated general review of the sand blast and the various kinds of apparatus for producing the blast. Serial, 2 parts. 8000 w. Zeitschr d Ver Deutscher Ing—May 10 and 17, 1902. No. 48239 each D.

Vacuum Pumps.

A Study of Vacuum Pumps (Etude sur Pompe Sèche). E. Portemont. A discussion of the air pumps used in drying beet roots in sugar refineries, with suggestions for improved valve and valve gear, with diagrams. 2500 w. Revue Technique—April 10, 1902. No. 48297 D.

Wire Drawing.

See Mining and Metallurgy, Iron and Steel.

MINING AND METALLURGY

COAL AND COKE.

American Exports.

American Coal in France (Les Charbons Americains en France). A. de Gennes. A review of the conditions, particularly in the United States, which have led to the export of coal to France. Map and diagram. 2500 w. Mem Soc Ing Civils de France—Feb., 1902. No. 48408 G.

Australia.

The Coal Resources of Australia. James Stirling. Report of a lecture in London. A Review of the coal-beds of the separate colonies, with illustrations. 2000 w. Col Guard—May 9, 1902. No. 48169 A.

Calorific Power.

The Heating Effect of Coal. W. R. Crane. Gives a simple method, with a description of apparatus which may be constructed easily and at small cost, which will permit such tests to be made with ease and dispatch and a fair degree of accuracy. 4000 w. Mines & Min—May 1902. No. 48010 C.

Coal Mining.

A Comparison of Coal Resources and Coal Getting. A. S. E. Ackermann. A critical comparison of British and American coal mining practice, showing the cost reductions effected by mining machinery. 3000 w. Engineering Magazine—June, 1902. No. 48393 B.

Coking.

The Manufacture of Coke from Compressed Fuel. John H. Darby. An account of results obtained with compressed fuel and the benefits derived. 2300 w. Ir & Coal Trds Rev—May 9, 1902. No. 48171 A.

The Recovery of By-Products in Coke-Making. J. Thiry. On the advantages of the Otto-Hilgenstock coke-oven, with report of tests with regard to temperature, draught and duration of the coking process. 3500 w. Ir & Coal Trds Rev—May 9, 1902. No. 48174 A.

Düsseldorf Exposition.

The Exhibit of the Dortmund District Society of Mining Industry at the Düsseldorf Exposition (Die Kollektwausstellung des Vereins für die Bergbaulichen Interessen im Oberbergamtsbezirk Dortmund auf der Düsseldorfer Ausstellung 1902). Hr. Hecker. A review of an exhibit of coal mining, mining machinery, etc., with plan. 3500 w. Glückauf—April 26, 1902. No. 48258 B.

Germany.

A Brief Review of the Coal Reserve and Mining Conditions in Germany. A summary analysis of a description given in a volume circulated by the Dortmund Coal-owners' Assn. 2000 w. Ir & Coal Trds Rev—April 26, 1902. No. 47889 A.

Inspection.

Coal Mines Inspection in 1901. Report of the Swansea district. 1800 w. Col Guard—May 16, 1902. No. 48357 A.

Coal Mines Inspection in 1901. A report of the West Scotland district. 3300 w. Col Guard—May 9, 1902. No. 48168 A.

Iowa.

Character and Strategraphical Peculiarities of the Southwestern Iowa Coal Fields. Charles R. Keyes. Describes these deposits, giving analyses. 700 w. Eng & Min Jour—May 10, 1902. No. 48036.

Mining Plant.

The Ehrenfeld Plant of the Webster Coal and Coke Co. Illustrated description of a large modern plant containing a number of novel features. 6200 w. Mines & Min—May, 1902. No. 48006 C.

North-West Territories.

Coal Mining in the North-West Territories and Its Probable Future. Frank B. Smith. A general outline of the coal-mining of this region and its value. 4000 w. Can Min Rev—April 30, 1902. No. 47902 B.

Progress.

Colliery Engineering Progress. C. M. Percy. Describes the Lancashire boiler, its proportions and method of construction; discusses early practice in smoke prevention, etc. 3500 w. Mines & Min—May, 1902. No. 48012 C.

Rhenish-Westphalian Syndicate.

The Report of the Rhenish-Westphalian Coal Syndicate for 1901 (Vorstandsbericht des Rheinisch-Westfälischen Kohlensyndikats über das Jahr 1901). A review of the report of the board of directors of this great German syndicate covering production, transportation, exports, etc. 2000 w. Glückauf—April 26, 1902. No. 48259 B.

Schnablegger's Coking Process.

Schnablegger's Process for Coking Saw Dust, Peat and Brown Coal (Schnablegger's Verfahren Sägespäne Torf, Lignit und Braunkohle zu Vercoken). F. Toldt. An account of a process part of which is still secret, with illustrations of the coke. 1000 w. Oesterr Zeitschr f Berg u Hüttenwesen—April 12, 1902. No. 48262 B.

Volcanic Action.

The Spanish Peaks Coal Region in Southern Colorado. Arthur Lakes. An illustration of the effects of volcanic action on coal seams. Ill. 2000 w. Mines & Min—May, 1902. No. 48013 C.

COPPER.

British Columbia.

British Columbia—Boundary Mining District—Progress in Mining and Smelting. William M. Brewer. Illustrated description of interesting features of this district where mining and smelting are carried on at less cost than at any other place in North America. 4300 w. Eng & Min Jour—May 3, 1902. No. 47956.

The Ore Deposits of the Boundary District, B. C. R. W. Brock. Read before the Can. Min. Inst. The district treated of occupies a foremost place in British Columbia lode mining and is one of the most important districts in Canada in the production of copper. 3500 w. B C Min Rec—May, 1902. No. 48088 B.

The Production of Copper in the Boundary District, B. C. Dr. Albert R. Ledoux. Describes the characteristics of the ore deposits, and gives costs and general information. 2500 w. Can Min Rev—April 30, 1902. No. 47901 B.

Converters.

Copper Converters (Les Convertisseurs pour Cuivre). P. Jannetaz. An extended review of the theory and practice of converters used in copper metallurgy, with particular account of the Manhes and David system, and the "selecting" process of the latter. 1 plate. 8000 w. Men Soc Ing Civils de France—Feb., 1902. No. 48-410 G.

Metallurgy.

The Wet Process and Cementation in the Metallurgy of Copper (La Metallurgie du Cuivre par Voie Humide et la Cementation). Paul Chalon. A review of copper metallurgical methods. 4000 w. Rev Univ d Mines—Feb., 1902. No. 48416 H.

Mexico.

The Cananea Copper Camp. G. E. P. Smith. Illustrated description of this camp which is the most modern in its equipment and methods of those in this vicinity. 900 w. Min Rept—May 22, 1902. Serial. 1st part. No. 48326.

Production.

The World's Copper Production. Horace J. Stevens. Gives the amount and relative production of the various countries, states, and mines, and discusses the prospects for the coming year. 3000 w. Mines & Min—May, 1902. No. 48014 C.

Smelting.

Costs and Profits in Pyritic Smelting of Low-Grade Copper Ores. F. H. Prentiss. Describes method used and gives calculations and the data on which they were based. 1100 w. Min & Sci Pr—May 10, 1902. Serial. 1st part. No. 48097.

Small Smelting Works. Herbert Lang. Illustrates and describes a copper smelter in Southern California, and discusses the requirements of small smelters, and related matters. 3000 w. Min & Sci Pr—May 3, 1902. No. 48016.

GOLD AND SILVER.

Colorado.

Crestone Mining District in San Luis Park, Colorado. Arthur Lakes. Illustrates and describes a region containing some good veins favorably situated for economical mining, yielding gold, silver, and copper. 1100 w. Mines & Min—May, 1902. No. 48015 C.

Cyanide Mill.

The Portland Cyanide Mill. From Bulletin No. 5, South Dakota School of Mines. Illustrated description of the mill and the methods used. 2000 w. Min & Sci Pr—May 10, 1902. No. 48099.

Cyanide Plant.

The Cyanide Plant of the Wasp No. 2 Mining Co., Kirk, S. D. Illustration, with description of the plant and its equipment, methods used and cost. 2500 w. Min & Sci Pr—April 26, 1902. No. 47851.

Drainage.

The Drainage of the Prako Swamp, Thames. H. D. M. Haszard. Calls attention to the importance of reclaiming this district in New Zealand, and its value to the goldfields. 1000 w. N Z Mines Rec—April 16, 1902. No. 48156 B.

Gold Mining.

The Mining and Working of Gold. Brief review of methods of securing this precious metal, its working and the production in the United States. 2500 w. Sci Am Sup May 17, 1902. No. 48103.

New Zealand.

The Gold Deposits of New Zealand. Alexander McKay. Considered in relation to the comparative quantities of reef and alluvial gold on the various gold fields of the colony. 3400 w. N Z Mines Rec—April 16, 1902. Serial. 1st part. No. 48-155 B.

The Kaimanawa Ranges, Hawke's Bay. Alexander McKay. An account of an expedition to examine certain parts where gold had been reported as occurring. Map. 3200 w. N Z Mines Rec—April 16, 1902. No. 48157 B.

Phase Rule.

Note on the Application of the Phase Rule to the Fusing Points of Copper, Silver and Gold. Theodore William Richards. Calls attention to results obtained by Holborn and Day in investigations published in this journal, and the theoretical interest attached to them. 700 w. Am Jour of Sci—May, 1902. No. 47833 D.

Transvaal.

Gold Mining in the Transvaal. Thomas Haight Leggett. Abstract of a paper read at meeting of Am. Soc. of Min. Engrs. A criticism of the paper of John Hays Hammond presented at the Richmond meeting last year. 5800 w. Eng & Min Jour—May 17, 1902. No. 48141.

IRON AND STEEL.

Alloys.

Alloys of Iron. Discusses various metals of importance because of the beneficial properties they impart to steel. 1200 w. Am Mfr—May 22, 1902. No. 48315.

Armor.

A New Krupp Armor. Gives illustrations of exhibition plates of this armor, and such information concerning it, as is now available. It is claimed to be hardly inferior to cemented plate, and applicable to any form or shape required. 500 w. Engr, Lond—May 16, 1902. No. 48367 A.

Blast Furnaces.

A New System of Cooling Tuyeres for Blast Furnaces. Horace Allen. Deals with the Foster System, bringing forward some new facts. 1800 w. Ir & Coal Trds Rev—May 9, 1902. No. 48173 A.

Method of Supplying Water to Furnace Tuyeres and Coolers. W. J. Foster. Describes improvements introduced in a plant at Darlaston, England. 2200 w. Am Mfr —May 1, 1902. No. 47920.

Recent Blast-Furnace Practice. Brierly Denham Healey. Read before the Soc. of Engrs. A comparison between old and new methods, with some results of recent working and illustrated description of furnace. 2700 w. Mech Engr—May 17, 1902. Serial. 1st part. No. 48353 A.

The Combined Blast-Furnace and Open-Hearth Furnace. P. Eyermann. Illustrated description of the furnace and its working, with an account of the evolution of the process. 7500 w. Ir & Coal Trds Rev—May 9, 1902. No. 48175 A.

The Largest Charcoal Blast Furnace in the World (Der Grösste Holzkohlen-Hochofen der Welt). An illustrated description of a blast furnace 70 ft. high, with a maximum production of 115 tons of iron per day, using charcoal fuel, at Vares, Bosnia. 1200 w. Stahl u Eisen—May 1, 1902. No. 48249 D.

Blow Holes.

Blow Holes and Pipes in Ingot Steel (Die Blasen und Lungerbildung des Flusseisens). A. v. Dormus. Illustrated descriptions of blow holes and pipes in steel, with mechanical and chemical methods for preventing them. 1000 w. Zeitschr d Oesterr Ing u Arch Ver—April 11, 1902. No. 48221 B.

Blowing Engine.

New Blowing Engine for the Pastuchoff Anthracite Blast Furnaces at Sulin, South Russia (Neue Gebläsemaschine für die Pastuchoffschen Anthracithochöfen in Sulin, Südrussland). Oscar Simmersbach. An illustrated description of a blowing engine built by the Allis Co. of Milwaukee, U. S. A. 1 Plate. 800 w. Stahl u Eisen—May 1, 1902. No. 48248 D.

Brazil.

The Iron Ores of Brazil. H. Kilburn Scott. Describes the deposits which the writer considers probably the most important known iron ore deposits in the world Gives also information concerning their manufacture. 4000 w. Ir & Coal Trds Rev—May 9, 1902. No. 48177 A.

Carbon.

The Chemical and Physical Properties of Carbon in the Hearth of the Blast Furnace. W. J. Foster. Gives results obtained by various experimenters, and the investigations of the writer. 2800 w. Ir & Coal Trds Rev—May 9, 1902. No. 48176 A.

Constitution.

On the Equilibrium of Iron-Carbon Systems. G. Charpy and L. Grenet. Translated from the *Bulletin de la Société d'Encouragement.* Experimental investigations of the constitution and chemistry of metals formed of combustions of iron and carbon. 1400 w. Engng—May 9, 1902. No. 48185 A.

Direct Process.

The Direct Production of Iron (Unmittelbare Eisenerzeugung). C. Otto. From the *Chemische Zeitung.* An addition to former articles of the author, describing a process of producing iron direct from the ore in a closed furnace under pressure. 700 w. Oesterr Zeitschr f Berg u Hüttenwesen—April 26, 1902. No. 48266 B.

German Exports.

German Iron Exports (Die Ausfuhrbestrebungen des Deutscher Eisengewerbes). An account of the efforts of the German iron trade to increase exports, with noteworthy results, and tables showing the exports of Germany, England, Belgium and the United States. 1500 w. Glückauf—April 19, 1902. No. 48257 B.

Ingots.

The Influence of Chemical Composition on Soundness of Steel Ingots. Axel Wahlberg. States the new theory based on recent researches, and gives the general principles of the formation of pipe and blow holes, describing the various types of ingot and Brinell's diagrams summarizing the results of researches. Ill. 8000 w. Ir & Coal Trds Rev—May 9, 1902. No. 48178 A.

Iron Industry.

The Old and New Iron Industry Compared. John Birkinbine. A brief resumé of the development of the iron and steel industry in the United States. 4200 w. Can Min Rev—April 30, 1902. No. 47906 B.

Krupp Exhibit.

The Krupp Exhibit at the Düsseldorf Exposition (Rheinisch-Westfälische Industrie-Ausstellung Die Krupphalle). An illustrated review of the Krupp exhibit of armor, turrets, cannon, shafts and all kinds of steel work at this large German Exposition. 1500 w. Stahl u Eisen—May 15, 1902. No. 48270 D.

Lorraine Ore.

The Minette Deposits of Lorraine (Die Minetteablagerung des Lothringischen Jura). Dr. Kohlmann. An illustrated comprehensive geological review of the extensive oölithic iron ore deposits of Lorraine, in Southern Germany, Northern France, Luxemburg and Belgium. Serial. 1st Part. 4500 w. Stahl u Eisen—May 1, 1902. No. 48250 D.

Magnetic Separator.

The Fröding Magnetic Separator (Frödings Magnetischer Erzscheider). From *Tecknisk Tidskrift.* An illustrated description of a Swedish magnetic separator, in successful operation at Herräng, which has a flat conical table revolving over electromagnets. 500 w. Glückauf—April 12, 1902. No. 48254 B.

The Thomson-Houston Magnetic Separator (Séparateur Magnétique Thomson-Houston). A brief illustrated description. 400 w. Génie Civil—May 10, 1902. No. 48289 D.

Mixer.

The Jones Mixer Decision. A review of the case of the Carnegie Steel Co. Ltd., against the Cambria Iron Co., interesting and valuable for the historical data furnished relative to the evolution of Bessemer practice in the United States. 4800 w. Ir Trds Rev—May 22, 1902. No. 48320.

Nickel Steel.

Nickel Steel and Magnetic Observation. Crittenden Marriott. Concerning the very peculiar magnetic properties possessed by nickel steel alloys. 800 w. Elec Wld & Engr—May 10, 1902. No. 48040.

Open-Hearth.

The Elimination of Silicon in the Acid Open-Hearth. Andrew M'William and

William H. Hatfield. An account of investigations made of "sand boils" and other similar matters as to their effect on steel. 2000 w. Ir & Coal Trds Rev—May 9, 1902. No. 48172 A.

Production.

The Production of Iron Ore in 1901. Summary of a report by John Birkinbine. All records of production exceeded. 2000 w. Ir Age—May 15, 1902. No. 48093.

Rails.

Specifications for Steel Rails. William R. Webster. Abstract of a paper presented at meeting of the Am. Soc. of Min. Engrs. States the present situation of rail specifications and the importance of discussion of the proposed modifications. 1100 w. Eng & Min Jour—May 17, 1902. No. 48140.

Wire Drawing.

Modern Practice in Wire Drawing (Die Moderne Praxis des Drahtziehens und ihre Ergebnisse). Wm. Garrett. A review of wire-drawing mills and methods, particularly in the United States. 3000 w. Stahl u Eisen—May 15, 1902. No. 48271 D.

MINING.

Bendigo.

Air Compressing Machinery. Johan Sarvaas. Read before the Australian Inst. of Min. Engrs. An account of its use in the Bendigo goldfields, and its many advantages as a power for underground work. Also notes defects of air compressors. 2800 w. Aust Min Stand—April 10, 1902. No. 48158 B.

Blasting.

Precautions to be Observed in Blasting (Emplois des Explosifs). H. Ramu. A discussion of the causes of blasting accidents in mining and quarrying due to delayed shots, etc., and recommendation of precautions to be observed. 1600 w. Bull Soc d'Encouragement—April, 1902. No. 48292 G.

Compressed Air.

Compressed Air for Mining from Electric Power. John B. Tregloan. A record of results obtained with a 10 x 18-inch duplex, single-stage belt driven compressor. Ill. 1900 w. Min & Sci Pr—April 26, 1902. No. 47850.

Dynamite.

The Care and Use of Dynamite. A. W. Warwick. Directions for storing, thawing, preparing cartridges and using. 1400 w. Min Rept—May 22, 1902. No. 48327.

Electric Blasting.

The Wiring Circuits for Electric Blasting (Die Shaltung der Sprengschüsse bei Elektrischer Zündung). Hr. Heise. A discussion of series, parallel, and combined systems of wiring where more than one shot are to be exploded. Diagram. 2000 w. Glückauf—April 12, 1902. No. 48253 B.

English Mines.

The Distribution of Power in English Mines. Sydney F. Walker. Discusses the horse, and the factors which enter into the expense ot haulage by animal power. 2000 w. Mines & Min—May, 1902. No. 48009 C.

Exposition.

The Charleston Exposition. Arthur L. Parsons. A brief survey of the mining features shown in the exhibits from the different states. 2200 w. Mines & Min—May, 1902. No. 48011 C.

Hoisting.

Graphical Methods in the Study of the Equilibrium of Hoisting Cables (Application de la Méthode Graphique à l'Etude de l'Equilibre des Cables d'Extraction). Henri Deschamps. A discussion of graphical methods for determining the varying weights of cable and power required in hoisting from deep shafts. Diagrams. 4 Plates. 7000 w. Rev Univ d Mines—April, 1902. No. 48420 H.

New Hoisting Engine Plants at Friedrichstahl. Rhenish-Prussia (Neue Fördermaschinen-Anlagen der Königlichen Berginspektion IX, Friedrichsthal). H. Deichmann. A description of a powerful hoisting plant at mines in the Saar district, with illustrations and indicator diagrams. 2000 w. Glückauf—April 19, 1902. No. 48255 B.

Winding Plants for Great Depths. Hans C. Behr. Read before the Inst. of Min. & Met. (England). Outlines the various systems that have been tried or suggested, explaining the mechanics of the problems, etc. The present paper considers only vertical winding. An important paper on this subject. Ill. 10500 w. Ir & Coal Trds Rev—May 16, 1902. Serial. 1st part. No. 48371 A.

Mine Flood.

Cardigan Proprietary Disaster. An account of this disaster in Australia, with editorial comment. 2000 w. Aust Min Stand—March 27, 1902. No. 47847 B.

Mining Industries.

A Review of Recent Progress in the Mining Industries of the United States. F. Lynwood Garrison. An address of the retiring president. 2200 w. Jour Fr Inst—May, 1902. No. 47995 D.

Mixed Sulphides.

Treatment of Mixed Sulphide Ores Containing Zinc by Hydrometallurgical Processes. Walter Renton Ingalls. Treats of the wet processes in which the zinc is brought into solution and precipitated by chemical reagents. 5000 w. Eng & Min Jour—May 3, 1902. No. 47957.

Oil Prospecting.

Prospecting for Oil in the Region of the Cliff Dwellers of Southwestern Colorado. Arthur Lakes. Describes the formations and discusses the possibilities of their containing oil. Ill. 3300 w. Mines & Min—May, 1902. No. 48007 C.

Ore Dressing.

Problems in Ore Dressing. A. W. Warwick. Considers some difficult separations of refractory ores, and the methods being tried. 1800 w. Min Rept—May 8, 1902. No. 48042.

Pumping.

The Harris System of Pumping by Compressed Air, as Applied at the Deloro Mine. J. P. Kirkgaard. Describes this installation and states its advantages. 2700 w. Can Min Rev—April 30, 1902. No. 47907 B.

Rock Drill.

The François Rotary Rock Drill (Note sur la Perforation Mécanique par Rodage Système A. et J. François). N. Orban. Illustrated description of rotary rock-boring machines, used in Northern French and Belgian coal mines. 3 Plates. 3000 w. Rev Univ d Mines—March, 1902. No. 48419 H.

Safety Lamp.

Experiments with the New Wolf Safety Lamp. Report presented to the French Committee on Firedamp by G. Chesneau. Illustrated description of the lamp with report of tests. The committee are of the opinion that the results show it to be safe enough for use in fiery pits. 1500 w. Col Guard—May 2, 1902. No. 48066 A.

Surveying.

See Civil Engineering, Measurement.

Ventilation.

A Simple Mine Ventilating Fan. Illustrated description of a simple ventilating fan, designed for metalliferous mines and small collieries. 1200 w. Col Guard—May 2, 1902. No. 48067 A.

Watering.

The Watering of Mines. Discusses the theories of Prof. Galloway, S. T. Evans and J. T. Robson on the subject of water as a preventive of explosions. 3500 w. Col Guard—May 16, 1902. No. 48356 A.

MISCELLANY

Alloys.

A Review on Alloys. Gustav Thurnauer. Considers combinations of metals, prepared in such a manner as to impart qualities not possessed by either constituent. Ill. 9000 w. Pro W Ry Club—April 18, 1902. No. 47945 C.

Beaumont.

Tankage Capacity of Beaumont Oil Field. Concerning the estimated capacity, cost, method of construction and quality of oil stored in the tanks already completed and under construction. 1000 w. Eng & Min Jour—May 10, 1902. No. 48035.

Corundum.

Mining and Concentration of Corundum in Ontario. M. F. Fairlie. A description of the mining of the ore and method of concentration as at present practiced by the Canada Corundum Company, with discussion of other methods in use. 3000 w. Can Min Rev—April 30, 1902. No. 47905 B.

Hungary.

The History of Mining in the Máramaros District, Hungary (Zur Entwickelungsgeschichte des Máramaroser Bergbaues). L. v. Schmidt and Ludwig Litschauer. A paper read at the Hungarian Mining Congress, 1901, and printed in *Bányázzati és Kohászati Lapok,* giving a general review of salt, metal coal, petroleum and other mining industries. 3500 w. Oesterr Zeitschr f Berg u Hüttenwesen—April 26, 1902. No. 48265 B.

Japan.

The Japanese Mining Industry, with Special Reference to Iron and Coal (Die Japanische Montanindustrie mit besanderer Berücksichtigung der Eisen- und Kohlenindustrie). E. Davidson. General statistics, with tables, abstracted from an article by A. Keppen in the Russian "Economic Review." Serial. Part I. 1500 w. Oesterr Zeitschr f Berg u Hüttenwesen—May 10, 1902. No. 48269 B.

Manganese.

The Manganese Deposits of Huelva Province, Spain (Die Manganerz-Lager der Provinz Huelva). Carl Doetsch. An account of the ores, analyses, mining industry and production. 2200 w. Oesterr Zeitschr f Berg u Hüttenwesen—April 19, 1902. No. 48264 B.

Russia.

Mines and Metallurgy in South Russia in 1901 (Les Mines et la Métallurgie dans le Midi de la Russie en 1901). A. Spillberg. A paper before the 26th Congress of Mine Operators of South Russia, giving a general review, particularly of iron and manganese. 6000 w. Rev Univ d Mines—Feb., 1902. No. 48417 H.

Saxony.

Mining and Metallurgy in Saxony in 1900 (Der Bergwerks und Hüttenbetrieb im Königreiche Sachsen im Jahre 1900). General statistics, with tables, from the "Jahrbuch für das Berg und Hüttenwesen in Königreich Sachsen." Vol. for 1901. 1000 w. Oesterr Zeitschr f Berg u Hüttenwesen—April 12, 1902. No. 48263 B.

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in March. A condensed record of the principal accidents, with remarks on the most serious ones. 3000 w. R R Gaz—May 9, 1902. No. 47968.

Block System.

The Introduction of the Block System on the Austrian Railways (Die Einführung des Fahrens in Raundistanz auf den Oesterreichischen Eisenbahnen). Ludwig Freund. An account of the change from the time-interval to the space-interval system of train operation, in Austria. 3500 w. Oesterr Wochenschr f d Oeffent Baudienst —April 19, 1902. No. 48216 B.

Fast Trains.

The Burlington Fast Mail. An account of the performance of these trains during the last two years, with comment. 900 w. Ry Age—May 16, 1902. No. 48139.

Fuel.

Fuel as an Important Factor in Railroad Operation. A. D. Parker. Read at meeting of the Rocky Mt. Ry. Club. Shows what a large expense fuel forms in the operation of a railroad, and discusses the losses and ways of lessening them. 2500 w. Ry & Engng Rev—May 3, 1902. No. 47964.

Speed.

Discussion on Speed of Passenger Trains. B. A. Worthington. A communication giving interesting ideas and information on this subject. Discusses the approximate difference in the cost of pulling a 7-car passenger train 100 miles on a 3-hour schedule, and the same train on a 3-hour and 20-min, schedule, particularly as to cost of fuel. 2400 w. Ry & Engng Rev—May 10, 1902. No. 48053.

Train Rules.

The Standard Code on the Chicago and North Western. Notes the principal features in which the code varies from the "Standard," as issued by the American Ry. Assn. 1700 w. R R Gaz—May 16, 1902. No. 48116.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Best Method of Handling Air Brake Work in Connection with Yard Testing Plant. Report of the committee to the Air Brake Assn. 2500 w. Ry Age—May 9, 1902. No. 48046.

Car Framing.

Graphical Method of Determining Stresses in Car Framing. J. H. Lonie. Gives diagrams with notes showing the application of this method. 1000 w. Am Engr & R R Jour—May, 1902. No. 47934 C.

Compressed Air Locomotives.

Compressed-Air Locomotives (Druckluftlokomotiven). M. Buhle and G. Schimpff. A well illustrated description of various compressed-air locomotives, particularly the system in use on the Western Railway of France, in and about Paris. 1 Plate. 4000 w. Zeitschr d Ver Deutscher Ing—April 26, 1902. No. 48228 D.

Continental Practice.

Features of Continental Locomotive Building. Chas. R. King. The first of a series of illustrated papers reviewing the latest European practice in locomotive construction. 5000 w. Engineering Magazine—June, 1902. No. 48395 B.

Corridor Cars.

Improvements in Bogie-Truck Corridor Cars (Neuerungen an Vierachsigen Durchgang-Personenwagen). Hr. Herr. A paper before the Verein Deutscher Maschinen-Ingenieure, giving a well illustrated description of new passenger cars on the Prussian State Railways and various details. 7 Plates. 4000 w. Glasers Annalen—April 15, 1902. No. 48241 D.

Dynamometer Car.

Test and Dynamometer Car, Chicago, Burlington & Quincy R. R. Drawings and particulars of this car and its equipment which has recently been thoroughly overhauled, with list of tests made. 2700 w. Eng News—May 15, 1902. No. 48110.

Locomotives.

Compound Duplex Tender Locomotive on the Mallet System (Verbund-Duplex-Tender-Lokomotive, System Mallet). An illustrated description of a 1-meter gauge locomotive with two sets of three-coupled driving wheels on the Mallet articulated system, built by the Swiss Winterthur works for the French "Departementaux" railway. 400 w. Schweiz Bauzeitung—April 26, 1902. No. 48275 B.

Compound Locomitives with Four Cylinders and Eight Driving Wheels (Note sur les Machines Compound à 4 Cylindres et 8 Roues Accouplées de la Compagnie des Chemin de Fer du Midi). A well illustrated description of compound locomotives, with four pairs of coupled drivers and pony truck, built by the Société Alsaciens, at Belfort, for the "Midi" Ry. Co., of France. 3 Plates. 3000 w. Rev Gen d Chemins d Fer—April, 1902. No. 48295 H.

Consolidation Engine for the Nickel

We supply copies of these articles. See page 651.

Plate. Illustrated description of a heavy freight locomotive, ten of which have just been placed in service. 900 w. Ry Age—May 9, 1902. No. 48045.

Heavy Tank Locomotive for the Port Talbot Railway and Docks Company. Illustrates and describes a new type for mineral traffic. 450 w. Engng—April 25, 1902. No. 47881 A.

Metre-Gauge Fairlie Engines for the Burma Railway Company. An illustrated description of the most modern form of double-bogie engine. 2500 w. Engr, Lond—May 16, 1902. No. 48368 A.

Oil-Burning Locomotives (Locomotives Chauffées au Naphte et au Goudron). F. Barbier. A well illustrated description of various kinds of locomotives, in different countries, burning oil, naphtha and petroleum residues. 1 plate. 3000 w. Génie Civil—April 19, 1902. No. 48282 D.

Pennsylvania Standard Consolidation Engine. Illustrated description of standard freight locomotives of this road. 800 w. Ry Age—May 23, 1902. No. 48335.

Prairie Type Freight Locomotives with Traction Increasers—Atchison, Topeka & Santa Fe. Illustrated description showing some slight differences between this type as designed for freight and the passenger locomotives previously described. 450 w. R R Gaz—May 16, 1902. No. 48118.

Prairie Type Passenger Locomotive for the Illinois Central R. R. Illustrates and describes one of the three types of engines with the wide firebox which will take part in the tests to be made by this road. 1600 w. Ry & Eng Rev—May 17, 1902. No. 48144.

Standard Freight Locomotives of the Columbian Government. Illustrated description of a new type of engine for heavy freight service. 500 w. R R Gaz—May 16, 1902. No. 48119.

Mechanical Stokers.

Mechanical Stokers for Locomotives. Fred H. Colvin. The advantages of mechanical stokers are enumerated and the stoker invented by John W. Kincaid is described and illustrated. 2200 w. Trans Am Soc of Mech Engrs, No. 0935—May, 1902. No. 47974.

Oil Fuel.

Oil as a Locomotive Fuel in England. Illustrated description of the Holden system of using oil as locomotive fuel as at present used on the Great Eastern Railway of England. 1300 w. Ry Age—May 23, 1902. No. 48332.

Piston Valves.

The Piston Valve as Applied to the Locomotive. J. E. Dixon. Reviews the history of the application of piston valves to locomotives, considering the benefits derived. Ill. 3500 w. Wis Engr—April, 1902. No. 47822 D.

Rolling Stock.

Norfolk and Western Standard Equipment: Illustrated description. 1200 w. Ry Age—May 9, 1902. No. 48048.

Steel Cars.

The Use of Steel in Car Construction. J. W. Stokes. Considers the general features of steel cars and related subjects. 2800 w. St Louis Ry Club—April 11, 1902. No. 47846.

Test Car.

Burlington Route Test Car. Max H. Wickhorst. Illustrated detailed description of the car and account of the uses made of it. 2400 w. Ry Mas Mech—May, 1902. No. 47914.

Train Lighting.

Train Lighting Tests. E. L. French and W. J. Spence. From a paper presented at the meeting of the Northwest Ry. Club. An illustrated account of tests made to gain light on train lighting in general and especially on the use of storage batteries. 2000 w. Ry Age—May 23, 1902. No. 48333.

German Progress in Electric Lighting for Railway Cars. Information from Herr Wichert's address giving results of the experiments with various forms of electric lighting made in Prussia. 700 w. U S Cons Repts, No. 1349—May 23, 1902. No. 48170 D.

Turntable.

See Electrical Engineering, Power Applications.

NEW PROJECTS.

Trans-Australia.

The Trans-Australian Railway. A review of the report of Mr. John Muir, the engineer who has been making a preliminary survey of the ground on which the projected line is to run. Map. 3000 w. Engr, Lond—May 2, 1902. No. 48054 A.

PERMANENT WAY & BUILDINGS.

China.

The Work of the German Railway Soldiers in China in 1900-1901 (Die Thätigkeit der Deutschen Eisenbahntruppen in China 1900-1901). Major Bauer. A paper before the Verein für Eisenbahnkunde, giving an extended review of work in building and repairing railways, bridges, etc., in the northern part of China, during the foreign military occupation. Serial. 2 parts. 18000 w. Glasers Annalen—April 15, May 1, 1902. No. 48240 each D.

Grade-Crossing Gates.

Gates at Crossings of Railways and Roads (Wegschranken bei Eisenbahnen). Karl Stöcke. Brief, illustrated description of gates to be operated from one side of the track. 1 plate. 700 w. Oesterr Wochenschr f d Oeffent Baudienst—April 12, 1902. No. 48214 B.

Shops.

New Shops at Du Bois, Pennsylvania. Illustrated description of the most important details, with particular reference to the locomotive shop, power house and round house. 2200 w. Am Engr & R R Jour—May, 1902. No. 47933 C.

Signalling.

Automatic Block Signals on the Philadelphia and New York Divisions of the Pennsylvania Railroad. An illustrated description of what is probably the most elaborate railroad plant, for so long a distance, in the world. It is equipped with automatic track circuit block signals for about 104 miles, the road being four tracked. 3800 w. R R Gaz—May 16, 1902. No. 48117.

Electric Signalling. W. R. Sykes' system is illustrated and described. 2400 w. Tram & Ry Wld—May 8, 1902. No. 48-379 A.

Interlocking Construction and Specifications. C. O. Tilton. Abstract of a paper read at the Railway Signalling Club, in Chicago. A brief review of the points of importance in the construction. 1200 w. Eng News—May 15, 1902. No. 48113.

The Virtues of the Enclosed Automatic Disk Signal. A letter to the editor aiming to show that the disk signal is equally reliable with the semaphore. 1800 w. R R Gaz—May 9, 1902. No. 47966.

Station.

The New Station at Basle, Switzerland. Describes a very large new station being constructed at a level of about 10 ft. below that of the present building, and so involving the lowering of the whole permanent way, but without interruption of traffic. 2000 w. Engr, Lond—May 2, 1902. No. 48060 A.

Track Elevation.

Allegheny River Bridge and Track Elevation at Pittsburgh. An illustrated description of a new bridge made necessary by elevating the tracks of the Pennsylvania System. It is of the double-deck, lattice girder type. The work of removing the old bridge is described. 1500 w. R R Gaz—May 23, 1902. No. 48324.

Tracks.

Track Improvements on the Baltimore and Ohio. Maps and illustrated description of points where the most important betterments are being made. 1000 w. Ry Age—May 9, 1902. No. 48047.

TRAFFIC.

Competition.

Competition of Steam vs. Electric Parallels. C. H. Davis. From a paper read before the Canadian Soc. of Civ. Engrs. Outlines the laws of passenger traffic and discusses the effect of competition. 2000 w. Can Engr—May, 1902. No. 47919.

Trains.

Maximum Trains; Their Relation to Track, Motive Power and Traffic. E. E. R. Tratman. Discussing the question of maximum train and car loading, more particularly from the maintenance-of-way point of view, considering also the maintenance of equipment. General discussion follows. 29000 w. N Y R R Club—April 17, 1902. No. 48043.

STREET AND ELECTRIC RAILWAYS

Berlin.

The Berlin Combined Overhead and Underground Railway. P. T. J. Estler. Illustrated detailed description of this interesting engineering work. 3400 w. Tram & Ry Wld—May 8, 1902. No. 48377 A.

The Financial Prospects of the Berlin Elevated and Underground Railway (Betrachtungen zur Wirtschaftlichkeit der Berliner Hoch und Untergrundbahn). Hans Dominik. A discussion of the costs, traffic and profitableness of this railway, with favorable conclusion. 1200 w. Ill. Zeitschr f Klein und Strassenbahnen—March 16, 1902. No. 48279 C.

Boston Elevated.

A Description of the Feeder Requirements and Installation on the Elevated Section of the Boston Elevated Railway Company's System. C. H. Hile. Ill. 1200 w. Wis Engr—April, 1902. No. 47818 D.

Effect of the Boston Elevated on Traffic. An estimate of the value of the service rendered and the striking features of the present situation. 1100 w. St Ry Rev—May 20, 1902. No. 48339 C.

Cardiff.

Cardiff Electrical Tramways. An illustrated article giving the history of the undertaking, with description of the line and its equipment. 7000 w. Elec Engr, Lond—May 16, 1902. No. 48348 A.

Car Sanitation.

The Sanitary Condition of Street Cars in New York. George A. Soper, in the *Medical News*. Discusses ventilation, heating, crowding, etc. 3700 w. Sci Am Sup—May 3, 1902. No. 47855.

Chamonix.

The Fayet-Chamonix Electric Railway (La Traction Electrique sur la Ligne du Fayet à Chamonix). M. Auvert. A well illustrated description of the line, rolling stock and power stations of this railway near Mont Blanc. 2 plates. 5000 w. Rev Gen d Chemins d Fer—April, 1902. No. 48296 H.

Controllers.

Restrictions on the Controller Handle. J. R. Cravath. Discusses the principles involved in the appliances for regulating the rate at which current is turned on, their advantages and disadvantages. 2000 w. St Ry Jour—May 24, 1902. No. 48-319 D.

Conversion.

Burnley Corporation Electric Tramways. Brief history of these tramways with an illustrated description of the conversion from steam to electricity. 3700 w. Tram & Ry Wld—April 17, 1902. No. 47863 B.

Electric Locomotives.

Speed Control of Electric Mine Locomotives. R. B. Williamson. An illustrated explanation of the construction of controllers and the reasons therefor. 3000 w. Mines & Min—May, 1902. No. 48-008 C.

Electric Traction.

Electric Railways (Les Chemins de Fer Electriques). Léon Gerard. A general review of electric traction of all kinds and comparisons between it and steam traction with classification tables of electric railways. Serial. 1st part. 5000 w. Mem Soc Ing Civils d France—March, 1902. No. 48413 G.

Electric Traction Progress. Philip Dawson. Read at Northampton, England, before the Tramways Committee. A review of the history of electric traction in England. 5800 w. Elec Engr, Lond—May 16, 1902. No. 48349 A.

Problems of Electric Railways. J. Swinburne and W. R. Cooper. Abstract of a paper read before the Inst. of Elec. Engrs. Urges the claims of series distribution of power for railways, especially for short lines, such as the tube and suburban types. 8500 w. Tram & Ry Wld—April 17, 1902. No. 47866 B.

Funicular Railway.

The Vevev-Mont Pélerin Funicular Electric Railway. E. Bignami. An illustrated account of the application of gas power to the generation of electricity for the operation of a mountain cable railway near Vevey in Switzerland. 3000 w. Engineering Magazine—June, 1902. No. 48-394 B.

High-Speed Tests.

The Berlin-Zossen Electric Railway. An account of the results so far obtained. 2000 w. Engng—April 25, 1902. No. 47885 A.

Interurban.

Interurban Railway Development in Western Pennsylvania. William Gilbert Irwin. Outlines the scheme of development in the vicinity of Pittsburg. 7500 w. St Ry Jour—May 3, 1902. No. 47955 D.

The Middleton Electric Tramways. An illustrated detailed description of an English electric tramway system connecting Middleton with Oldham. 2000 w. Tram & Ry Wld—April 17, 1902. No. 47864 B.

Light Railways.

Light Railways and Land Development. J. M. Hewitt and W. G. Rhodes. Describes the system of eight railways and methods adopted in Belgium and their effect on the value of land and property. 2500 w. Elec Rev, Lond—May 16, 1902. Serial. 1st part. No. 48351 A.

Locomotives.

Electric Locomotives (Elektrische Lokomotiven). Illustrated descriptions of a variety of electric locomotives built by the Allgemeine Elektricitäts Gesellschaft. 1200 w. Ill Zeitschr f Klein und Strassenbahnen—March 16, 1902. No. 48278 C.

Electric Locomotives for Both Rack and Adhesion Traction (Elektrische Lokomotiven für Zahnrad und Ahdäsionsbetrieb). M. Gaze. A well illustrated description of electric locomotives to be used in and about a large sugar refinery, which are to operate on a rack railway, as well as by ordinary adhesion. 4000 w. Zeitschr d Ver Deutscher Ing—April 26, 1902. No. 48-229 D.

Michigan.

Houghton County Street Railway. Illustrates and describes a road for passenger service between various towns in the copper region. 5500 w. St Ry Jour—May 3, 1902. No. 47952 D.

Milan.

Milan Street Railways. Effren Magrini. An account of these railways in Italy, where the city owns the tracks but leases them to a private company. 3500 w. Munic Af—March, 1902. No. 47894 D.

Motor Equipment.

Selection of Street Railway Motor Equipment. Fred A. Jones. Read at meeting of the Southwestern Gas, Elec. & St. Ry. Assn. Gives a statement of efficiency showing great need of economy, and discusses what should be considered in the selection of the motor equipment. 1800 w. St Ry Jour—May 17, 1902. No. 48137 D.

Mountain Railway.

The Fayet-Chamonix Electric Railway Brief illustrated description of an interesting line 11.8 miles long, with steep gradients and sharp curves. 2000 w. Engng—May 2, 1902. No. 48064 A.

Newcastle-on-Tyne.

New Transportation System for Newcastle-on-Tyne. Illustrated description of an electrically operated system and its cars. 4800 w. St Ry Jour—May 3, 1902. No. 47953 D.

Oerlikon Experiments.

Electric Traction on Normal Railways (Die Elektrische Zugförderung auf Normalen Eisenbahnen). A paper by Hr. Huber before the Zürich Engineers' and Architects' Society, partly abstracted from the *Schweizzerische Bauzeitung*, giving an account of experiments about to be made by the Oerlikon Co., using single-phase currents. 4000 w. Elektrotech Zeitchr—April 17, 1902. No. 48203 B.

Paris.

Metropolitan Railway of Paris. Abstract of the report of Lieut.-Col. Yorke, giving interesting facts and brief discussion of the applicability of the shallow tunnel system to London. 3500 w. Tram & Ry Wld —April 17, 1902. No. 47865 B.

The Paris Metropolitan Railway. C. H. Wordingham. Reviews the report of Lieut. Col. H. A. Yorke concerning this railway, summarizing the salient features of the construction and operation and commenting on points of interest. 2000 w. Elec Rev, Lond—April 25, 1902. No. 47874 A.

Paris-Arpajon.

The Paris-Arpajon Electric Railway (Chemin de Fer sur Route de Paris à Arpajon). G. Boeto. A well illustrated description of railway, power station and rolling stock. Both accumulator locomotives and motor cars are used. 1 plate. 5000 w. Génie Civil—April 26, 1902. No. 48-284 D.

Power Plant.

New Power Plant at Baltimore. Illustrated description of the reconstruction of the plant of the United Railways and Electric Co. 3000 w. Steam Engng—May 15, 1902. No. 48330.

Power Plant of the Hartford and Springfield Street Railway Co. Illustrated description of a direct-current generating station having compound condensing engines. 1400 w. Eng Rec—May 24, 1902. No. 48190.

Rail Welding.

Rail Welding (Schienenschweissungen). Karl Beyer. A discussion of rail welding, and a table of results of experience with the Goldschmidt aluminothermic process on German and Danish street railways. 1400 w. Schweiz Bauzeitung—April 19, 1902. No. 48273B.

Rapid Transit.

The Boston Rapid Transit Situation. Louis Bell. A critical study, discussing also the character of railway construction of the future and the mistakes of the past. 3300 w. Elec Rev, N Y—May 3, 1902. No. 47898.

The New Electric Rapid Transit Railway in Berlin, Germany. An illustrated description abstracted from a series of articles by Herr Langbein, published in the *Zeitschrift des Vereins Deutscher Ingenieure*. 5700 w. Eng News—May 15, 1902. No. 48114.

I. The New York Rapid Transit Commission's Plan for a System of Interborough Rapid Transit. II. The Proposition to Abandon the Construction of the Third East River Bridge at New York. Gives in the first article a communication recently presented at a meeting of the Commission, discussing it in the editorial in the II. article, in connection with the subject of abandoning the Third East River Bridge. 3500 w. Eng News—May 22, 1902. No. 48312.

Repair Shops.

New Repair Shops at Providence, Rhode Island. Illustrates and describes details of building construction, equipment, shop methods, method of keeping records, etc. 4000 w. St Ry Rev—May 20, 1902. No. 48-338 C.

Resistance.

Train Resistance. W. J. Davis, Jr. Discusses train resistance as affected by the interurban service of electric railways. Also comments on this paper, by engineers who have given special attention to the subject. 7500 w. St Ry Jour—May 3, 1902. No. 47954 D.

Shops.

The New Repair Shops at Providence. Illustrated description of one of the most carefully equipped of modern electric car repair shops. 2500 w. St Ry Jour—May 3, 1902. No. 47951 D.

Single Rail.

Improvements in A. Lehmann's Single-Rail System (Neuerungen an A. Lehmann's Einschienenbahn). Illustrated description of a single-rail road, at ground level, and cars for hauling freight and passengers by man or animal power. 700 w. Oesterr Wochenschr f d Oeffent Baudienst—May 3, 1902. No. 48219 B.

Suburban.

Grimsby and Cleethorpes Electric Tramways. Illustrated description of a line about six miles in length in which the overhead equipment is used. 1200 w. Tram & Ry Wld—May 8, 1902. No. 48378 A.

Syracuse, N. Y.

The Street Railway System of Syracuse, N. Y. An illustrated description of improvements which have greatly increased the efficiency of the road, with report of operation. 4200 w. St Ry Jour—May 3, 1902. No. 47950 D.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b w,* a bi-weekly, *s-w,* a semi-weekly, *m,* a monthly, *b-m,* a bi-monthly, *t-m,* a tri-monthly, *qr,* a quarterly, *s-q,* semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
American Telephone Journal. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Armee und Marine. *w.* Berlin.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, Eng.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin Scientifique. *m.* Liege.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Age. *m.* New York.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical Times. *w.* London.
Electrical World and Engineer. *w.* New York.
Electrician *w.* London.

Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemist & Metallurgist. *m.* London.
Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *w.* New York.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Indian and Eastern Engineer. *m.* Calcutta.
Ingenería. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Assn. Eng. Societies. *m.* Philadelphia, U.S.A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, Mass.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallographist. *qr.* Boston.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. w. San Francisco, U.S.A.
Mining Journal. *w.* London
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. m. Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Wurtt. Ver. f Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Power Quarterly. New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Railroad Digest. *w.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. ed Agr. *b-m.* Catania.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Steam Engineering. *m.* New York.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Telephony. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am.Ins.of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a. S.

THE WORLD IS ITS FIELD.
THE ENGINEERING MAGAZINE

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THE COMMON SENSE OF THE ISTHMIAN-CANAL DECISION.

An Editorial Review.

THE choice of the Panama route for the Isthmian canal is a striking case of sound reason, based on engineering certainties, winning a hard fight over sentiment and mistaken or prejudiced partisanship. It is a conclusion in which the United States was practically sole arbiter, but the whole world vitally concerned, each nation's interest in a right decision (as pointed out heretofore in these pages) being in almost direct proportion to its sea-borne commerce and especially its shipping. Every consideration of physical economy was on the side of the Panama route. Its plea for favor on account of its shortness, its lower lockage, its easier curvature, its cheaper and less troublesome regulation, its much slighter exposure to earthquake damage, its greater safety and service to shipping, its almost absolute assurance against any unforeseen difficulties of construction—this plea was unanswered, and unanswerable. But against it was raised a clamor for another route, based largely on a misunderstanding, but more difficult to deal with because its moving principle was sentiment, and sentiment for a time overpowered sense. There is nothing so hard to change by argument as a "party watchword." It becomes a thing almost sacred, and he who questions it thereby puts himself beyond the pale of regard or influence. And belief in the Nicaragua Canal for years was taken to be one of the first articles in the creed of American patriotism.

That this was largely based on a misunderstanding has just been said. The misunderstanding was that Isthmian Canal and Nicaraguan Canal mean one and the same thing. The beginnings of this belief are easily found. They lie in the fact that at the time when the cutting of the Isthmus by the United States was first actively urged, the Panama route was seemingly pre-empted by France, and wholly out of reach. It was Nicaragua or nothing, so far as the United States was concerned. Setting the Darien route aside from serious consideration, the only possible American canal across the Isthmus then was the Nicaragua Canal. And the several companies, with many and often-changing names, which sought to seize and speculate in a "concession" for the Nicaraguan rights, were zealous in painting the Stars and Stripes over their very hazy plans. Under proper encouragement, the term Nicaraguan Canal was brought into general use and unfailingly offered to every political convention; the term Isthmian Canal was sent to limbo. The national interest and the national pride were thus almost unconsciously fixed, by the use of a name, upon a locality instead of upon a result. Gradually, that which had been at first by virtue of necessity came to be held as almost of Divine institution. It became heresy even to hint there could be another route, to say nothing of a better route, than the Nicaraguan.

But meantime the situation on the Isthmus had changed completely. On both lines, companies had been at work and had come to wreck. At Panama the undertakings were huge and the ruin proportionate; at Nicaragua, both were pitiful rather than overwhelming. But let anyone who shrinks from Panama on account of a "legacy of failure or shame" study carefully the history of the Nicaraguan attempts.

The whole region was again open for study and choice, without the limitations which had narrowed the field free to the United States at the earlier period. And yet, so strong and lasting is the force of a form of words, well learned and often sounded, that it was with great difficulty Congress was persuaded to seek and then wait for the report of a competent commission; it was with still greater difficulty it was persuaded to act upon the strong and unanimous recommendation of that commission against the clamor of still persistent adherents of Nicaragua. But so strong and sure is the ultimate power of economic fact—so inevitably must the unfit in the realm of engineering give way to the more fit—that clear statement won its way against passionate oratory, and common sense prevailed over unthinking partisanship. Within six months occurred a most surprising change of view in a law-making body dealing with a long active question. The minority of 102 Congressmen who in December fixed their choice upon the Panama route, if obtainable, in June had grown to a majority of 252. The huge majority of uncompromising Nicaraguan adherents had dwindled in the same time to a handful of 8. With all allowances for those who voted for the Spooner bill because they believed it would be impossible to get as good title at Panama—a belief, by the way, for which there is no foundation whatever—and that therefore the mandatory provision for building the Nicaragua canal would come into effect—with all allowance for these members, the change of understanding and feeling is striking. It is characteristic of the spirit of the times—the spirit which compels the withdrawal of every method and every agency which is less efficient than it might be, in favor of one which does the work better, faster, more cheaply; the spirit which sees that man's duty is to develop the resources of the earth with the utmost economy and with the utmost utility—which recognizes waste, whether of substance, time, or power, as a crime.

It is this inspiration which has led The Engineering Magazine to take the same stand on the Isthmian Canal question as on every other question of engineering practice treated in its pages. It has worked and fought for the choice of the means which would best serve the end of usefulness and economy—which, in the case of the canal, would most safely, most surely, and most cheaply aid and enlarge commerce and traffic. And these means it firmly believes are found in the Panama Canal. In the faithful championship of this view, now so widely accepted, this Magazine has borne much of the burden and heat of the day, and not a few of the blows. Against the absurd charge of servility to the interests which are said to be seeking to prevent the making of any canal, we need only point to the steady policy of the Magazine, and, even more tellingly, to the first and the latest articles on the question we have published; the former, by Hon. Warner Miller, in March, 1893, setting forth the commercial advantages of cutting the Isthmus; the latter, by Mr. S. A. Thompson, in July, 1902, showing the fallacy of the view that it would work any hurt to the railways of America, and the heartiness with which they should support, instead of opposing, the measures for prompt and vigorous work for the completion of the waterway. Surely, those who in reason are most nearly allied to the no-canal party are they who would make an unserviceable canal—one which by its risks and difficulties would discourage free use by sea carriers; and our whole contention has been that the Nicaragua Canal, by its length, its tedious lockages, its narrow and crooked channels, its questionable harbor facilities at its termini, and its possible subjection to stoppage by earthquakes, volcanoes, or difficulties of regulation, would reduce to a minimum the possible usefulness of a waterway across the Isthmus. Better have it than have none—but why not have the best of all?

Between these earliest and latest efforts toward what we are sure is the right course, stand a long series of contributions directed steadily to the same end. They were led by Mr. C. B. Going's article on "The Absence of Facts about the Nicaragua Canal" in June, 1896, showing the wholly unsatisfactory character of the case for that route, the many serious problems unsolved, the reckless folly of going into any irrevocable adoption of the route at that time, and the urgent need of full and careful study of the matter before any final action was taken. The caution which the country adopted at that time saved the expenditure of many millions for an imperfect project and worthless concessions. In July and August, 1898, the end of the Spanish-American war having brought the canal question up again for study, we presented two articles which in the interests of fairness and of argument from all sides were prepared, one by Prof. L. M. Haupt —a strong pro-Nicaraguan, although his argument was in this instance for an Isthmian canal rather than for the choice of any one route in preference to another—and the other by Mr. Joseph Nimmo, an opponent of the canal idea. In October following we published Professor Haupt's rejoinder to Mr. Nimmo, but took that opportunity to state that, so far as the Nicaraguan project was concerned, The Engineering Magazine was unconvinced of its engineering feasibility or its commercial sufficiency, and was strongly against espousal of the project by the American government.

In December of the same year we reviewed the physical advantages of the Panama route, and urged the injustice and unreason of letting a former financial fiasco blind us to its very great merits from an engineering point of view. In January, 1899, we again protested editorially against taking over the Nicaragua scheme until it had been thoroughly examined by a competent and disinterested commission. This was followed, in February and March of 1899, by two particularly able and convincing papers by Mr. W. Henry Hunter, chief engineer of the Manchester Ship Canal, pointing out the enormous benefits of such a waterway, and comparing very clearly the Nicaragua and Panama routes in matters both of engineering construction and practical navigation. In the following August we reviewed the personnel of the "Walker Commission," with satisfaction that the first point of our contention had been gained, and the whole region was to be thoroughly surveyed before action was taken.

In February, 1900, with the express view of correcting the general false idea that the collapse of the first Panama effort had been due to engineering obstacles, we presented an admirable statement of the present condition of the undertaking by Mr. Charles Paine, past president of the American Society of Civil Engineers, together with a very fine map showing the extent and accuracy of the surveys and the advanced condition of exploratory and actual construction work. In March and April we again protested editorially against the clamor of the Nicaraguan party, who, apparently fearful of the results of examination, urged that their route be chosen without waiting for the Walker Commission's report. In April also we published a very concise and instructive comparison of the two routes by Mr. George A. Burt, bringing out vividly their differences in point of ease of navigation. June, 1900, we reviewed at length certain grave geophysical difficulties apparent in the Nicaraguan route, especially the shifting sands at Greytown Bight, the dangers of earthquake and volcanic disturbance, and the question of a changing level in Lake Nicaragua, and developed this last point quite fully in a review of Professor Heilprin's notable studies of this point and Mr. C. Willard Hayes' not fully satisfying reply. September, 1900, we discussed Mr. Wheeler's report on the topography of the Nicaragua route, which brought out with new distinctness the difficulties of canalizing the San Juan and dealing with the great volumes of volcanic sand. In April, 1900, we reviewed fully Col. Peter C. Hains' studies of the fortification of an Isthmian Canal in its military and naval aspects, and in June of the same year gave in condensed form M. Bunau-Varilla's striking data of volcanic disturbances, showing, as since confirmed by the disturbances in Guatemala and especially on Lake Managua, that the Nicaraguan waterway would be in great danger of damage from this cause.

In January, 1902, appeared one of the most important of all the contributions we have presented—General Abbot's widely quoted article on the International Aspects of the Isthmian Canal. At this time we made an energetic protest against the folly of plunging into the unknown difficulties and known dangers of the Nicaraguan route, for lack of courage to attack and solve the alleged financial difficulties in the way of getting full ownership of the Panama Canal.

The next month, reviewing the vote in the lower House on the Hepburn Bill, we pointed out and emphasized General Abbot's argument that facility of maintenance and use far outweighed questions of first cost, and suggested the great importance of calling the shipping interests into the debate, as Senator Hanna did so effectively a few weeks later. In the same number we summarized Dr. George A. Soper's conclusions as to comparative sanitary conditions, completely dispelling the illusion that Nicaragua is more healthful than Panama. In March we reviewed our course in the support of the Panama movement, and stated our motives as we have again in this article—the conviction that in industrial life and action, the supreme considerations are plain practicability and utility.

Mr. John George Leigh's review of the report of the Walker Commission from a British standpoint appeared in our issue for April of this year. In June, we pointed out the impressive confirmation of M. Bunau-Varilla's predictions as to volcanic and earthquake dangers in Nicaragua, the proof being furnished by the year's earthquake readings recorded by General Abbot, showing fifty shocks in San Jose de Costa Rica as against five slight tremors in Panama. And in July (last month), besides Mr. Thompson's important article on the general economic influence of waterways, we pointed out the conversion of public thought to true economy as indicated in the passage of the Spooner bill, and forecast the concurrence of the House.

The bill, passed by both houses, has received the President's signature. The way is at last open to the long-hoped-for piercing of the Isthmus—for the joining of the seas which themselves join the continents. If there is a fatal flaw in the Panama title, then the choice must be Nicaragua; but that we do not for a moment fear. All past disputes have been finally settled in the French courts, by which all parties are bound. Governments and owners concur in confirming the transfer. No mere difficulties should be permitted to interfere, if they can in any way be removed. Financial obstacles to the speedy acquisition of Panama will be more readily overcome than the physical obstacles, both to completion and use, which would be met at Nicaragua. It will be far easier to get and keep a clear title at Panama under the laws of France or of America than a clear waterway at Nicaragua under the laws of wind and flood which are shoaling the Caribbean and would oppose every steamer threading the crooked San Juan.

Our unshaken belief in the Panama Canal and in its final adoption by the United States springs from the same roots as our faith that misrule in Africa would go down—that false independence and short-sighted extortion would unfailingly give way to true liberty and self-government and a policy of justice and encouragement of industry. Another outgrowth of the same creed was our confidence in the restoration of peace in China without seizure or partition of territory, and our forecast of a joint stand by Britain, Germany, the United States and Japan for the integrity of China and free commercial opportunity. The vital force of this philosophy is profound conviction that the supreme figure in the modern world is the engineer, and the supreme test of any material proposition is efficiency. If it makes for greater economy, it will prevail; if it makes for needless waste, it will fall. The rule runs the same whether the thing tried by it be a tool, a labor policy, a ship-canal, a government, or a human institution. The Nicaragua Canal, the Boer oligarchy, the war spirit in the Far East, had the foredoom of failure written upon them because they tend to waste of human effort and material resource. The strike leader, the jingo, the "war lord," are going the same road, and every new proof of the wastefulness of war puts them farther toward complete rejection. The name of Utilitarian is losing its evil sense as it is more clearly seen that every saving of effort or substance leaves man by that much freed for better things. The fitness that leads to survival is fitness in point of economy and efficiency—the fundamentals of all engineering effort. Because he serves these ideals, the engineer is already the foremost figure in the social order, far outranking statesman and soldier. The art outranking all arts is "the art of directing the great sources of power in Nature to the use and convenience of man."

THE TREND OF PRICES IN ENGINEERING INDUSTRIES.

By C. L. Redfield.

Dr. H. M. Chance, in a most thoughtful article on "The Present Value and Purchasing Power of Gold" published in the Magazine in May, 1896, forecast the very conditions which Mr. Redfield discusses in their latest phases in the following article. Rarely is an economic prophecy so strikingly fulfilled as that has been with which Dr. Chance concluded the articl just mentioned. The subject has gained new and great importance from the constant and cumulative increase in the rate of exploiting the world's great gold fields. Mr. Charleton's recent articles in this Magazine on Australian gold-mining, Mr. Tonge's accounts of constant progress in Colorado, Mr. Mabson's story of the Rhodesian prospects, told in our issue of March, 1900, Mr. Queneau's article last month on Cape Nome, Mr. Hammond's striking leader on the Transvaal situation in July, Mr. Leigh's description of the Gold Coast this month—all have one burden:—an enormous yearly addition to the supply of gold, and an inevitable fall in the purchasing power of this commodity. The question is even more important from the fact that the world has settled most of its vexing outside problems—in Africa, in the Indies, in the Far East—and has before it an era of busy peace, the progress of which must be accompanied by, and in large measure depend upon, the settlement of the ever-present internal problems ot cost of production and payment of the worker. A right view of the meaning and tendency of prices is fundamental to the case, and toward this view Mr. Redfield helps ably. —The Editors.

A COMMODITY is anything which is an article of exchange and which has value because of the human effort expended in its production. The price of a commodity is a statement in arbitrary units of the amount of gold which must be given in exchange for a specified quantity of that commodity. As gold is an article of exchange, and is obtained only through human efforts, it is also a commodity, and as a commodity is subject to the same laws as other commodities. The fact that prices rise and fall shows that the values of commodities vary from time to time, and the fact that the measuring and measured commodities are subject to the same laws indicates that price is a statement of the relationship of one variable to another variable. Any forecast as to the future trend of prices must therefore be based upon a study of the variations in value of different commodities, and to do this properly we must analyze the causes of such variations.

Under the old political economy, the ratio of supply and demand to each other is considered sufficient to explain all variations in price, and under the old conditions this explanation was practically satisfactory. In a limited sense and for particular cases the old formula is true today. It will determine the price when the supply is strictly limited, as in the case of rare coins, or when the demand changes suddenly, as in the case of articles made to meet the requirement of transient fads and fashions. It is also an explanation of temporary fluctuations in prices; but for staple articles the relationship of supply to demand fails as an explanation when we consider the gradual changes in prices which take place during considerable periods of time.

At the time when the law of supply and demand was first stated nearly all production was the result of hand labor, and the productive power of the community sufficed to supply but little more than what food and clothing was completely consumed. As the demand for food to sustain life and clothing for protection against the weather is an urgent demand, and nearly constant in quantity, it will be readily seen why a variation in the normal supply should cause a considerable variation in price.

With the gradual introduction of mechanical power and improved machinery, the productive capacity of the community has increased to such an extent that it has become potentially unlimited. The fact that the greatly increased supply of commodities arising from increased productive capacity has neither checked production nor ruined the producers by a demoralization of prices, shows that supply is not of itself the controlling factor of price. The explanation of this may be found in the motives which control human actions. The average producer knows little of the theories of political economy, and cares less. What he is interested in is furnishing some commodity at a price which will give him a reasonable compensation for the efforts expended in its production. As long as this reasonable compensation is forthcoming he will continue to furnish the article, but he seriously objects to furnishing it at a loss, or at a price so close to its cost of production that he is not enabled to obtain a respectable living. When the principal lines of production were limited to food and clothing, the man who was producing commodities at a price yielding only a bare subsistence had few opportunities to change; because of the scanty dissemination of general news he lacked knowledge of opportunities for change that existed; and because of the general lack of capital he could not hold his surplus product nor have it held until a suitable price could be obtained, but was compelled to dispose of it at the immediate market price. He was therefore often compelled to continue the production of a given commodity irrespective of the degree of his compensation or what the market price might be.

All this is now changed. The machinery which increased the productive capacity of the community has added a large number of new avenues of employment to which he may turn if his own prove unremunerative; newspapers, telegraphs, and a traveling public now keep him informed of what others are doing and of opportunities that exist; increased facilities for transportation enable him to send his surplus to distant points; and the increase of capital and storage capacity permits an unsalable surplus to be held for a more propitious market. With all these opportunities the modern producer will not long continue to furnish a commodity unless the selling price is higher than the cost of production; the practically unlimited power of increasing the supply of a commodity and the ever-present competition will not permit the price long to remain more than a reasonable amount above the cost of producing it; hence, in the long run, the cost of production will determine the price.

When the majority of producers were independent workers, few men knew what the cost of production was, and the market was dominated by the supplies furnished by those who did not know. With the expansion of the wage system producers learned to calculate the cost of producing articles, and independent producers were enabled to determine the same thing by comparing what they received for their labor with what they would receive as employees. In the light of the information thus gained we find the cost of production is a summation of the total effort required in bringing things from their natural state to that condition in which they become articles of trade or commerce.

Effort does not include the natural energy of nature that may be absorbed without expense, as the wind that propels a vessel or the caloric in coal that produces steam, but it does include the human labor involved in spreading the sails and handling the coal. Nor is it confined strictly to labor, as contended by the socialists, but it includes the mental processes of invention, guidance, and superintendence, and a legitimate return upon that condensed labor known as capital. The man who of his own volition and by extra diligence builds a waterwheel and compels the forces of nature to perform part of his own labor, and part of that of his fellow men, is entitled to whatever he has gained by his own diligence and foresight, and also to a small portion of the extra profit gained by those who use his wheel, but did not originate it. In other words, he has, by extra mental and physical efforts, brought about a state of affairs by which less future effort is required to produce certain commodities, and because less effort is required the cost of producing these commodities is reduced. As price is dependent upon cost of production, we see that it may ultimately be traced back to amount of effort exerted, and as the amount of effort expended in producing commodities is continually being reduced by the action of concentrated effort at previous times, the tendency is for the values of commodities to decline.

What is said in regard to values would be true of prices, if price and value were synonymous; but as prices are measured in a commodity which is subject to the same laws as other commodities, it is necessary to consider the extent to which concentrated effort may reduce the total effort necessary to produce gold, as compared to that necessary to produce other commodities.

Until recent times both gold and silver have been used as measures of values, and both have been produced by manual labor assisted by such tools as the miner could carry with him. As neither metal occurs in large masses, the amount of effort required to produce them long remained a nearly constant quantity, from which fact came the idea that they represented definite and uniform values. In the 70's large silver deposits became available by reason of the introduction of improved machinery. This machinery represented concentrated effort, by the use of which less total effort was thereafter required to produce silver. The consequence of this was a reduced cost of production, and this reduced cost was in a few years reflected by a fall in the price of silver compared with gold. If, during this period, silver instead of gold had been the standard for measuring price, it is evident that prices, as commercially stated, would have risen, though there would have been no rise in values. It would simply have been a case of stating prices in units of continually declining value.

During the last decade concentrated effort has been going into the production of gold, exactly as it went into the production of silver some thirty years ago. This concentrated effort has been, and is now, reducing the cost of producing gold. Owing partly to the comparatively short time through which the improved methods of producing gold have been in operation, and partly to the temporary shutting off of the least expensive supply, by reason of the South African war, the amount added to the general stock at the reduced cost of production has affected market values to only a limited extent. With the reopening of the South African mines and a continuance of the process of reducing the cost of producing gold, its value as a purchasing commodity will decline. It is impossible to say to what extent the value of gold will decline, but it seems probable that during the next twenty years the decline will amount to about fifty per cent. Whatever may be the extent of this decline, we may be quite certain that it will be considerable and will continue for a number of years. We may therefore say that in the immediate future prices will be stated in units of continually reducing value. In other words, it will take an increasing amount of gold to pay for articles which have a uniform value.

The obvious meaning of this is that prices will rise, but it does not follow that all prices will rise. Some will rise while others will fall. To determine whether or not the price of a given commodity will rise or fall we must first determine the percentage of effort that may be saved in its production, as compared with the percentage saved in the production of gold. We have already suggested that the probable saving in the cost of producing gold will be about fifty per cent. Those articles for which the saving will be greater than this will fall in price, while those for which it will be less will rise.

This may be illustrated by a few concrete examples. From ore to finished product, nails are produced principally by natural forces acting through machinery and under human supervision. While the amount of human effort consumed in the production of nails will undoubtedly be reduced from time to time, this human effort is now a very small part of the total energy consumed, and it is not probable that the percentage of reduction can equal that for gold. With considerable confidence we may therefore say that nails will be higher in price twenty years hence than they are now. What is true of nails is also true of the majority of those staple articles which are now produced principally by automatic machinery. We may say the same thing of the mass of agricultural products, because the element of time in production cannot be reduced to an appreciable extent, and because the reductions obtainable through larger product from a given area and through improved shipping facilities form only a small part of the total cost. We may also find other reasons why the prices of agricultural products will rise. Land, being a natural product, cannot be reduced in cost by improvements in processes of production; being strictly limited in supply it will rise in price by reason of increase in demand, even without any concurrent fall in the value of gold. These will cause an increase in the cost of producing agricultural products which probably will fully offset any reduction of cost in other ways. From the foregoing it will be evident that the future rise in prices of agricultural products will be a fairly good index of the concurrent fall in the value of gold.

The commodities which in the future will fall in price are those now produced by hand labor, but which may be produced by machinery, and those which are now produced in small quantities by isolated producers, but which may be produced by large combinations. These articles are principally articles of luxury, fancy articles, and the odds and ends of commerce.

We have determined value to be a representation of human effort, and price to be a statement of value in units of continually declining value. From these we may determine that labor of a given quality will, in the future, command higher prices. But labor, through education and training, is becoming more efficient, and consequently wages will rise faster than the value of gold will fall. The argument that the continual displacement of human labor by the introduction of machinery will glut the market with idler laborers whose competition will reduce wages is not a good one. The man who by the displacement of manual labor makes fifty thousand dollars does not carry that fifty thousand around in his pocket nor does he put it in a safety deposit vault. In neither of these places would it be of any use to him, and no man will exert himself to obtain that which is useless. The only way that he can make that money useful to him is to employ it, and the only way that it can be employed is to set men to work making something. What therefore his machinery enables him to avoid paying to labor for making one thing, he immediately pays to labor for making something else. This is an addition to the world's supply of things which would not have existed except for the introduction of his machinery, and as the new things are usually those which demand higher rates of pay, the scale of wages is thereby increased instead of decreased. The engineer who earns ten or twenty dollars a day is the descendant of a man who a few generations ago considered himself fortunate in being able to get fifty cents a day. It was the displacement of labor by the introduction of machinery which brought about the conditions that have made the engineer possible. If improved machinery and improved methods had not been put into operation, the ten-dollar man of today would be struggling along on the miserable pittance received by his ancestors.

WEST AFRICAN GOLD MINING AND THE "CONCESSIONS INDUSTRY."

By John Geo. Leigh.

Mr. Leigh's article has two important features—first, the very wholesome discouragement of reckless and visionary gold-gamblers, and, second, the intimation that to strong, sound, and well managed companies, guided by good engineering advice and contented with moderate dividends, the Ashanti gold reefs may offer opportunities comparable with those of the Rand. The support which such a prospect gives to Mr. Redfield's argument advanced in the preceding article is obvious.—The Editors.

PLACE before an average man, and any but a very exceptional woman, having a small amount of capital at disposal and consequently an exaggerated estimate of its importance, two prospectuses—the one inviting coöperation in a sound industrial enterprise offering opportunity for reasonable dividends; the other dilating upon the untold wealth hidden in a gold mine in some country of which the recipient of the document has previously scarcely heard—and there is little doubt as to which will claim the larger share of attention. Moreover, if, as usually happens, the second prospectus comes to hand after systematic advertisement of the auriferous wealth of the said country and certain more or less hypothetical fortunes won therefrom, and can point to the possession by the new-born company of a live lord, or a baronet or knight, at least, among its directors, the desired result is doubly assured.

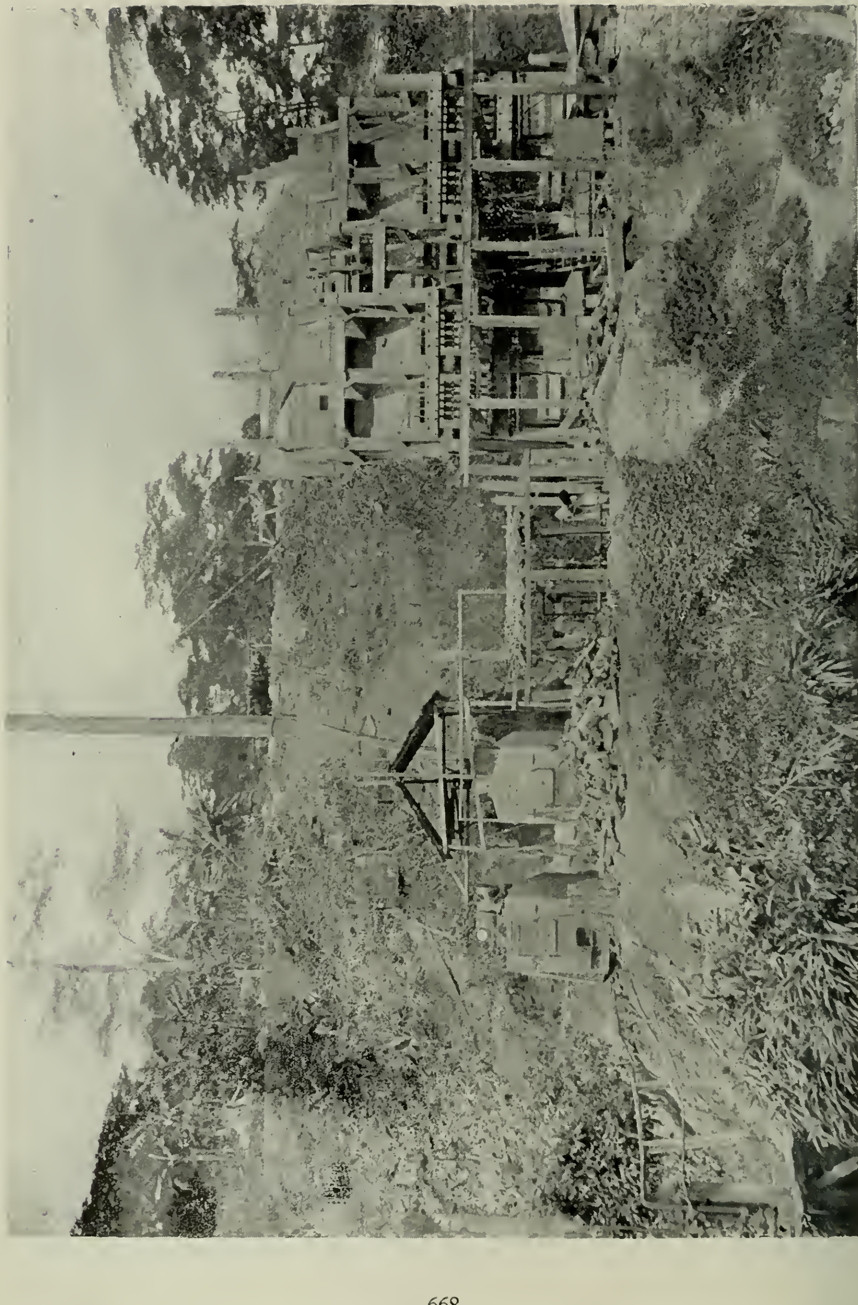
Truth to tell, an irresistible fascination is exercised over the minds and purses of most people by an alliance of the two substantives "gold" and "mining." The most, or only, familiar form of mining is that which places coal within the reach of everyone, and by the majority of the uninformed—their name is legion, regardless of degree—gold in its natural state is always associated with nuggets. The effect of this conjunction of ideas, that gold lies buried in masses a short distance below the surface of some favoured spots and can be won without considerable labour and cost, is usually disastrous to those who entertain it. They fall ready victims to the wily phrases of company promotion and,

THE CROSSING OF A JUNGLE RIVER.

hurrying, as they hope, to enrich themselves, learn all too late that their fancied bonanza existed only in the heated imagination of the compilers of the prospectus, or, at best, had swallowed more of the precious metal than it could ever disgorge.

These remarks are apropos of perhaps the most extraordinary boom which has agitated England since the palmy days of the "Kaffir circus," when every man, woman, and child deemed it a patriotic duty to assist in the exploitation of the auriferous and diamondiferous reefs of Southern Africa. Much money, of course, was made and lost in the historic cycle boom and the flotation of West Australian gold mines, but these episodes, though striking in their way, lacked many of the characteristics of the movement which, a few years ago, necessitated an enlargement and subdivision of the Stock Exchange mining department.

In an interesting article contributed to THE ENGINEERING MAGAZINE some two years since, reference was made to the influence of "apt alliteration" in popularising the magnificent railway scheme so long associated with the magnetic personality now at rest in the Matoppos Hills.* There is much in a name, and "gold mining on the Gold



SANSU MILL SITE, ASHANTI GOLD-FIELDS CORPORATION.

Coast" has proved a phrase dangerously fascinating even to the most unimaginative minds. History and legend are in large degree accountable for the witchery, for the region of the Gulf of Guinea has, since Europeans first became acquainted with it, been regarded as rich beyond the dreams of avarice in hidden stores of the ever-coveted metal. Whatever may today be thought of it, there is no doubt that in the past the Gold Coast was no misnomer.

A MAIN STREET IN AN AFRICAN GOLD COAST VILLAGE.

It is interesting to note that as long ago as 1470, the Portuguese, the original discoveries of the land, conferred upon one of their earliest settlements the name La Mina (Elmina), in honour of the quantity of gold obtained therefrom. We know also, on reliable authority, that Captain Thomas Windham on a single occasion in 1551 conveyed to England 150 pounds of gold dust, and that a second English expedition, fitted out a few years later under Captain John Lok, brought from the now famed golden land precious metal weighing 400 pounds and 250 elephant tusks. The Portuguese for many decades looked upon their West African possessions as one of their principal sources of revenue, but during the few years before and many following the cession

EUROPEAN AND NATIVE QUARTERS AT A WEST AFRICAN MINE.

to Holland of the entire Gold Coast, in recompense for the withdrawal of Dutch claims to Brazil, gold appears to have occupied a subordinate position among exports from the country. The reason for this is by no means clear, for William Bosman, chief factor for the Dutch at Elmina, in his "New and Accurate Description of the Coasts of Guinea," published early in the eighteenth century, says that all the rivers and streams contained gold dust, and mentions several districts in which, according to native report, the metal was abundant in the shape of nuggets. In more recent years, private estimates and official returns serve only to increase the surprise that gold has not been forthcoming in larger quantities. For instance, in 1816, one authority rated the annual export from the Coast at 100,000 ounces; five years later a second estimated its value at £3,406,275; while a third tells us that Britain's receipt of gold from the whole of West Africa during the three years ending 1834 was but £250,000. Judging from official figures dealing with subsequent years I am inclined to think the last estimate substantially correct, for I find that during the decade 1886-95 the annual exports of gold from the Colony were:—

	Weight ozs.	Value £		Weight ozs.	Value £
1886	20,799	74,828	1891	24,475	88,112
1887	22,547	81,168	1892	27,446	98,806
1888	24,031	86,510	1893	21,972	79,099
1889	28,667	103,200	1894	21,332	76,796
1890	25,460	91,657	1895	25,416	91,498

This shows an average of 24,214 ounces, valued at £87,167, which, be it noted, favourably compares with many later years. Yet, during these, scores of English companies, assisted by American managers and engineers, have been hard at work endeavouring to develope the industry.

Before reference to these efforts and the "boom" which, for a time at least, placed much of the wealth of England at their disposal, mention should be made of the reputation, now two centuries old, of Ashanti as a land abnormally favoured by Nature in her distribution of gold. The Ashanti nation, which for so many years was as a thorn in the flesh of the Gold Coast, appears to have reached the zenith of its power early in the last century. Frequent conquests, the command of an army which included practically every able-bodied man in the country, and the possession of a plentiful supply of firearms, induced the Ashanti kings to consider themselves invincible, and this supposition received no little encouragement when the hinterlanders, in 1816, besieged Cape Coast Castle and Annamabo, were bought off by the English governors, and made themselves masters of the entire littoral from Assinie to the Volta. So disturbing to trade was this state of things that the Royal African Company sent

A VISIT FROM THE KINGS OF ADANSI.

a mission to Kumasi, an interesting account of which appears in a book published in 1819 by T. Edward Bowditch, one of the delegation. If Kumasi really was what Bowditch described it, its wealth must have been astonishing, for we are told that, at the reception of the mission, "the sun was reflected, with a glare scarcely more sup-

ONE OF THE GOLD-COAST AMALGAMATED MINES.

portable than the heat, from the massive gold ornaments which glistened in every direction." The king sat on a throne, and was resplendent with breast-plate, anklets, and sword hilt, all of solid gold; his guards wore belts and his band played instruments of the same precious metal; even the most lowly of his attendants were decorated with layers of fine gold chains, while every native in the town seems to have been adorned with what would now be costly jewelry. Echoes of the same tale have come to us in later years; for instance, Captain Boisragon, after visiting the Ashanti capital in 1892, wrote that "The king alone was a sight to see, being a mass of gold from a kind of fireman's helmet he had on to the tips of his sandals, which alone must have been worth some hundreds of pounds."

What has become of all this wealth? Was it the product of the soil, and, if so, is it not reasonable to suppose that there yet lies buried in the ground and in the beds of the rivers and streams of Ashanti and its southern neighbour as much at least of the precious metal as was ever extracted by native methods, crude and wasteful? These are among the questions repeatedly asked by men of enterprise, or by those who, without aspiration to be themselves enriched, long for the peaceful developement and civilisation of heretofore unhappy, despoiled West Africa. To the first inquiry, wonderful though it be that a country almost weighed down with gold should in a few short years have lost everything, it is not possible to return a satisfactory answer; to the second and third, more important because they deal with the future, there seems but one reply—and that an emphatic affirmative. For the somewhat remarkable fact that there is yet a dearth of convincing evidence wherewith to justify this optimistic attitude, Britain has to thank some of her sons, "too clever by half," in the heart of the Empire and in the Colony.

Legitimate attention was directed to the Gold Coast and its hinterland as profitable fields for British enterprise by the virtual annexation of Ashanti in 1896,* the suspension of mining operations in the Rand consequent upon the outbreak of the South African war, and the final suppression of the rebellion which broke out at Kumasi in April, 1900. Many ventures, concerning which few words of disparagement can be said, were in rapid succession brought before the public, and the response of the latter was such that, for quite a considerable period, scarcely a day passed without the issue of a number of prospectuses, dilating in more or less glowing terms upon the exceptional value of the concessions acquired by the new-born companies and the certainty of early and profitable returns. A conspicuous percentage of these ventures, fortunately perhaps for some of the persons concerned in their flotation, stopped short at the allotment stage; while others ended brief, inglorious careers in liquidation, voluntary or otherwise. Nevertheless there still exist many hundred companies—particulars of no fewer than 420 appear in the recently published *Mining Manual*—whose shareholders presumably expect to handle dividends derived from West African gold. I regard it thankfully as no part of my duty to play the *rôle* of prophet in this matter, and am well content to echo, without comment, the views of others better qualified, by reason of City experience, to assume the dangerous distinction. One authority to whom I put the necessary

* It was not until September of last year that Ashanti was formally incorporated into the Empire,and an end made of an administrative interregnum perplexing alike to officials and the natives. Heretofore, even at Kumasi, the native kings shared in the government; the chief British representative continued to be styled "Resident," and his duties were practically undefined. Under the new arrangements, however, the relations of Crown, colony, and conquered territory were placed on a new and positive basis. The Gold Coast remains a Crown colony, with limits somewhat enlarged at the expense of Ashanti; the latter was constituted an independent possession, while the Northern Territories were "placed under the protection of his Majesty the King," or, in other words, become a "sphere of interest" until such time as their political or economic worth calls for a closer bond. Under the new *régime* Major Nathan, the governor of the Gold Coast, was appointed also governor of Ashanti, with power to appoint a chief commissioner (Captain Donald Stewart, whose excellent work as resident at Kumasi thus received appropriate recognition), and other officials needful for the administration of the country. He was also directed to respect "any native laws by which the civil relations of any native chiefs, tribes, or populations under his Majesty's protection are now regulated, except so far as the same may be incompatible with the due exercise of his Majesty's power and jurisdiction, or clearly injurious to the welfare of the said natives."

AYENIM MILL, ASHANTI GOLD-FIELDS CORPORATION.

A PROSPECTOR AND HIS CARRIERS.

questions was sufficiently optimistic to opine that some sixty companies would prove remunerative investments, and that probably two-thirds of those whose shares still stand at a premium would justify this position. A second was by no means equally hopeful and inclined to estimates at least fifty per cent. less favourable; while others hovered practically between the two opinions. All, however, agreed that, given time and patience, the Gold Coast and Ashanti would prove themselves to be very highly mineralised and consequently deserving of great commercial interest.

In all British colonies, and especially those yet unblessed with representative government, commercial transactions between whites and natives are very strictly ruled for the protection of the aboriginals. Particularly, and very properly, is this the case in all matters relating to the alienation of land. Often, however, a question arises whether the "man and brother" principle is not occasionally so strained that manifest injustice is done to the white, while the other party is made objectionably overbearing, even to the extent of relying upon his colour as ample excuse for spoiling the alien. Whatever the cause, this at least is certain, that the West Coast chiefs, in the matter of mining concessions, have usually proved themselves more than a match for the presumably smart individuals of lighter hue with whom they have had dealings. They were quick to see that the white man, usually acting for "friends at home," desired something in the way of a bargain, and very promptly evinced inclination to oblige. Many scandals have resulted, some of which have been publicly exposed; but the *modus operandi* and evil consequences of the traffic have never been so clearly and authoritatively proclaimed as they were by Governor Nathan in the course of a speech delivered at a dinner of the Chamber of Commerce at Cape Coast Castle in September last. Having referred in not (as I read them) very hopeful terms, to the prospects of general trade and the mining industry, Major Nathan thus proceeded:—

> "This is a somewhat discouraging state of things, but worse remains behind. Many hundreds of concessions have been registered in the colony this year, and notices of them have been filed in the concessions court; and I have never met a gold prospector, barrister, merchant or official, who, when we talk of the gold industry, does not tell me that a large proportion of these concessions are not worth the paper on which they are written. In truth, a concessions industry has grown up, which is quite distinct from the mining industry, and threatens to ruin it and permanently injure the future of the colony. The industry has its centre in this town, where clerks and persons of no standing act as middlemen between the native chief who is willing to lease his stool lands to any person and to any number of persons who will give him money, and the speculator who buys wholesale from the clerks the documents they have executed with the chiefs, without inquiry whether the lands referred to represent any value as a gold-mining property. The speculator hopes to get back from a company the commission money he has paid to the middleman and the earnest money he has paid to the chiefs, together with a very handsome profit to himself; while the company, formed nominally to work the concession, looks to the public and not to the gold on the concession to recoup expenses. It is difficult to protect people from the consequences of their own folly, but I certainly advise the public, before taking shares in any gold-mining company, to see that it has been satisfactorily reported on by a man qualified by his character, capacity, and knowledge to prospect for gold."

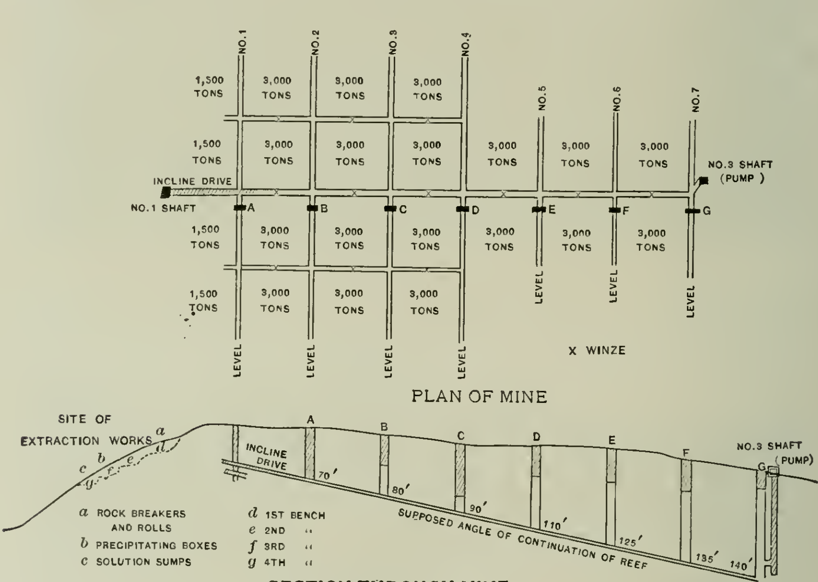
Here we have in concise terms, from the highest official in the colony, a picture of what has been going on for several years. The facts are indisputable and, indeed, have long been notorious, at least in City inner circles. Yet I do not hesitate to think that, were it possible to revive the "Jungle boom" tomorrow, a certain section of the public, despite burnt hands and repeated official warnings, would promptly rush to its support.

Much wiser is the policy which has been adopted by the leading companies and endorsed by their shareholders—to ignore market operations and devote themselves to the developement of their properties in really businesslike fashion. Some ideas may be formed of

THE TAMSU MILL, LOOKING FROM THE TOP OF THE RIDGE.

CEMETERY FOR MINING MACHINERY, TAMSU.

the severity of the existing slump from the fact that, during three weeks last fall, the depreciation in twelve of the more important companies amounted to no less than £8,250,000. With increased facilities for the transport of machinery and stores from the coast, the work of the next six months should add very materially to the general knowledge of the mineral wealth of the country, and perhaps even result in an early output of gold. The initial mistake made by a majority of the companies was in minimising the difficulties likely to be encountered, with the result that shareholders became disheartened, not only on account of the market outlook, but also because they thought unjustifiably slow progress was being made in connection



PLAN OF MINE

SECTION THROUGH MINE

with their properties. Strength was very frequently given to this feeling by the injudicious and, I believe, quite unnecessary reticence observed by directors and officials. In this connection, I gladly draw attention to the accompanying plan and section, not only because of their intrinsic interest, as showing the developement done and proposed by one of the most promising enterprises (one of the Wassau group) on the Tarkwa banket reef, but also on account of the systematic manner in which the shareholders are periodically informed of the progress of the workings. Each investor is supplied with a section map showing the arrangement of the various shafts and levels, and as reports arrive, postcards are sent from the office giving detailed information as to the footage completed.

Much stress has been laid upon the difficulties of transport from the coast to the mine, and certainly the latter have, in this regard, been very severely handicapped. West African jungle is of the densest descrip-

MARKET AT OBWASSI.

tion, the roads even near the coast should more properly be described as paths, carriers have been few in number and exorbitant in their demands, while the railway, from which so much is hoped, is still in course of construction so deliberate as almost to provoke derision. Work in connection with the line was commenced more than three years ago, but up to the present the only section open to public traffic—a somewhat elastic phrase, as miners and traders know to their cost—is that between Secondi and Tarkwa, a distance of 39¼ miles. In February, after the opening, a friend of mine, travelling to Secondi and back for the purpose of bringing up-country £1,000 in specie, was compelled to travel in open trucks, crowded with native labourers and their accompanying odours and exposed to the full glare of the sun. Each train went off the line only once, which was regarded as evidence of most brilliant engineering; and one of the trips was accomplished in the phenomenally brief time of 6½ hours, an average of one mile in ten minutes, over which the officials crowed consumedly. For the railway, such as it is, or will be, the colony must primarily thank, not the Government, but the Ashanti Goldfields Corporation. The

MILL AT TAMSU.

latter, finding the authorities unwilling to incur the risk of the enterprise, undertook to guarantee, for a term of twenty years, payments sufficient to make up the net annual receipts to £20,000 as soon as the railway reaches Obuassi, the center of its property, and to increase the guarantee to £30,000 when the track is completed to Kumasi, a distance from Secondi of 169¼ miles. In official circles, a hope is entertained that the rails will touch Kumasi by the end of 1903, but local opinion is by no means equally sanguine.

Reference to the railway has necessitated departure from a policy which I intended to pursue throughout this article, namely to avoid mention of particular companies. The Ashanti Goldfields Corporation, however, seems to occupy a unique position among the enterprises engaged in exploiting West African quartz reefs, inasmuch as more than a year ago it reached the producing stage and can already point to an output of many thousand ounces. Its experience, therefore, is not without value in connection with the belief of many West Africans that crushing on quartz reefs will, for some time at least, give a greater output of gold than the banket formation. Many thousands of tons crushed in the Obuassi district have averaged 2 ounces of gold. This is probably a very exceptional yield, but an all-round one-half as good cannot fail to have important results, if, as experts claim, the gold-bearing veins of West Africa have been traced over a greater distance than those of the Rand. It is also noteworthy that the company referred to, which is working nine different mines and employs over 4,000 natives, repudiates in emphatic fashion the accuracy of current assertions as to the difficulty of obtaining labour, claiming that the trouble, where it exists, is usually created by those who complain of it rather than by the natives. Often enough, there is much to be said in support of this theory; and equivalent discrimination is not undesirable in connection with that permanent obstacle to the developement and civilisation of West Africa—the evil reputation of its climate. There is little hope that, in our time or for many generations to come, science will achieve much in lessening the perils to life and health which lurk in all directions. In the meantime, however, much might be done by Government, employers, and even the most subordinate among the white residents, to improve existing conditions. In olden times, before hinterlands were thought of, all the whites, by force of circumstances, were compelled to live on the

MEMBERS OF MINING STAFF AND THEIR QUARTERS, GOLD-COAST AMALGAMATED MINES, TAMSU.

low-lying coast, in places long since recognised as within the fever zone. Nowadays, except in rare instances, there exists not the slightest necessity for such gratuitous courting of danger; nevertheless, thanks to innate conservatism, the parsimony of Government, and the false economy of employers at home, the administrative and commercial headquarters of each colony remain where they were placed hundreds of years ago, and comparatively healthy spots a few miles inland remain deserted. Moreover (and this applies unhappily to not a few of the gold-mining companies), the notorious disrepute of the West African climate has fostered two ideas;—First, that slightly enhanced remuneration must be regarded as sufficient *quid pro quo* for all risks, and as relieving the employers from responsibility for even the most elementary measures conducive to the health and welfare of their staffs; and, second, that so long as a man remains uninvalided, it is "good business" to get out of him all the work possible. All this is the most false of economies; the frequent changes of *personnel* cause the work to be almost invariably in arrear

WORKSHOP DESTROYED BY A FALLEN TREE.

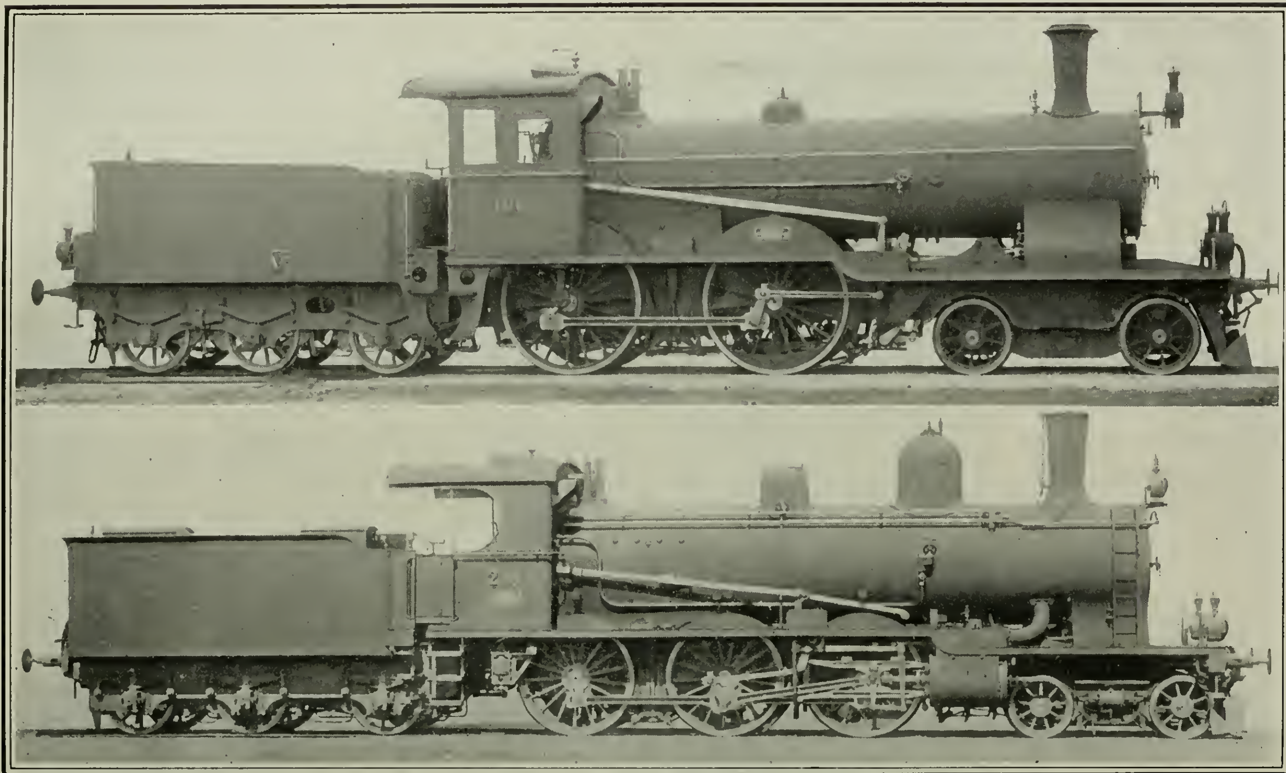
and never thoroughly mastered, the natives dislike more than anything else transfer from one authority to another, and the annual saving in passage money disbursed on account of reliefs would go far toward providing funds for improvements calculated to diminish the present almost continuous journeyings to and fro. *Surtout point de* *zèle;* West Africa is not a country for work at high pressure, and the manager inclined to forget this should be promptly restrained rather than encouraged.

Although the Gold Coast Colony and Ashanti have been particularly referred to, it is very probable that other parts of the coast may

FOUNDATIONS FOR A TRADING STORE, GOLD-COAST AMALGAMATED MINES, ADJA BIPPO.

soon claim attention as gold producers. Thanks to the cloud which at present overhangs the "Jungle," much interest is temporarily devoted to the Ivory Coast, and not a few British companies, which so far have done little or nothing in the way of practical mining, are said to contemplate active intervention in the latest boomlet. There has also been much mysterious talk about the doings and hopes of certain syndicates formed for the purpose of prospecting the hinterland of Lagos, long regarded as a future Eldorado, but the reports of the experts who have examined the various concessions appear to be unanimous in declaring that, whatever advantages the country may possess, gold is not among them.

A few final words concerning the photographs with which this article is illustrated. For those descriptive of the country where are found most of the mines associated with the banket formation, I am indebted to the camera which, in various and widely-sundered parts of the world, has often rendered me yeoman service; for the use of those representing operations in what was once the realm of Kings Kwoffi Kari-Kari and Prempeh, my thanks are due to the Ashanti Goldfields Corporation; while two are selected from many courteously placed at my disposal by the editor of *West Africa*, a journal much to be commended for its consistent championship of honest finance and fair dealing with the natives.



TYPICAL SWISS COMPOUND EXPRESS LOCOMOTIVES.

The engine above is the two-cylinder compound of the Northeastern Railway of Switzerland; its peculiarities are the bent frames and the absence of cams on the cranked axle. It has no dome, and steams without priming. Works compound when the engine is linked up (Winterthur-Mallet device); it has a rocking lever to avoid the use of eccentrics. Below is the four-cylinder compound express engine of the St. Gothard Railway, Switzerland, with direct steam brake on the bogie truck.

FEATURES OF CONTINENTAL LOCOMOTIVE BUILDING.

By Charles R. King.

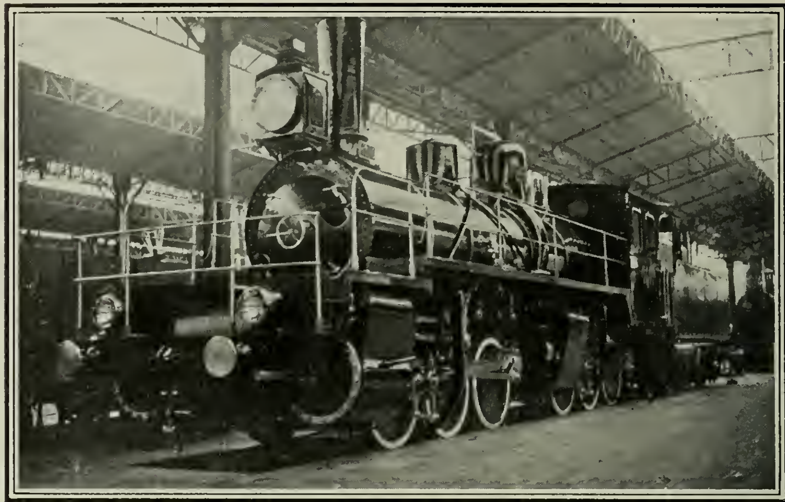
III.—SWISS, SAXON, RUSSIAN AND NORTH EUROPEAN TYPES.

Mr. King's review began in our June issue. The first portion dealt with the French compound locomotives, the fastest regular runners anywhere. The second described some characteristic Italian and Austro-Hungarian types. The article below concludes the discussion.—The Editors.

THE representative of Swiss locomotive building at the Paris Exposition of 1900 was the compound four-connected express engine of the North Eastern Railway of Switzerland—a very successful type employed in working the fast Swiss services, including the international trains over the line between Zürich and Basel. The engines were designed some two or three years ago by the Schweizerische Locomotiven and Maschinen-Fabrik of Winterthur to the general conditions of Herrn. G. Haueter, chief engineer of mechanical power. They were required to haul trains of 265 tons at speeds of 28 to 32 miles per hour in ascending grades of 1 per cent. High speeds are not general in Switzerland, but the engine mentioned with a train of average weight can easily attain a rate of 56 miles per hour, running very steadily and economically.

The cylinders, which are placed beneath the boiler and have the large diameters of 18⅛ and 26¾ inches, have necessitated the bending of the side frames outward to increase the width by 5 inches, this bending being done carefully after the side plates are bored, punched, and slotted in bundles of four. The plates are 1 inch thick, of Siemens-Martin mild steel or *flusseisen*, and very solidly braced together. The valve gear is Waelschaert-Heusinger's, worked from an outside rocking shaft, a method of transmission adopted because it enables the cranked axle to be made of the simplest form possible, since there are no eccentrics, with their well-known disadvantages as compared with an outside eccentric crank, avoiding beside the inconvenience with large eccentrics for getting at the inside main-rod big ends.

The expansion links are located inside the frames, and the valve-chests, with partially balanced valves, are placed above the cylinders, inclined toward the outside and easily accessible. The cylinders and valve-chests are cast in one piece at the foundry of the adjoining



THE MOST POWERFUL ENGINE EXHIBITED AT PARIS—THE TWELVE-WHEEL COMPOUND OF THE MOSCOW-KAZAN RAILWAY.

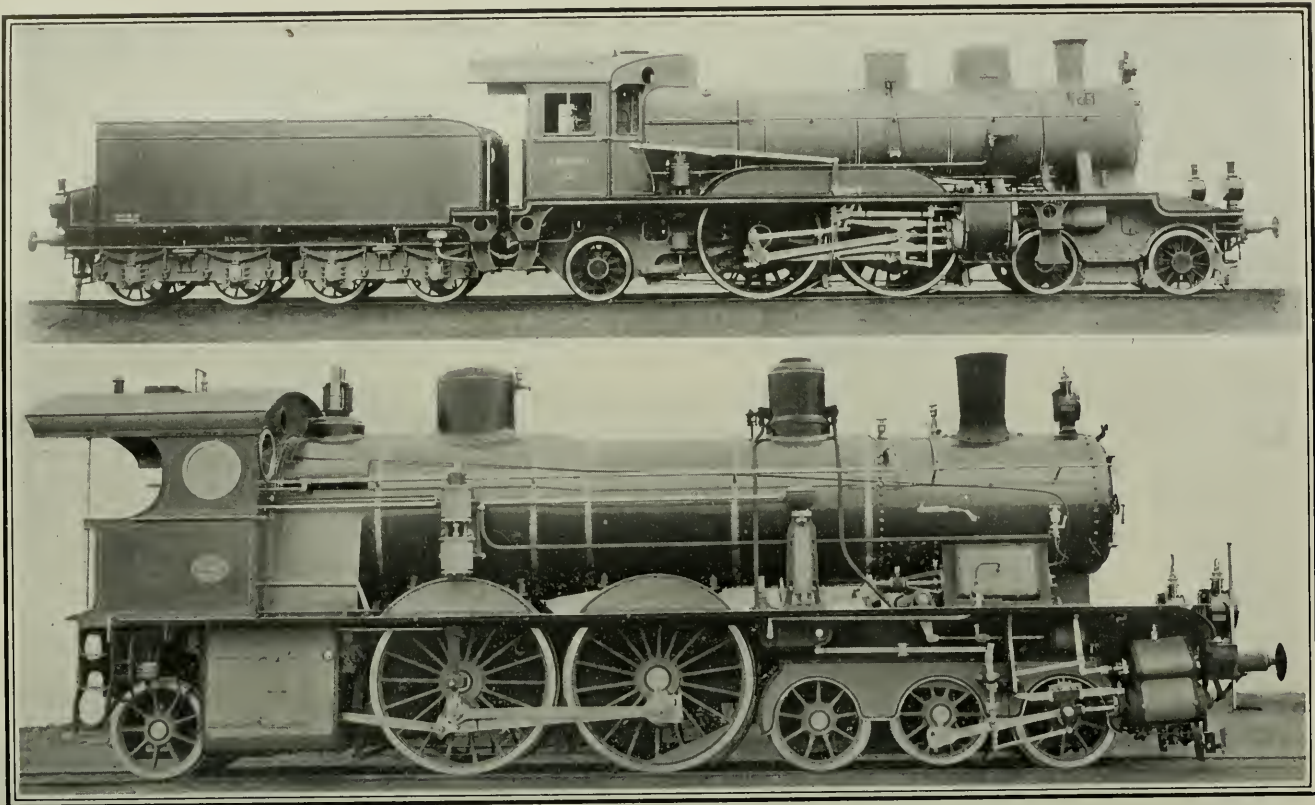
works of the renowned firm, Sulzer, and are fitted with a half-automatic starting valve having a double-seated piston valve and combined auxiliary valve for live-steam admission. On starting, and when the reversing screw is at one or the other extreme end of its travel, each of the two cylinders receives steam direct from the boiler and exhausts direct to the chimney, independently as in a single engine. In linking up to a position corresponding to a cut-off of 70 per cent. this valve is reversed and compound working commences. This action may be easily observed in engines leaving stations by the slower and quieter exhaust which takes place after the machine is well started. The main driving rods are of nickel steel from Krupps and the connecting and coupling rods are of Siemens-Martin steel. The blast pipe is of annular invariable type with its orifice level with the top line of tubes. The axle boxes are cast in Martin steel, their rubbing surface lined with bronze and fitted with adjustable wedges. The boiler is of Siemens-Martin mild steel. At the front end the copper firebox is supported by dilatation stays, the rest being the ordinary crown stay bolts. Mild steel is used for the tubes and their firebox ends are of copper. The throttle valve is situated in the smokebox, there being no dome; the Nord-Ost Bahn locomotives have no such boiler mountings, from the fact that a former *maschinemeister,* known as the Swiss "Stirling," was opposed to their use. But as there is never a trace of priming water upon the boiler or chimney—such as used to mark the domeless broad-gauge locomotives of the Great Western of England—and as the boilers are so far large enough for all present needs, there is with these Swiss engines no necessity for a dome. A collector steam pipe is carried along the top edge of the boiler and has longitudinal slits in its upper surface. On the boiler, in the position usually occupied by the dome, is a manhole surmounted by two safety valves, and two other valves are located in front of the cab. The front truck has a straight pin and its frame has a direct lateral movement. On each side of the pin are two elliptical springs with short camber thrust pins permitting the necessary displacement. The side supports beneath the cylinder casting have their spherical surfaces turned upward instead of, as usual, the reverse. Such a truck might be considered stiff in vertical action as compared to those having a swing frame and no side rests, yet, as an instance to the contrary, it may be mentioned that once when one of these engines was proceeding at 50 miles per hour down-grade, a front truck tire flew off, and after the accident had been signaled to the engineman by a platelayer it was found that a considerable distance had been run upon the wheel rim without any particular damage to any other part.

The spring hanging on the driving wheels is by means of plate and spiral springs, and equalising levers are employed between the two pairs of wheels.

BULGARIAN COMPOUND LOCOMOTIVE.

An example of the "articulated locomotive," Mallet type. A Mallet engine similar to this takes a heavy passenger and mail train from Basel every morning.

The equipment comprises "Nord-Ost" injectors, Nathan No. 8 oiler, from Friedmann of Vienna, Gresham steam sander from Hardy of Vienna, speed indicator and counter by Klose (inventor of the well-known articulated locomotive), steam train-heating apparatus, and Westinghouse brakes for locomotive and tender.



COMPOUND EXPRESS LOCOMOTIVES OF CENTRAL EUROPE.

The upper picture shows the ten-wheeled four-cylinder compound express passenger engine of the Saxony State Railways; the lower figure is the twelve-wheeled two-cylinder compound Krauss locomotive with auxiliary pony engine on the pilot truck. This engine has been much adversely criticised by English and French journals. The main frames are pierced to make room for the cylinders inside.

The engine, like nearly all Swiss engines, has the boiler sheathed in black "Russian" iron, made not in Siberia but in Germany. Boilers so jacketed keep a very fine appearance, like a polished gun-barrel, as the metal never rusts. The locomotives are kept nearly as trim as on English railways and the sides of the tires, originally turned bright, are in all Swiss engines kept scrupulously polished. The cab and tenders are usually painted a dark green. The total time spent on the cleaning averages 3 hours per day.

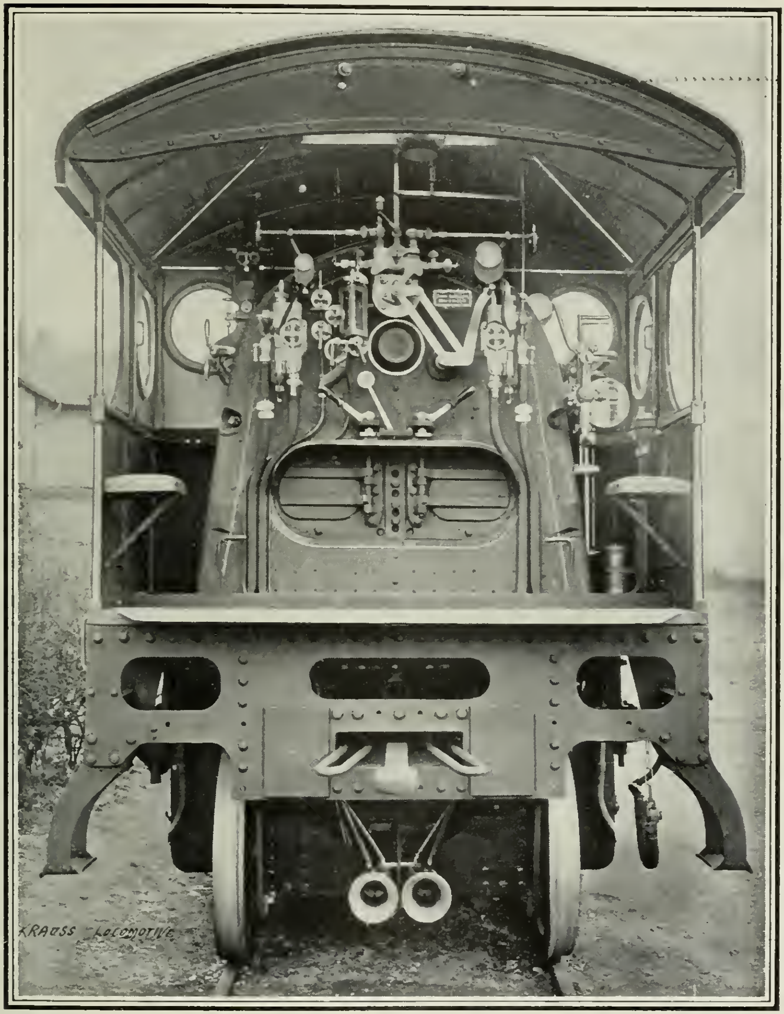
10-Wheeled Four-Cylinder Express Engine, Saxony State Railroads.—This engine, of which two were in service last year, was designed and built by the Sächsischen Maschinenfabrik Actien Gesellschaft, vorm. Richard Hartmann, Chemnitz, Saxony. Being of an entirely new type, like so many of the engines exhibited at Paris in 1900, the engine is still in its trial period on the Saxony State railroads. It will be remembered, in the matter of trial periods, that the first four-cylinder compound engine of the Northern Railway of France was put into service in 1886, and it was not until August, 1891, that the first regular standard engines of the same type commenced service. These Saxon engines are working the fast train services very satisfactorily between Dresden and Leipsic, and comprise in their construction a number of details well worthy of notice. The general disposition of the four cylinders is just that which was so successfully introduced into current practice by the Belfort works of the Société Alsacienne de Constructions Mécaniques, and that arrangement, it need hardly be said, is the only simple one practically available—one which indeed it would be difficult to avoid unless by following either the Woolf tandem, the Vauclain superimposed, the Mallet duplex, or the Adriatic cross-compound. Therefore to class the Saxon engine as being of the de Glehn system would be a simple misstatement of fact, just as it would be to say that M. de Glehn's manner of placing the cylinders was merely Webb's plus an extra low-pressure cylinder. The Saxon engine differs in its starting arrangements for the working entirely by simple expansion—the system employed being Lindner's, admitting, it will be remembered, live steam by a special cock into orifices in the high-pressure slide valves and so located therein that steam from the receiver passing to either side of the high-pressure piston equalises the efforts in the two pairs of cylinders until the engine is linked up, when a four-way cock, operated from a rod connected to the weigh-bar shaft, is closed and the engine works double expansion. This well-known arrangement is very simple, dispensing with special starting valves which necessarily increase the expense of maintenance;

yet notwithstanding this advantage it reduces the starting powers of the engine, while the process of equalisation on the two sides of the high-pressure piston presents certain momentary objections in working, especially in two-cylinder engines.

There is no provision for a direct exhaust from the high-pressure cylinders, as is possible with many compounds and exists in the de Glehn arrangement, such appliances being considered by the Saxon builders to be scarcely ever employed in locomotives so fitted. In this point, only, it is similar to the Adriatic and Mallet four-cylinder locomotives.

For the outside engines Heusinger valve gear is employed, and for the inside or low-pressure engines Joy's valve gear has been adopted, in order to allow the greatest amount of surface possible for the journal bearings and cranks of the front axles. The valves are of the Von Borries type; their relief plates are all of crucible cast-iron and each valve has compensating steam ways—1/2 inch wide for those of the high-pressure, 9/16 inch for those of the Allan balanced low-pressure valves for normal speeds, and 13/16 inch for those of the Richmond high-speed low-pressure valve. The second set of valves for the low-pressure cylinders are intended only for speeds ranging from 56 to 75 miles per hour and for the purpose of giving a maximum of opening for the admission and for lead to the exhaust, with a reduction of compression. All valves are given an inside clearance or lead for eduction—1/4 inch for high-pressure, 1/8 inch for the normal low-pressure valves, and 3/8 inch for the Richmond low-pressure valves. The two distributions can be reversed simultaneously by an ordinary screw, to the slide block of which is attached a notched quadrant, its lever connecting with one, only, of the weigh bars, so that the latter may be operated independently, whenever required, for varying the respective cut-off in the two groups. At high speeds the proportion of cut-off found most suitable for the high-pressure and low-pressure pairs is 40 to 45 and 70 per cent., or a 10 per cent. greater admission for the low-pressure than that we have seen most frequently employed with the French Eastern engines.

The whole of the valve motion is of mild Siemens-Martin steel and its bearings are made as large and ample as possible. The expansion links are of weld iron, cemented and case-hardened, and the dies in the Heusinger gear are of homogeneous iron (mild steel) cemented and hardened, and in the Joy gear these are of phosphor bronze. All have oil boxes to prevent scoring, and are forged solid with the die.



VIEW OF THE CAB AND BOILER END, KRAUSS LOCOMOTIVE WITH PONY-TRUCK DRIVERS.

The cylinders, which have diameters of 13¾ inches and 21⅞ inches by 26 inches stroke, are protected from condensation by a layer of cork composition and by wood cleading covered up by the usual sheathing. Ordinarily on the Continent a hermetic metal sheathing inclosing a layer of hot air is preferred to any non-conductive material. The boiler is of Siemens-Martin steel or *flusseisen* from Krupps of Essen, constructed in the usual way with butted longitudinal seams double welt strapped and double zig-zag rivetted and with telescopic circumferential seams. A peculiarity to be noticed is the Saxony State Railroad's practice of joining the barrel to the smokebox by a narrow welded ring which, in case of corrosion of the smokebox tube-plate, can be easily replaced without removing any of the long barrel rings. To increase the smokebox diameter a thick hoop is interposed between its circumference and that of the boiler barrel. Steam is supplied to the dome on the forward ring by a collector pipe having transverse slits in its upper circumference and extending back close to the firebox shell crown.

The blast pipe has a fixed orifice calculated, along with the chimney proportions, according to Von Borries. A spark arrester of American type is formed of ¼-inch wires ½ inch between centres. The chimney is of cast iron. At the bottom of the smokebox in front a small trap is provided by which the cinders can be raked out into a funnel let in flush with the front of the running board.

The driving axles and coupled axles are of nickel steel, the driving and coupling pins being of Siemens-Martin steel, case-hardened. The wheel centres are steel castings, cast with their counterweights calculated on Von Borries' formula, and the tires are of crucible steel, the whole of this material being by Krupp. The driving boxes are of cast steel with cast-iron keeps and oil reservoirs below. Their rubbing faces are lined with brass and the axle is made dust tight with felt washers. The horn blocks are single-piece steel castings from Krupps and are fitted with screw wedges for taking up the play at the front guide block.

The frames, 1 3/16 inches thick, are also of Siemens-Martin steel. They are 37 feet 4 inches long and, while cold, are bent outwards 3 inches on each side to give an internal width of 4 feet 6 1/4 inches in order to allow room for the large low-pressure cylinder casting. The side frames are built together very strongly by longitudinal, transverse, and vertical platings.

The front truck pivot is of steel with a half-sphere, 11 3/4 inches diameter, of copper cast upon it and resting in a step bearing in the cradle frame, which is a steel casting. This half-sphere is retained in its bearing by an iron ring between which and the top of the half-sphere there is a play of 3/16 inch to prevent strains. The truck swing frame has a play of 3/4-inch on each side. The bolts supporting the swing links, by which the swing frame is carried at their lower ends, are given a sharp edge to increase the sensitiveness of the suspension. A play of 3/4 inch is also allowed to the radial bearing wheels below the firebox. The method of keeping the wheels normally central in their radial guides is worth notice. The weight of the engine is here carried by a pair of transverse and inverted plate springs, and their hangers are spread outwards and upwards at each side of the axle to longitudinal yoke arms cast on top of the axle boxes, the inward pull thus exerted tending to keep the wheels flexibly central. To prevent strains from this inward pull a heavy bar is pinned between the crowns of the two opposite radial box guides.

All truck wheels are equipped with brakes, operated from an air cylinder located on the main frame by which a braking effort of 14 tons is effected, equal to 62 per cent. of the weight below the truck tires.

The engine and tender are painted in the usual German colours of dark green for the boiler and red for the wheels. The whole engine and the machine work is of very fine finish.

Tandem Four-Cylinder Compound, Russian State Railways.—This engine is characteristic of Russian design and, apart from its four cylinders, affords a good idea of the generality of Russian locomotives—built without regard to the cramping effects of small loading-gauges, with a height of 15 feet 9 inches and width of 9 feet 6 inches on a road gauge of 5 feet; altogether, to us, not very compact-looking, but probably to Russian eyes presenting a less huddled-up appearance than Western locomotives. This engine, which was brilliantly painted a dark crimson, like those of the English Midland, and relieved with nickeled mountings such a side buffers, name plates, window frames, and beadings, was constructed by the Poutilow works of St. Petersburg to the designs of H. E. the Professor N. P. Petroff. The first of the series was built in 1898, and being very successful in service the type has been definitely adopted as the standard for the St. Petersburg-Warsaw section, there being now some fifty or sixty of this type at work.

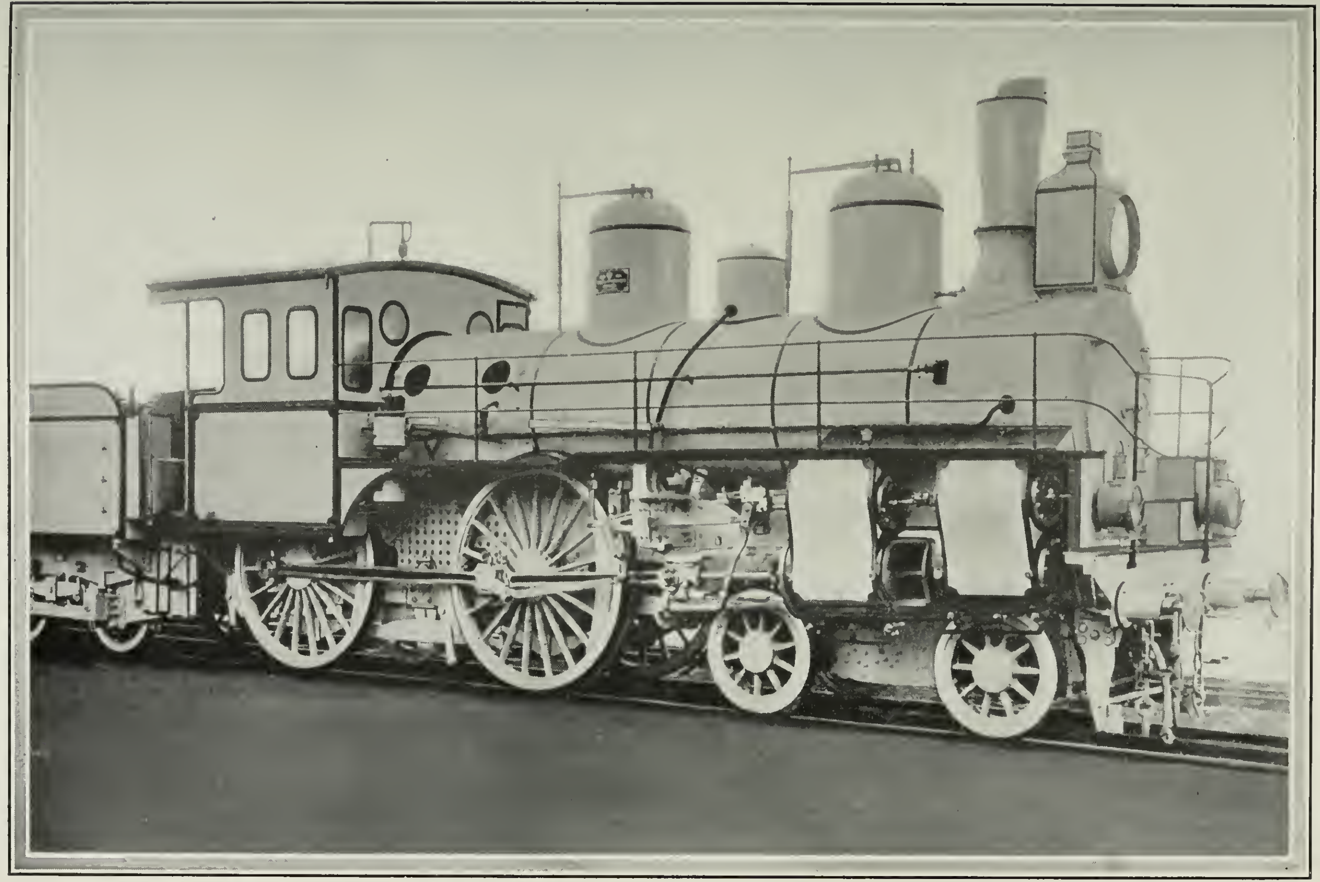
The low speed of Russian trains is often the subject of adverse comment by Westerners, yet in the trials with the first of these locomotives it hauled a train of 250 metric tons the distance of 170 miles from St. Petersburg to Pskow in 3 hours 31 minutes, or at the average speed of 48.5 miles per hour, the velocity up the long grade of 0.6 per cent. being 45 miles per hour, while descending the same grade and on the level the speed was limited to 68.7 miles per hour. Again, with a train of 260 metric tons composed of 10 double-truck coaches, or 360 tons gross load and mounting a grade of 0.5 per cent. with 55 per cent. cut-off in the high-pressure cylinders, the speed of 42.2 miles per hour was maintained.

As in the United States, where the same practice of outside cylinders prevails, the only disposition for a four-cylinder engine is either in vertical or tandem grouping. In both cases the equalised turning effort realised in French compounds and the co-equal division of the stresses in the motion here become lost advantages. This raises the complicated question of low first cost of some locomotives as compared with others of greater durability and costing more for construction but less for maintenance, with longer life to the rails and permanent way, and perhaps also of the enginemen—but this latter does not count.

The Russian State railroad compound has each group of tandemed cylinders bolted outside the frames at an inclination of 1 in 20 from the horizontal. Each pair is cast together with its cylindrical valve-chests and the covers are held up to their seatings by concentric rings and stud bolts. The high-pressure is 14⅜ inches diameter and the low-pressure 21½ inches by 24 inches piston stroke. There is a space of 17½ inches between the tandemed cylinders, and the valve spindle between the valve chests is adjustable by a screw and special lock-nut arrangement. The piston valves, with external admission, are 8⅝ inches diameter. A clearance volume is allowed of 8 per cent. for the high-pressure and of 6½ per cent. for the low-pressure cylinders.

The whole of the motion, including the main and side rods, is of carefully designed proportions combining with the necessary strength great lightness. All rod ends are of the solid pattern with cotters. The valve motion is Heusinger von Waldegg's with closed or box expansion link connected downwards to the eccentric rod by a short extension and the advance lever bent to clear the guide bars. The wheels, of cast steel, are 78¾ inches diameter and have a distance between centres of 9 feet 10 to accommodate the firebox between their axles. The fuel is naphtha and coal. The boiler, which is of iron, has a working pressure of 161 pounds only. The maximum theoretical tractive effort is 14,080 pounds.

In the general construction we notice that the flanged edges of the boiler head are drawn out to long feather edges and welted down to a splice joint inside the sides of the round-topped firebox, the longitudinal seams of which are butted and double strapped. The edges of the copper firebox side sheets are likewise drawn out thin and lapped over the flanged edges of the fire-hole sheets. The "Webb" system is employed in making up the two boxes at the fire hole, but the usual covering lip has been replaced by a simple iron plate at the



STANDARD EIGHT-WHEELED TANDEM-COMPOUND EXPRESS ENGINE, RUSSIAN STATE RAILWAYS.

shovel edge. The curved sides of the firebox shell are braced with a row of four transverse stays; the head and the tube plate are stiffened with angle irons and plate girder stays, but without any longitudinal direct stays. The copper firebox crown is supported by the usual crown bolts and the flue sheet is secured to the rear boiler ring by eight copper stays screwed into the water-space belly stays. Copper ferrules are employed for the tubes at the firebox end. The deep plate frames covering the sides of the firebox are drilled through opposite to each copper screwed stay in order to reveal fractures and facilitate examination and repairs.

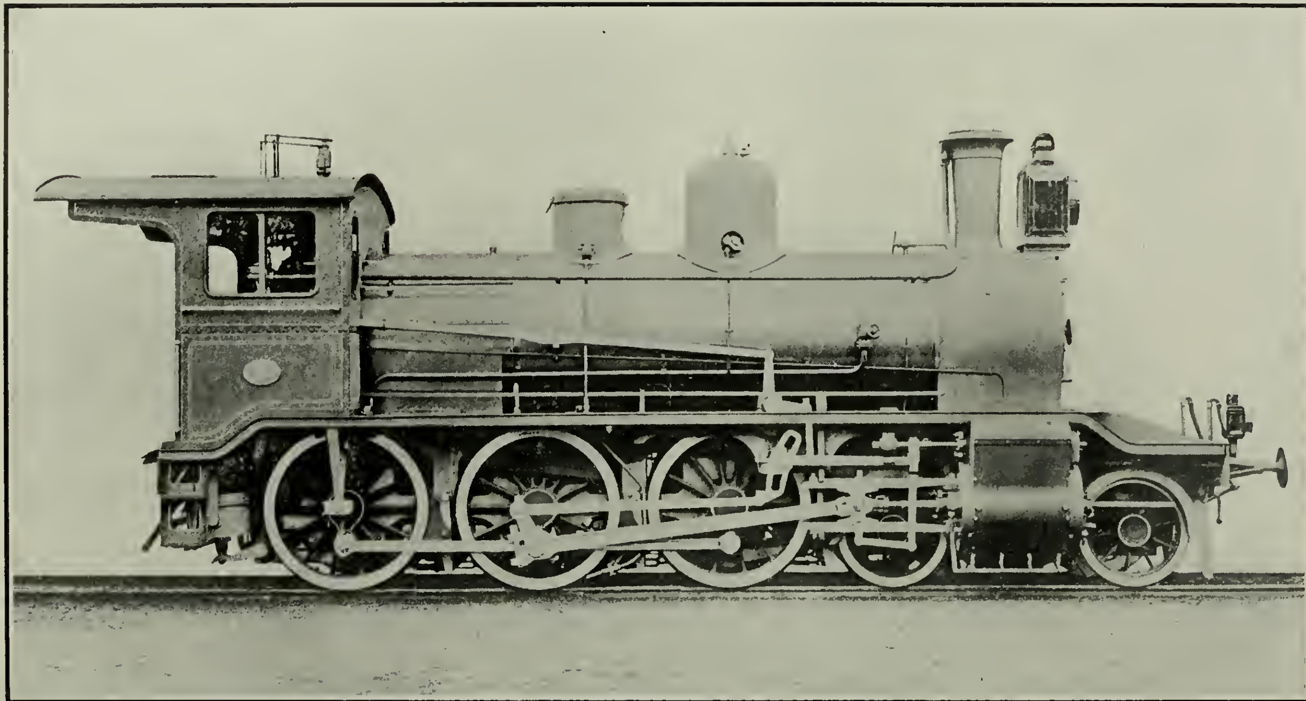
The grate is level and divided into four transverse fixed sections. There is no brick arch. The steel brackets supporting the firebox on the frames are faced with bronze grooved liners. The boiler barrel is lap jointed, smallest ring in the middle, and the smoke-box is increased in diameter by a thick welded hoop over the forward edge of the first boiler ring. As a power reservoir, the boiler capacity is considerably augmented by two high domes, over the first and third rings, and fitted with lever safety valves. These domes are often, in European practice, coupled by an outside pipe. Here they are connected by an inside pipe 5 inches in diameter, joining two cast-iron stand pipes, each of which is fitted with a steam trap that is calculated to knock out the moisture remaining in the steam after it has passed, as it does, through baffle plates in each dome. The delivery pipe in the forward dome reaches to a little behind the throttle valve. By these means the livelier steam of the firebox region is brought nearer to the cylinders, and whether the engine is on up or down grade or the throttle is opened suddenly, the forward dome is certain to get steam as dry as possible. With the well-known greater efficiency and consequent economy of dry steam it is remarkable to find so many devices for getting the heat either by firebox steam or by hot-air chambers to the forward end of the boiler. For the operation of transit cannot possibly take place without loss in traversing these throttling mechanical makeshifts. In the far-off future some master mechanic will probably find out the error.

The throttle valve is of the semi-balanced type, and steam from the main standpipe, 5¼ inches diameter, is conveyed by 3½ inch copper pipes forward through the smokebox to the high-pressure valve chest; the exhaust therefrom is effected by 4¼-inch diameter pipes to the low-pressure and by 5¾-inch pipes from the low-pressure to the blast pipe. The receiver-pipe volume is one-fifth that of a high-pressure cylinder. A rectangular space around the blast pipe is shut in by a

BELGIAN LOCOMOTIVES AT PARIS BEING DISMANTLED FOR SENDING HOME.
Showing how all national initiative, so strong in Belgium a few years ago, has been abandoned for slavish imitation of the Scotch Caledonian locomotives.

perforated spark-arrester, each side of which is equal to the diameter of the chimney base—about 26 inches. This great area of the chimney base is intended to generalise the draft in the side tubes without favouring only those of the centre, already too much under the influence of the blast. For years previous to the Belgic craze for locomotives of Scotch *"façade"* the Belgian railways made use of rectangular chimneys spread out at their bases to almost the full width of the smokebox; likewise the most recent locomotives of the Alsatian railways have the petticoat pipe outside the smoke arch, and double chimneys have sometimes been used for the same purpose. Most engineers appear to think this matter trifling. That the unequal draft resulting from a narrow chimney is a serious defect was seen by the writer from heavy leakages occurring in a Belgian locomotive having three boilers, all in a transverse row, and with but one firebox, one smokebox, and only one chimney. Here, in spite of the large chimney base before referred to, the fire always took the shortest line to the centralised uptake and by unequal dilatation caused much trouble with the firebox tube plate and with the tubes; yet had the smokebox been provided with side chimneys and side blast pipes, the locomotive would have been more successful mechanically notwithstanding its immense flue chest.

The iron framing is very massive. The side plates are 1 3/16



MOGUL TWO-CYLINDER COMPOUND WITH VON BORRIES STARTING VALVE. NORWEGIAN STATE RAILWAY.

inches thick; at the firebox they are 40 inches deep. From end to end the side frames are braced by vertical and longitudinal plates. The length of 5 feet 6 inches from the smokebox to the truck pivot frame is made particularly strong as a fixing for the tandem cylinders. The frame is not riveted to the smokebox as is usual, but instead a bracket plate, riveted to each side of the smokebox, projects downwards and hooks freely over the top edges of the T-transverse saddle plates, allowing thus free dilatation to the boiler at the front end.

The practice, common in England, is followed of fixing the rail-guards (pilots) to the front end of the frame instead of to the truck; this plan is unquestionably the best as it avoids any possible deviation or shock to the truck pin from heavy obstructions. The pivot consists of a hollow steel pin 7½ inches diameter with a 2-foot flange, and is bolted beneath the main-frame caisson, which has a depth of three feet. It is stepped into a steel casting recessed collar plate of larger diameter and this in turn is free to slide transversely along the H section built-up truck bed plate. Seatings of bronze are interposed between respectively the pivot and its collar bearing and between the bearing and its sliding edges on the bed plate. The engine main frames project outwards beyond the truck frame, and brackets bolted outside the latter support a helical spring below each edge of the engine frame, allowing a certain amount of flexibility to prevent strains, only; for the form of the pivot is such as to permit very little adaptation of the truck to superelevations of the rail, at least, other than the comparatively small amount that is always possible with the axle springs.

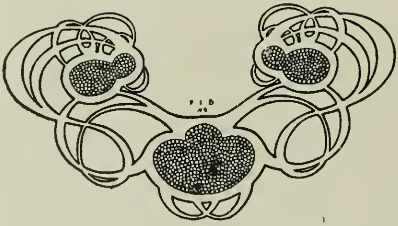
Binding of the journals against the inner or outer edges of the brass is generally avoided by forming a transversally rounding crown on the latter, so that it may tilt in its box to conform to the slight angle assumed by the axle on curves. In the Russian locomotive the truck brasses and boxes remain unchanged, but the camber buckles are forged with spherical-ended bosses or studs which, resting in a cup bearing on top of the axle boxes, permit as much inclination to the latter as their side flanges will allow. The truck frames are inside the wheels and with inside journal boxes. The journal brasses, as is most usual on the Continent, are flanged around the axle box to form a bearing against the wheel naves and against the axle collar. The iron equalising beams between the driving springs are of unusual appearance, being formed of two trussed iron bars 6 feet 1 inch between the spring hangers; a shoulder iron bracket 1⅝ inch thick is bolted to the frames and passes downward between the two bars upon

4-CYLINDER EXPRESS-COMPOUND, SOUTHERN RAILWAYS OF ITALY.

which the weight is carried by two steel knife-edged fulcrums secured to the bracket. The arrangement appears to be more sensitive than the usual one with fulcrum pins.

For the Russian locomotives the cabs are hardly less convenient than those employed in America. The windows in the Warsaw engine are fairly deep, so that the engineman is not obliged to stand near to it to see all over the road in front.

A drop seat is fixed to the cab side for the fireman, and a saddle seat to the top of the driving wheel cover for the engineman. The reversing screw is similar to those for simple engines, a mere notched locking disk taking the place of a hand wheel. The engineman can stand on either side of the cab to work the throttle and this is effected by means of a joint in the throttle handle provided with a notched quadrant which permits the extended lever to be set at any desired angle to suit the convenience of the engineman.



ELECTRICAL PROBLEMS OF MAIN-LINE RAILWAY TRACTION.

By Charles T. Child.

The interest which characterised all of Mr. Child's writings is heightened in a peculiarly sad way in this case by his death, which occurred on June 23. The proofs had already had the advantage of his revision. The article—probably the last of Mr. Child's electrical writings to appear—exhibits markedly his happy characteristic of concise and lucid expression. It is remarkable as a comprehensive general statement of the conditions to be met in heavy railway service, and the sufficiency or insufficiency of present modes of electric traction to satisfy them.—The Editors.

EVER since the change of motive power from horses to electricity was accomplished upon the majority of city tramway lines, the public has felt the day for the electrical equipment of main-line railways to be close at at hand. With this belief no inconsiderable number of electrical and other engineers have agreed, but there seems to be no very wide-spread movement in railway circles towards the supersession of the locomotive. Indeed many, if not most, railway engineers still regard the general equipment of their lines with an electric-traction system as little short of chimerical—as a thing that may be interesting to talk about if no more serious subject of conversation is at hand; but only a few have gone so far as to look closely into the fascinating problems presented by the design of an electrical system. To give some account of these problems, with brief reference to what has been accomplished towards their solution, is the purpose of this paper.

The service of a tramway is all of one kind. The service of a railway is differentiated into two great classes, the transportation of freight and of passengers, and these classes are further subdivided, in accordance with local demands and the nature of the railway itself, into more or less numerous sub-classes distinguished by the composition, speed, and schedule of trains. For the different classes of trains and service different types of locomotives have been evolved, ranging all the way from many-wheeled slow-geared mountain-climbing and freight-hauling engines, to the high-drivered racers that compete for the prizes of speed records in express-passenger service.

On account of all this differentiation of classes of trains and service and of speeds and schedules, the motive-power requirements vary very greatly from train to train. Suburban passenger service, for example, requires that trains shall be sharply accelerated when leaving stations, in order to attain a high speed from end to end of their runs. Through express trains require high speeds to be maintained for long distances and considerable intervals of time, while rapid acceleration is not so important in their case. In these two classes of passenger service the weights of trains also differ widely, as they do in local and through freight service. In short, every train presents conditions determined by its speed and schedule which require its motive power, for the attainment of the highest efficiency, to be applied in amount and method differently from its application to other trains.

Whatever the nature of the motive power applied to the moving train, it must be under instant and perfect control, must be reversible, and must admit of continuous operation at all speeds between the highest desirable and the minimum needed while coupling cars, crossing switches, and in such other situations as require the lowest speeds. The nature of the power equipment should, of course, be such as to cause no increase in risk to the personnel of the railway or to property, or none that is not fully compensated in some way. And, naturally, the operating expenses of the railway must be reduced by any change in motive power, not necessarily as a total, but certainly reduced when measured against the ton-mile of goods transported or the passenger-miles traveled. Of course these statements are the merest truisms, but they are essential and fundamental to any discussion of the railway traction problem, and are all too frequently lost to sight by those who have looked upon electrical equipment of any sort and at any cost as the coming method of working railroads.

Having thus noted that the motive-power requirements of railways are of many sorts, and that they require conformity to certain simple fundamental engineering and financial principles in any novel undertaking, it is well to examine the present state of the art of electric traction to see what it offers and how best it may be made to serve the exigencies of railway operation.

Only two general methods of operating moving cars or trains by electric power have been devised. One of these, that utilizing a source of electrical energy carried on the train itself—a storage or primary battery—can be left out of consideration because of the commercial inefficiency of such apparatus for this purpose. Their depreciation-cost more than counterbalances any advantages they may possess.

The other method of operation is to distribute electrical energy along the right of way upon a fixed conducting structure, from which the train derives its power through a moving contact. This method of working, which has proved its entire practicability upon thousands of miles of street railways and light railroads, requires a different type of conducting structure and of distributing network according to whether direct or alternating current is used at the train motors, and whether or not the track rails are used as electrical conductors. The simplest case of an electrical power-supply system is that exemplified in the usual trolley road, where a constant difference of electrical potential is maintained between a fixed conductor parallel with the track and the track itself, direct current being used throughout. Perhaps the most complex case met in practice is that of a number of American long-distance interurban lines, where current is generated as three-phase alternating, stepped up in voltage for distribution, stepped down again at sub-stations, where it is also converted into direct current, and thence distributed to the conductor parallel with the tracks.

Of the two varieties of electric motors, those using direct and alternating currents, each possesses distinct advantages and as distinct limitations for railway service. The direct-current motor has very high initial torque or starting power, and through its use high acceleration can be had. Its construction presents no difficulties, and ample experience has been had with it under every variety of operative conditions. It can be made of large output for a given weight and its cost is comparatively low. Its mechanical strength is great and its depreciation in service small. It can be controlled and regulated with ease and certainty in several ways, and it lends itself admirably to the multiple-unit method of operation, by which each car of a train may carry its own motive-power equipment and all may be controlled from a single point, no matter how many cars are assembled to form a train. But with all these advantages it is handicapped severely by the inability of manufacturers to build it for high voltages of supply.

The present limit of safe practice in direct-current motors seems to be at about 700 or 800 volts—a pressure requiring a current flow of about one ampère for each horse power developed. With heavy trains and high speeds the problem of collecting the necessary large current becomes of almost insurmountable difficulty. Added to this is the equally difficult matter of supplying such volumes of current efficiently along an extended conducting system. Indeed, the limits of working with direct current are so sharply set by the energy loss and voltage drop in conductors that compromise system—that using alternating-current generation and sub-stations—has already been forced upon a number of engineers as a make-shift. More than a make-shift this hybrid system can not justly be considered, since it involves an unnecessary cost for labor in operating the sub-stations and increases fixed charges out of all proportion.

The alternating-current motor is of several kinds, possessing differing characteristics. For railway uses the polyphase induction motor has already been employed in a number of notable installations. This type of motor has almost as many advantages as the direct-current machine. It is very simple, has no commutator, and possesses enough initial torque to start from rest any load it will work under. It is singularly enduring in service and has an almost negligible depreciation. While not quite so efficient (commercial types are under consideration) as the direct-current motor, it is sufficiently so. It is somewhat larger and heavier for the same output of power than the direct-current motor, but not to an objectionable degree. It can be made, and herein lies one of its largest claims for recognition, for practically any voltage that can be generated directly, or for pressures up to 12,000 or 15,000 volts in large motors. Coupled with these advantages, however, are the detrimental qualities of low power-factor, requiring line, dynamos, and motors to be built a substantial percentage larger than the requirements of the working power transmitted indicate, and difficulty of control.

To remedy the latter difficulty (the former is practically irremediable) recourse has been had to a number of devices and methods, some of them of high promise. The fact remains, however, that the regulation of the speed of induction motors is not yet satisfactory; they can be stopped, started, or run at half-speed when two are used together, but they can not be depended upon at present to pull a heavy freight train at three miles an hour across a temporary repair job in the track, or to back a train up gently to a waiting Pullman car.

But the alternating current has all the advantages, save one, when its distribution and generation are considered. Indeed, it is the only kind of current that can be satisfactorily and economically distributed along a hundred-mile section of railway, for example. The cost of generation is not essentially different whether the current output be alternating or direct, though alternating generators cost a little less than direct-current machines, both in their purchase and their up-keep. Once outside the power house, though, the cost of transmitting large powers by direct current, at the voltages imposed by the motors, is utterly beyond reason for long lines, and for short ones of heavy traffic. The weight of conductor metals—copper, aluminium, or iron —that would convey with a given loss 1,000 horse power ten miles at 500 volts, will conduct the same power 200 miles at 10,000 volts with the same loss. The latter voltage is well within the limits of safe alternating-current practice.

But a very serious practical difficulty exists in using an alternating-current feeding system. Polyphase currents require at least three conductors for their transmission—that is, two conductors and the track, if the latter be used as part of the electrical circuit. The direct current requires only two conductors—or one conducting system, trolley wire, third rail, or whatever else may be used, and the track. The electrical system paralleling the track may be made electrically continuous and of one polarity in this case. If the track is not used as part of the circuit, then the conductors must be of two polarities with direct current and of three with alternating, unless some way of utilizing single-phase alternating currents is discovered. Just here the difficulty arises, since at every switch-point and crossing these different polarities would be brought together.

The third rail may be looked upon as a temporary device, sanctioned perhaps in certain extreme cases where nothing else will serve the purpose, but unsafe and inviting accidents and damage suits wherever put down. On absolutely restricted rights of way it may survive for a time; but on a main-line right of way it is impracticable. A shunting yard full of "live" third rails would be as dangerous as a battlefield.

A considerable number of sectional third-rail systems have been patented—some 400 of them in the United States Patent Office alone—but their use has been very limited. At best they are a costly compromise and probably as dangerous as the live rail, by virtue of their seeming safety which invites carelessness. Apparently the only safe and sure way to install a conducting system is to put it overhead, either immediately over the tracks or at one side of the right of way. Even with this construction there are bridges and tunnels to consider. If only it were possible to operate both direct- and alternating-current motors on the same train and track, so that the advantages of both might be secured, the problem would be very much easier. This has actually been suggested—most recently by Mr. James Swinburne—and a number of methods of accomplishing this apparently impossible result have been devised. In effect they consist of a sub-station on each train, alternating current being taken from the line conductors, where all its great advantages are preserved, and either by means of transformers and rotary converters or of synchronous motors driving dynamos, converted into direct current for use on the motors. Terminal and suburban sections might be equipped only with direct-current feeders, so as to simplify the motor equipment of local trains and shunting locomotives. All this, while very interesting, would be more satisfactory to railway engineers if it had been tried long enough to give data of costs of operation and maintenance and, above all, of certainty of operation.

For, after all, the first duty of a railway power equipment is to move the trains in accordance with the schedule and with the degree of safety to which we are accustomed. It is a safe prediction that electrical equipment will not become general for main-line railways unless it accomplishes an increase in economy of working, or else, which amounts to much the same thing; increases the traffic possibilities of the line. The former improvement would be welcome everywhere; the latter would be of little use to railroads, of a type common in the United States and in many other countries, that have less traffic than can already be handled on a single track.

The first place for electrical equipment on main lines is on suburban sections, for the handling of heavy passenger traffic. Here the superiority of electric traction is already manifest and here, doubtless, will be the theatre of experiments in which the best variety of conducting equipment, of rolling stock, and of electrical apparatus will be discovered and standardized. The advantages to be gained by small diminutions in the motive-power costs are not so large as are commonly thought. In America the labor costs for railroad operation are about twice as large as all the other costs combined, including motive-power, administrative, and maintenance costs, and only a large saving in motive power expense would make much of a showing in the totals. Naturally the whole problem of costs is incapable of generalization, since conditions differ widely amongst different railroads. Questions of cheap water power and dear fuel, of strictures upon the stream of traffic interposed by natural obstacles, such as sections of heavy grades, and the like, make the solution different in each case. Undoubtedly electricity will play an increasing part in railway traction, but the present equipment of locomotives on most railways will probably be worn out in service—unless the induction motor can be brought under more perfect control. If that happens—and there is no safety in the word "impossible" in electrical engineering—we may expect to see important changes. As the problem stands today, however, the solution is certainly not apparent.

SOME UNACKNOWLEDGED CONDITIONS IN BRITISH WORKSHOPS.

By T. Good.

Mr. Good's assertions are startling, but any pains-taking investigator who will direct his inquiries carefully will soon come upon ample proof of every count in the indictment. Of the confirmation secured by the Magazine before publishing this article we shall have more to say at another time. It is enough now to say that it is astonishing in its completeness and its authority. But we are by no means disposed to think the evil is more than sporadic. It is not an "institution," either national or of trades-unionism, that Mr. Good attacks; it is an abuse, injurious to both employer and workman, to be found, in America as well as in England, where a lack of conscientious purpose in the subordinate officials co-exists with lack of discipline in the controlling officials, or owners. Its inevitable result is degradation of the workmen and decadence of the establishment. Our purpose will be served if attention is directed to the possibilities of evil which lie in the system Mr. Good exposes, and the interest of manufacturers is so awakened that they will prevent its gaining or keeping any foothold in their works.—The Editors.

NOW that there appears to be real cause for alarm concerning the British industrial position we are hearing a good deal of what is known as the "Ca'canny" policy, and its injurious effects are being pretty clearly demonstrated. As one who has been able to study this problem on the spot I beg leave to disagree with much that is written upon the subject by those whose knowledge of workshop methods is necessarily limited. That this "Ca'canny" policy is in extensive operation in many industries, that it has a demoralising influence upon workmen, and that it materially affects the larger problem of foreign competition, I freely admit; and that this foreign competition question is to the worker a wage question, to the employer a profit question, to the landlord a rent question, and to the entire community a national question imperatively demanding the strictest attention, I fully recognise; but, because I have had the advantage—or, perhaps, disadvantage—of practical and personal experience in workshop government, have witnessed some of the evils thereof in their naked deformity, have carefully traced them to their natural sources, and, having been behind the scenes, have arrived at conclusions not in accordance with those generally accepted, I claim indulgence to put part, at least, of the blame upon the right shoulders

By universal admission, the great stimulus needed in the British industrial system is some method by which men shall be paid, or promoted, according to individual ability, and every man encouraged to do his best. A dead level of mediocrity is incompatible with a progressive industrialism. How is efficiency to be cultivated in the national interest, and rewarded in the individual? In the first place, what prevents the free development of individual ability and energy to-day, in British workshops? In a word, why do men who have sold so many hours, or days, of their lives to an employer, "go-easy"?

There are many reasons. The cardinal fault is this:—under present conditions a good clever workman (and there are many of them, even in Britain) is in too many cases valued by his employer no more than a bad one, simply because the employer is unaware of his superior abilities. The management of all large establishments is in the hands of managers and foremen who are seldom shareholders in the undertakings, with the result that favouritism frequently plays havoc with the employer's interest. Managers are often appointed through social influences, rather than by merit or fitness for posts of trust; foremen are selected because they are favourites with the manager; and chargemen, or gangers, are selected because they are favourites with the foreman. At least ninety per cent. of the workshop promotions that have come under my personal notice have been bestowed upon men other than those best fitted for the honours. And the consequences have been, and are, simply deplorable, for under such a system men lose all incentive to put forth their best energies, and honest work and genuine ability are placed at a discount. It is a sorry admission, but I must say that my varied experience has convinced me beyond the shadow of a doubt that honest workmanship seldom pays.

Under conditions at present existing in many workshops—and here I would urge those who shed tears of ink over the British workman's indolence to mark well what I say—the man who gets on the best, who is favoured by the cleanest and most comfortable jobs, who maintains his employment when others are dismissed through temporary slackness, and who is singled out for promotion, is he who regularly attends either the same place of worship or the same public-house as his foreman, and it by no means follows as a corollary that this is the best man in the shop; in fact, the reverse is usually the case. The result under these circumstances is that men who have secured positions of trust in a workshop through dishonourable means are not too self-respecting to receive bribery in the shape of "tips" and "treats" from some of those workmen under their authority, to the detriment alike of honest labour and capital. When I say that this pernicious system of bribery is a very powerful factor in the industrial problem—a very real and great evil in every-day operation—and is largely responsible for a chronic form of "Ca'cannyism," I only say what I know to be true. I could quote a case where a firm employing about five thousand men were rendered bankrupt, their plant and machinery laid idle, and the whole district in which the works were situated thrown into industrial chaos, through this very system, which was carried on glaringly for many years, until at length the crash came—capital and labour suffering indiscriminately.

I have seen methods of bribery at work in some shops to an extent positively appalling. In such cases, few men who failed regularly to tip or treat their foreman stood any chance of either promotion or constant employment. Time after time I have known good, efficient, and honest workmen dismissed when trade has been a little slack, whilst the services of drunken, unprincipled, good-for-nothings have been retained, the employer thinking, quite naturally, that his trusted subordinate official could be relied upon to weed out the most undesirable men only. Knowing what I do of "workshop politics," the wonder to me is that British workers, man for man, perform as much honest work as they do, so seldom is a good, capable workman encouraged. With all due respect to those managers and foremen who are honourable men, I do not hesitate to say that speaking generally, present-day methods of workshop management constitute a national disgrace! I have known men who were managers' favourites to charge their employer, day after day, for overtime that was not worked. To my knowledge men have drawn their full wages, with overtime rates added, for doing absolutely nothing for their employer, but a portion of the money has been handed to the manager. Cases have come under my notice of men drawing full-time weekly wages from one firm, whilst at the same time they have been earning money elsewhere, having been enabled to do this through a fraudulent system of timekeeping, although from the same works good honest men have been dismissed for losing two "quarters" during one week.

Besides tipping and treating, there are other forms of workshop bribery which I deem it my duty as a Briton, anxious for the welfare of my country, to expose. One method by which a premium is put upon dishonesty is a system of trading carried on by managers and foremen with their workmen. Many managers of works accept commission agencies from furniture dealers, clothiers, jewellers, and others for the supply of goods on the credit system to workmen. Under such a manager, all the lazy, inefficient man has to do in order to keep his employment, whether trade is good or bad, and to get paid for a liberal amount of overtime, is to patronise the shop-keeper whom his manager nominates. There are many managers and foremen in Britain who draw more money from shop-keepers in the shape of commission, than they draw in salaries or wages from their employers. Where such foremen are in power, the honest and dignified workman who will not stoop to such despicable means of gaining favour, but insists on buying for ready cash in the cheapest market, is put on all the dirtiest and most unpleasant jobs, and got rid of as speedily as possible. Whenever I find a man employed uninterruptedly for a great number of years in a large shop where other men are being constantly suspended, or dismissed, I am suspicious of that man's ability and integrity.

Another industrial evil that places honest skill and faithful service at a discount, and that has come under my personal observation, is money-lending. Frequently, foremen advance small sums of money to men under their charge, and receive good interest in return—usually two pence in the shilling. It naturally follows that the drunken spendthrift—seldom a capable workman—who is always in debt from Monday to Saturday, is unduly favoured at the expense alike of honest labour and capital. I have known men of this stamp who for months together have never been at work before breakfast, but they have, nevertheless, drawn full wages all the time, with the knowledge and consent of their foreman. Other cases I have in mind where men under dishonest foremen have enjoyed full wages without rendering an iota of service to the firm paying the wages; they have simply held sinecures. Men thus favoured have, of course, served their foreman in some way—perhaps by a little gardening, or by assisting in a shop when the foreman has been a shop-keeper, or by their wives or daughters doing a little domestic work gratis. Need I expose these methods of bribery any further?

Under these conditions, which are far more prevalent than any writer or speaker upon industrial problems who has not had the benefit of practical experience in workshop methods has any idea of, and which I am endeavouring, without sensationalism, to make plain, can we wonder that Britain, as a nation, appears to be lagging behind some of her competitors?

Now there is another point in connection with the labour question to which I wish to draw attention; and here I must say a word in defense of the middle-aged, or elderly, workman, which will not be very complimentary to the young men. There is a tendency on the part of many employers to discard middle-aged or elderly workmen, and give preference to young men, especially since the passing of that legal monstrosity, the Workman's Compensation Act. In many industries men over forty years of age are out of the running for a job, whilst some employers even refuse to take on men who are over thirty. This I regard as a mistaken policy. After careful observation I am convinced that the man of forty or fifty years of age is of far more value than the young blood of twenty. The elderly or middle-aged workman goes about his task, as a rule, methodically, continuously, carefully, and with due regard to the safety of life, limb, and property. But this is not the case with the average youth or very young man; he does his work more often by fits and starts, and is careless alike of the safety of his fellow-workmen, and his employer's property. He cannot, owing to lack of experience, exercise the judgment and caution of an older and more skilful man. If he has to rig a stage, scaffolding, or gangway, he has not the experience of the elderly man to guide him to the safe completion of his labour. I have stood near the gates of large works when it has been the time for setting on workmen, and it has pained me to see the youth of twenty called in, whilst the man of forty, a householder and the head of a family, has been turned adrift. This policy is economically unsound, and morally wrong. Our young men of to-day, if we are to hold our own in the commercial race, need less work, but more *education*.

The greatest fault in the British industrial system, at least so far as methods of workshop management are concerned, is the wideness of the gulf between the employer and the man who uses the tools. Why should the employer, or managing director, consider it *infra dig.* to be personally acquainted with the man at the bench? If employers could, or would, take a little more interest in their men, take a little more cognizance of the human nature that is at work in their establishments, and place a little less reliance in their subordinate officials, there would soon be a marked change for the better in workshop life; but so long as employers place absolute confidence in managers and foremen who are seldom shareholders in their business; so long as it is possible for the unprincipled loafer, the wasteful and inefficient scamp, to be as well treated as the good, clever and dignified worker, or even better treated —so long will "Ca'canny" be an industrial epidemic. I would strongly urge upon employers the importance of realising that men are not machines and that the British workman, at any rate, can be more easily led than driven. My point is this:—an employer may have a hundred machines all of equal capacity and value, but out of a hundred men he has no two alike, and very often the man who suits the foreman the best, serves his employer the worst. I would advise employers to ascertain for themselves, as far as it is possible, who really are the best men in their shops, and to reward them accordingly. I would like to see a round-table conference of representatives of the employers' federations and the workmens' unions and to have this question of individual merit thoroughly discussed. I am sure a good understanding might be arrived at, and some practical scheme adopted whereby ability, honesty, and dignity would be cultivated. Britain has reached a period in her industrial life when it is necessary for her to examine her ailments and deformities, and to apply remedies that will make her a healthy nation—industrially, commercially, and morally.

By the foregoing I do not wish it to be inferred that I regard the "Ca'canny" policy as the only drawback to a healthy and progressive industrialism. There are evils far greater and more deep-rooted in British methods of production and modes of business than this slackness on the part of the workers—evils that clog the wheels of industry at almost every turn; evils that are rapidly rendering the whole of the British industrial system obselete, and undermining the very foundations of Britain's greatness. These faults and failings, these antiquated methods and artificial restrictions, which have been borne tolerably well hitherto, but which are approaching a prohibitive point now that some of Britain's erstwhile customers are manufacturing for themselves—these industrial drawbacks will have to be exposed in the very near future as the "Ca'canny" policy is now being brought to light, and drastic remedial measures adopted if Britain is to maintain her supremacy, or even a respectable position, in the world of trade and commerce. But these subjects do not come within the province of this article, which is simply an unvarnished statement of facts—evidence of an eye-witness—upon a subject of public importance, and one that must be taken into consideration in connection with the larger problem of foreign competition.

ACCURACY AND VALUE IN THE TESTING OF CAST IRON.

By Dr. Richard Moldenke.

Dr. Moldenke, in the article below, comments upon and in a measure dissents from the methods of testing advocated by Mr. Buchanan in our May issue. Both join in advocating the "test to destruction" of a specified selection of the castings, as the completely satisfactory method wherever the test to destruction is possible to apply. Both recognize the same variables—casting temeperature, rate of cooling, etc.—as causes of difficulty in getting a bar to represent the casting fairly when test-bar indications must be relied on. It is upon the resultant mode of procedure that they differ. Mr. Buchanan would associate the test piece so closely with the casting it is to represent that it should be subject as nearly as possible to the same conditions, of every sort, and therefore should have the same chemical and physical constitution and actually indicate the kind of iron in the casting. Dr. Moldenke would discard this policy as inadvisable, cast the test bar separately under conditions as nearly ideal as practicable, and thus make it represent the maximum possibilities of the iron in the ladle. He would then rely on knowledge and control of the variable influences to insure equally good results in the casting itself, and on separate foundry inspection to assure the buyer that these conditions were observed.

The foundry has been often referred to in these pages as the proper starting point of economy in most engineering works. In this view Mr. Buchanan's article and Dr. Moldenke's will serve as introduction to an important series on foundry management soon to follow.—The Editors.

IN the May number of The Engineering Magazine there appeared a very interesting article written by Mr. Robert Buchanan, in which he ventilates the test-bar question from the English standpoint. Toward the end of this article mention is made of the specifications for testing cast iron recently adopted by the American Foundrymen's Association, and it is pointed out that the results obtained by their use can only be misleading as to the character and quality of the castings represented.

I happened to be the chairman of the committee entrusted with this rather large undertaking, and I cordially welcome Mr. Buchanan's criticisms, and at the same time thank the management of The Engineering Magazine for the opportunity afforded to present the American view of the situation, showing why these specifications, now generally recognized as the fairest and simplest solution of a complex problem, were made to include the testing of bars; why these were given the shape, and were made in the way specified.

In America we recognize the fact that the only true way to test castings is to do so "to destruction." Our whole buying practice is based upon this wherever possible. Pipe, car wheels, couplers, fittings, are some of the castings which are generally accepted only on a test to destruction of a specified number from a given lot. Other classes of castings, such as rolls, gears, and ingot moulds, have guarantees attached which amount to tests to destruction; for if the castings fail to come up to the guarantees, the maker is given an opportunity to remove his material from the premises of the buyer.

The small castings bought on tests to destruction are legion; because, however, they are nearly always bought by private contract, the specifications are seldom heard of by others than those interested. I have been for many years in contact with these things, and am satisfied that where this is really a possibility, the testing to destruction in the case of those castings will come about just as quickly as the necessary knowledge of the characteristics of cast iron becomes common property. Paragraph three of the specifications adopted by the American Foundrymen's Association states that "when the castings themselves are to be tested to destruction, the number selected from a given lot, and the tests they shall be subjected to, are made a matter of special agreement between founder and purchaser."

It is further a recognized fact that only a small portion of the world's production of castings can be tested to destruction. By far the greater quantity does not lend itself readily to this method of judging value. Witness an engine bed-plate, a fly-wheel, or other casting the strength of which it is quite essential to know at least approximately. The system recommended in Mr. Buchanan's article, that of attaching coupons to the work and testing these, though still in use here in government and cylinder work, is, according to our best-informed American foundrymen, happily on the wane. Such directly attached coupons suffer more or less from the very fact that they are thus connected, and may sometimes be severely strained in the cooling, not to speak of inaccuracies resulting from temperature variations, as may be seen from Mr. Buchanan's results. To compare such coupons with the castings they are supposed to represent, especially where the bars are cast flat, and would give different results tested cope-side-up from cope-side-down, and where they are rectangular in section, would certainly be misleading, in the light of our most recent knowledge of cast iron.

When we consider that there are so many variables connected with the making of iron castings, there is little wonder that the task of obtaining a test bar which will represent a casting properly seems hopeless. American foundry thought, at least as represented by the most progressive element in the actual production of castings, found its expression through the work of the American Foundrymen's Association, in the decision that, apart from the testing of castings to destruction, it is necessary to cut loose from the idea of judging the merits of a casting from a bar supposed to represent it. What is really wanted is a method which would confine itself to the proper and accurate representation of the kind of iron going into the casting. What the iron becomes when in the casting depends upon the conditions prevailing at the time, and the skill of the founder in regulating them to obtain the effect desired. This decision at once put the matter into an entirely different light. The iron is now to be given the best possible chance, not to be made artificially strong, for the sizes adopted (diameters of 1½ inches, 2 inches, and 2½ inches) are sufficiently large to preclude this by wiping out the effect of green and dry sand moulds, and moderate variations of the pouring temperature. The softest irons have the smallest diameter quoted above, the cylinder and heavy castings the medium, and the chilling irons the largest diameter bar. The round cross-section was selected to avoid the weakness caused by intersecting planes of crystallization.

Test bars are to be cast on end, to remove the errors incident to casting them flat. The slightly higher combined carbon found at the bottom of a bar cast flat makes it stronger when tested in the position in which it was cast, the lower side being in tension under a transverse strain. Were the bar reversed, the softer upper side, as cast, would be in tension in being forced downward, and a lighter weight would cause rupture. It is true that a bar cast on end is more difficult to make, but after all, this means only a little practice on the part of the molder.

The bars are specified to be short, the transverse test being made with supports 12 inches apart, for investigation has shown that with the lengthening of the test bar the value of a transverse test, especially for resilience, is greatly diminished. In this particular we differ radically from Continental practice, where very long bars are the rule. The tensile test for cast iron, though provided for, is not to be specially recommended; on the other hand, we would welcome properly applied impact tests. What we want are easily made, simple bars, to work with in our daily shop tests. What better system, beyond the tests to destruction, can be devised, than one which enables the manufacturer to invite the purchaser, or his inspector, to make the foundry his home for awhile; to observe the processes as carried out; the bars, which should fairly indicate the quality of the metal poured into the castings, tested; and to have constant access to the laboratory records, nothing either good or bad being concealed? Let the purchaser break the castings rejected for surface blemishes, and thus receive the assurance that the iron has received proper treatment after leaving the ladle. Ten chances to one, he will feel safer when using the castings than if he had tested a coupon attached to a piece of metal perhaps 2 feet thick. Iron which shows excellent qualities when put into a 1½ inch diameter bar, and cast under the most uniformly fair conditions possible, will be safe to go into important work. If, on the other hand, the test shows doubtful iron, no risks should be taken.

In the pamphlet issued by the American Foundrymen's Association on the subject of testing cast iron, complete instructions as to the best method of molding up these bars are also given. These were the work of the veteran foundryman, Mr. Thos. D. West, and this will account for the universal acceptance of their value.

I was fortunate enough to participate in the recent Congress of the International Association for testing materials, held at Budapesth, and was agreeably surprised at the general interest shown when the subject of testing cast iron was brought up for discussion. The American members present fought valiantly for the recognition of cast iron as a material requiring our most earnest study, and succeeded so well that special steps were taken to adopt ultimately specifications for quality requirements in this branch of the iron industry. Our American Association for Testing Materials is now engaged in looking over the ground, and "tests to destruction" will form a point to be strongly dwelt upon.

We will welcome our English and Continental friends in helping us clear away the difficulties encountered in the path of true progress, and most earnestly hope that the ultimate result will be to put the foundry product on a more exact basis for properly judging its value.

THE ECONOMY OF MECHANICAL STOKING.

By William Wallace Christie.

In Mr. Christie's previous article the structural and operative features of the principal mechanical stokers were described, the fundamental principles upon which the construction of modern successful stokers is based being discussed. The present paper, concluding the subject, considers the general economy of mechanical firing, based upon data obtained from the operation of various existing installations, and thus free from the uncertainty attending conclusions founded upon theory alone.—THE EDITORS.

THE operative advantages to be expected from the substitution of mechanical stoking for hand firing may be enumerated as:—lower cost of firing, greater uniformity in condition of fires and operation, readiness for burning all grades of fuel, and less production of smoke.

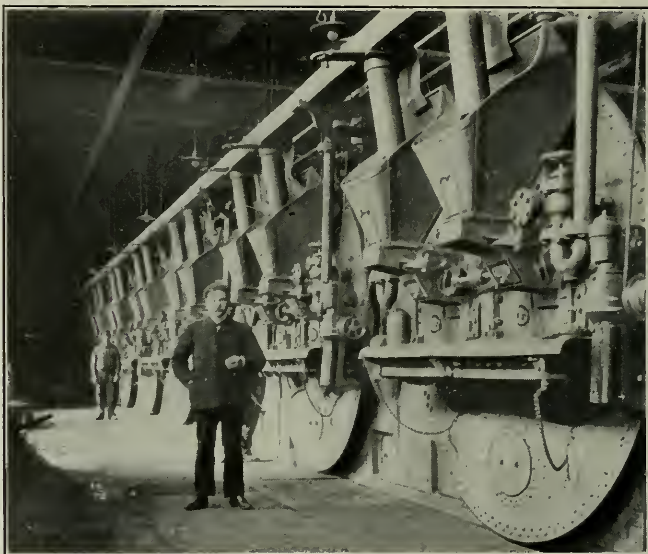
Considering the lower cost of firing, it must be realized that much harder firing is now required than was formerly necessary. From a desire to get the greatest possible financial return out of a given plant, the rate of combustion has been increased until the maximum quantity possible of poor fuel per square foot of grate per hour has been burned. This has been followed by the use of free-burning grades of bituminous coal, giving a still higher rate of combustion, until the work required of firemen has become excessive both in amount and in cost. A full day's work for an able fireman is the shoveling of not more than 10 tons of coal in 12 hours, or about sufficient for 450 boiler horse power. If the same man is required to handle coal into hoppers for mechanical stokers, he could take care of two units of 500 horse power each, while if the coal was fed into the hoppers automatically he could take care of four such units, or 2,000 horse power.

The cost of labor would thus be reduced in the proportion of 450 to 2,000, or about three-fourths, one man being able to do the work formerly requiring four. The time required for cleaning a fire under a mechanically fired boiler is also said to be less than one-tenth that needed for similar work with hand-fired furnaces.

Uniformity in condition of fires is doubtless best secured by the continuous processes of automatic firing, and it is undoubtedly true that mechanical stokers give the best results with a fairly uniform rate of combustion, involving a regular thickness of fire and a uniform pull of chimney draft.

Considering the ability to use any kind of fuel, it must be admitted that a mechanical stoker is a most desirable addition to many power plants where very low grades of fuel are burned, and where labor conditions sometimes compel sudden changes in the character of fuel supplied. The varied character of coals used for steaming is well shown by the classification of Prof. Humboldt Sexton.

Kind of coal.	Carbon, per cent.	Hydrogen, per cent.	Oxygen, per cent.
Non-caking Coal—Long flame	75-80	5.5-4.5	19.5-15.0
Gas Coal	80-85	5.8-5.0	14.2-10.0
Furnace Coal	85-89	5.5-5.0	11.0- 5.3
Coking "	88-91	5.5-4.5	6.0- 5.3
Anthracite "	90-93	4.5-4.0	5.5- 3.0



AN INSTALLATION OF BENNIS STOKERS FITTED TO INTERNALLY FIRED BOILERS.

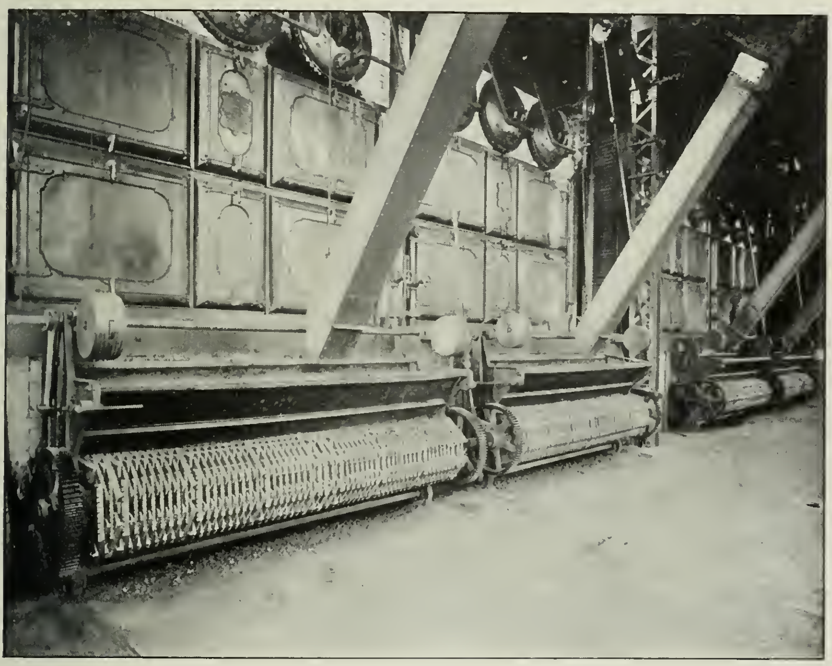
M. Gruner* in his "Metallurgy" gives a classification of coals in which he uses the length of the flame as an index.

	Per cent. Residue of Coke.	Per cent. Volatile matter.	Specific gravity.	Calorific value B. T. U.
1. Lignite	30-45	70-55	1.15-1.20	12600-14400
2. Long Flame	50-60	50-40	1.25	14760-14400
3. Bituminous Long Flame	60-68	40-32	1.28-1.30	15300-15840
4. " Ordinary "	68.74	32.26	1.30	15840-16740
5. " Short "	74.82	26-18	1.30-1.35	16740-17280
6. Nearly Anthracite	82-90	18-10	1.35-1.40	17100-16560
7. Anthracite	90-95	10- 5	1.40 and above	16560-16200

The above tables may be termed "chemical" from the character of the information that they supply.

* Bertin & Robertson—p. 47.

Along practical every-day lines we have a table which was given by Mr. McClave of Scranton, Pa., in a paper read by him before the Anthracite Coal Operators' Association, January 9, 1896, which table gives the relative values of anthracite and bituminous coals when used

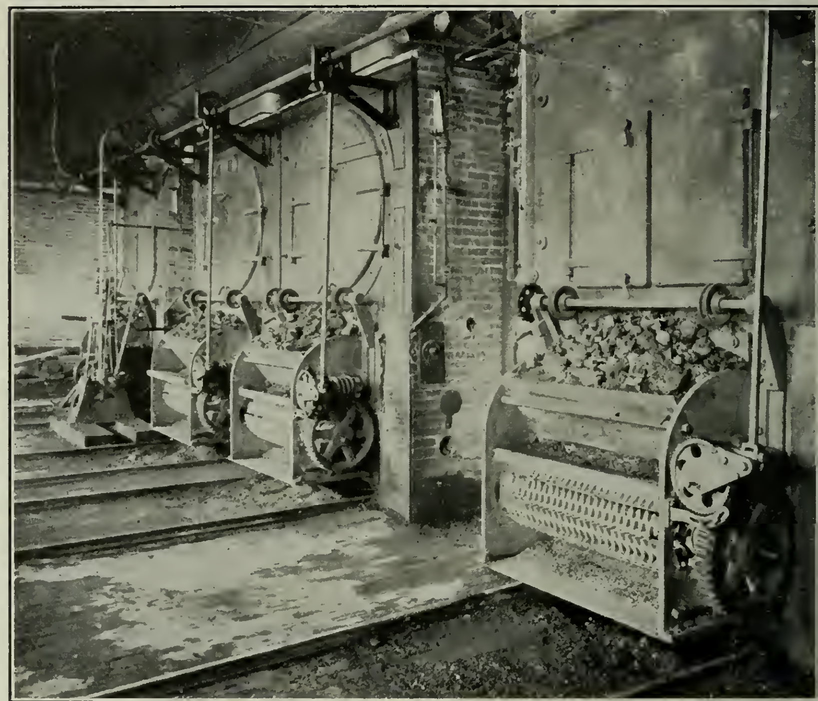


TRAVELING LINK GRATES, KAW RIVER POWER HOUSE OF THE METROPOLITAN STREET RAILWAY, KANSAS CITY, MO.
Green Engineering Co., Chicago, Ill.

for the purpose of steam raising; the last column gives the per cent. of additional weight of the various grades that must be burned to equal in fuel value the best anthracite and bituminous coals.

Kind of Coal.	Value.	Per cent. To add.
Bituminous coal, good quality	100	
Bituminous slack, " "	90	11.1
Anthracite, steamboat, good quality	95	5.3
" broken " "	97	3.
" egg " "	100	
" stove " "	100	
" chestnut " "	100	
" pea " " well cleaned	95	5.3
" " mixed with bone slate	90	11.1
" buckwheat, No. 1, good quality	93	7.5
" " " 2, " "	85	17.6
" " " 3, " "	83	20.5
" culm, mixed with 20 per cent. soft slack, good quality	83	20.5
" No. 2 " " " " " " " "	77	29.9
" " 1 alone, good quality	75	33.3
" " 2 " " "	70	42.9

Diminished production of smoke is a necessary result of uniform firing, and so far as this condition is complied with the mechanical stoker may be regarded as a means toward the abatement of the smoke nuisance. At the same time it must be understood that smoke production is a result of imperfect combustion, and that mechanical

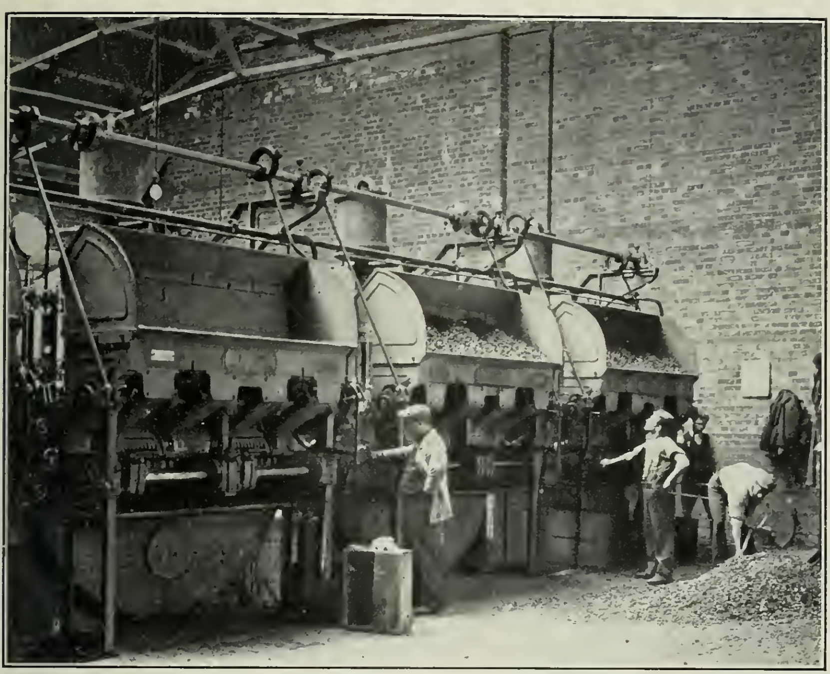


AN INSTALLATION IN THE BOILER PLANT OF THE SUPERIOR SHIP-BUILDING CO., WEST SUPERIOR, WIS., BURNING RUN-OF-MINE COAL.

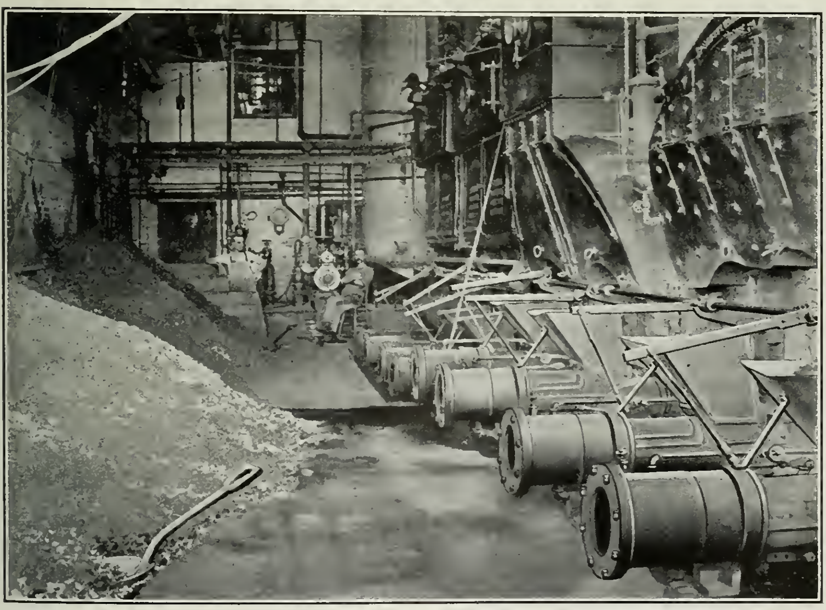
Duluth Stoker Co., Duluth, Minn.

stokers are not smokeless when hard pushed. In this connection it may be noted that the evaporative power of a boiler is not materially influenced by the admission of surplus air, as will be shown by the following table:

Absolute Steam	Evaporative Power in a Perfect Boiler as from and at 212° F.		
Pressure, lbs. sq. inch.	Air 1.	Air 1½.	Air 2.
14.7	15.67	15.46	15.24
30	15.56	15.29	15.02
50	15.48	15.16	14.85
75	15.4	15.05	14.70
100	15.34	14.96	14.58
150	15.26	14.84	14.42
200	15.19	14.73	14.28
250	15.13	14.65	14.17

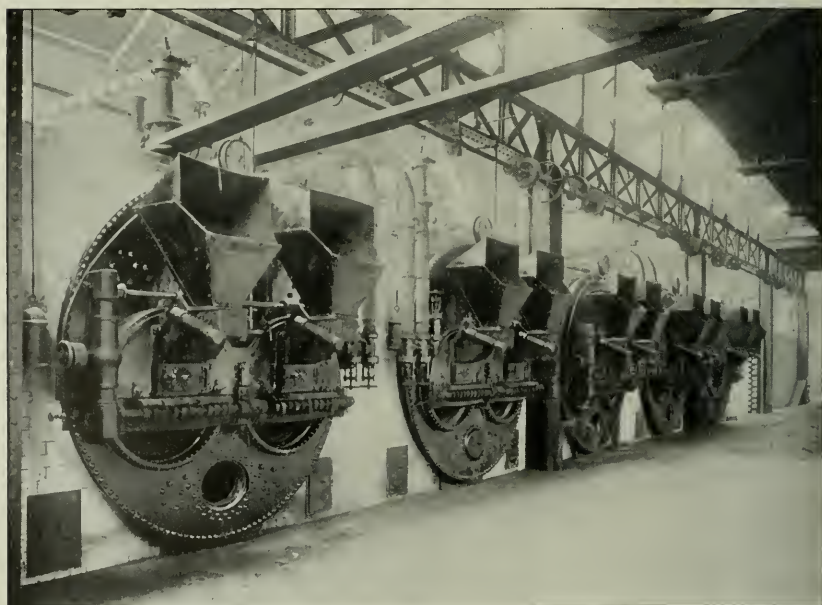


VICARS' STOKERS APPLIED TO LANCASHIRE BOILERS, POWER STATION OF THE HULL CORPORATION TRAMWAYS.



MECHANICAL-STOKER INSTALLATION AT THE PLANT OF BAUSCH & LOMB CO., ROCHESTER, N. Y.
The Underfeed Stoker Co. of America.

RONEY MECHANICAL STOKERS, 96TH STREET POWER HOUSE, METROPOLITAN TRACTION CO., N. Y.
Westinghouse, Church, Kerr & Co., N. Y.

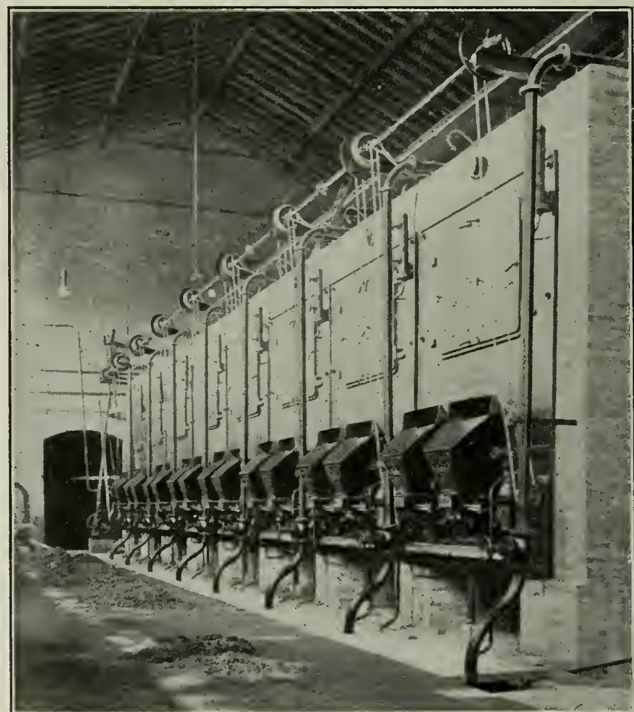


INSTALLATION OF TRIUMPH STOKERS AT THE NEW CORPORATION ELECTRICITY-SUPPLY STATION, HYLTON ROAD, SUNDERLAND, DURHAM.
Triumph Stoker, Limited, Ransomes & Rapier, London and Ipswich.

VICARS' STOKERS IN A LARGE LONDON POWER STATION.
T. & T. Vicars, Earleston, Lancs.

The influence of the mechanical stoker upon boiler efficiency has been discussed, but definite information is not readily obtained, although general opinions as to the advantages of mechanical stoking are numerous. The efficiency of a boiler, and consequently of a group of boilers, depends upon several independent and distinct factors. Thus we have the furnace efficiency, a measure of the completeness of the combustion in the furnace; this is measured by the ratio of the temperature in the furnace to the temperature of the escaping gases. We have also the efficiency of the boiler proper, measured by the quantity of heat transmitted to the water compared with that generated in the furnace. There are also two other kinds of efficiencies—

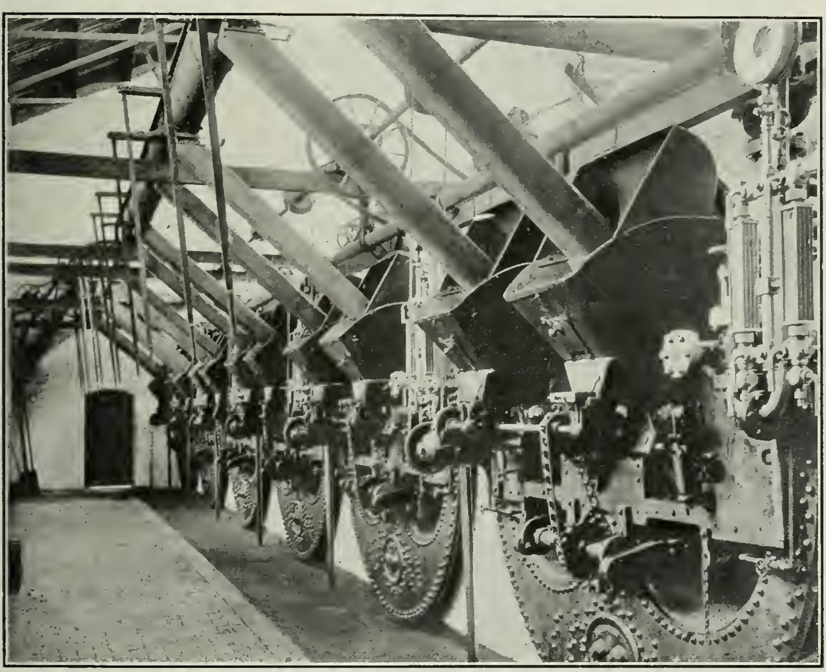
one the heat efficiency per pound of fuel, the other the so-called "investment efficiency," which takes into account the cost of buildings, apparatus, boilers, chimneys, wages, fuel, etc. Any statement of the efficiency of a stoker or other boiler apparatus should be accompanied with such data as will enable its relation to these various standard efficiencies to be determined, otherwise comparison will be difficult, if not misleading. Probably the grate itself may be found to be the best pulse from which to deduce the ability of a boiler to make steam, especially as it has a positive value when we know the character of coal to be burned and the draft to be had.



BENNIS STOKER PLANT FITTED TO EIGHT WATER-TUBE BOILERS AT A SUGAR FACTORY NEAR BARCELONA, SPAIN.

Bennis Lancashire Stoker Works, Bolton.

It has been maintained that the most economical rate for boiler operation is that of an evaporation of 4 pounds of steam per hour per square foot of heating surface, and certain boiler tests may be cited to show this. Other tests, however, show that the evaporation per square foot of heating surface may vary while the steam economy remains constant. Thus six tests on an internally-fired multitubular boiler with corrugated firebox, with ordinary hand firing, show that at rates of combustion varying from 21 to 32 pounds of coal per square foot of grate per hour, the equivalent evaporation from and at

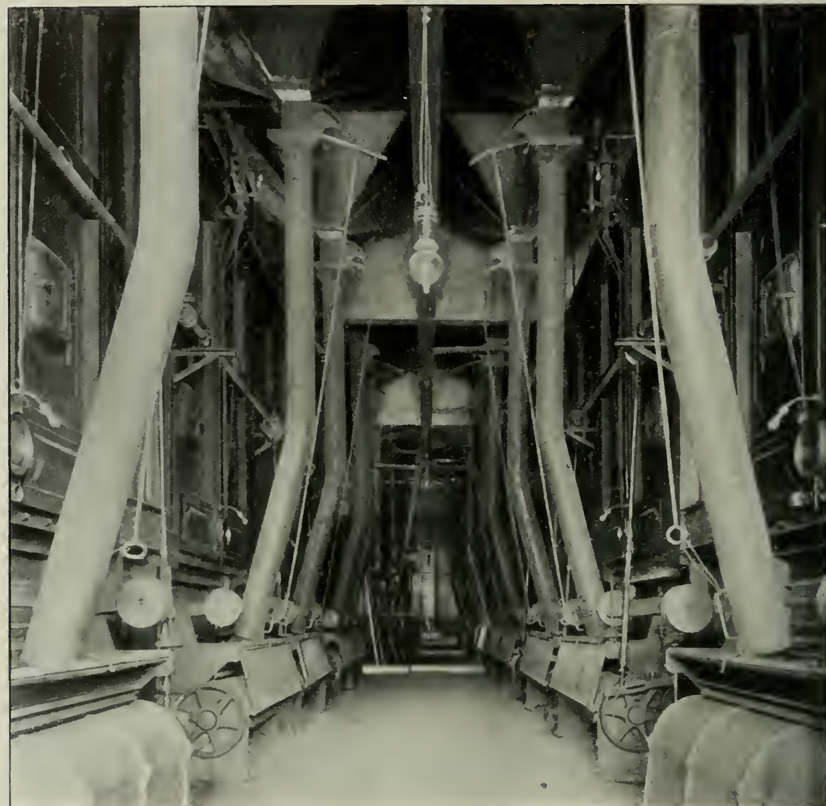


PROCTOR'S SHOVEL STOKER APPLIED TO FOUR EIGHT-FOOT LANCASHIRE BOILERS, NEW HYDRAULIC STATION OF NORTHEASTERN RAILWAY, MIDDLESBORO.

The stokers are fitted with a complete coal-handling plant, delivering coal automatically to the stoker hoppers by elevators and conveyors. Proctor, Burnley, Lancs.

212 degrees F. per pound of combustible remained constant, while the rate of evaporation per square foot of heating surface varied from 3 to 4 pounds.

The completeness of combustion can be told best by the temperature of the escaping gases and by an analysis of their chemical composition. Thus for excellent combustion the temperature of the discharged gases should not be higher than 400 to 500 degrees F. If the percentage of oxygen is 1.5 to 2 per cent., it indicates that the fires are too thick and the rate of combustion too high for the draft employed. If the oxygen exceeds 8 per cent., the fires are too thin, the draft too heavy, or too much cold air is entering the furnace above the fire. If there is an excess of CO and of O, the boiler is faulty in design, and good results cannot be expected. The quantity of air fed



GREEN TRAVELING-LINK GRATES, BOILER ROOM OF THE UNION TRACTION COMPANY, CHICAGO.

to the fire also influences the economy of the boiler to a limited extent, as shown on page 720.*

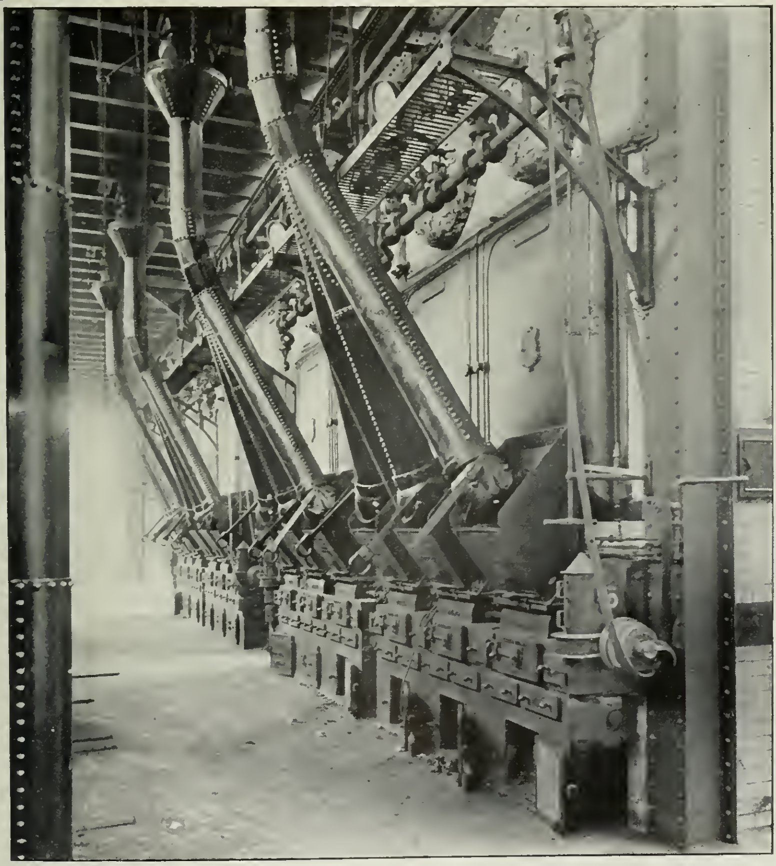
When steam is used under the grates to assist the draft and prevent the coal from clinkering badly, as it is in some stokers of the over-feed type, the steam, at the high temperature of the furnace, becomes dissociated into the separate elements H and O, and in the process takes up about 10,000 B. T. U. for every pound of steam so used. This heat is given back again in the process of combustion in the combustion chamber, or later, where the heat produced may be more efficiently absorbed. This fact may furnish a possible reason for the comparatively high economy of a well-regulated steam-blower draft in connection with a mechanical stoker.

* See also THE ENGINEERING MAGAZINE, April, 1901. Article by W. W. Christie.

Nowhere has hand stoking been more onerous than on shipboard, but thus far mechanical stokers have not been successfully installed. Bertin says:

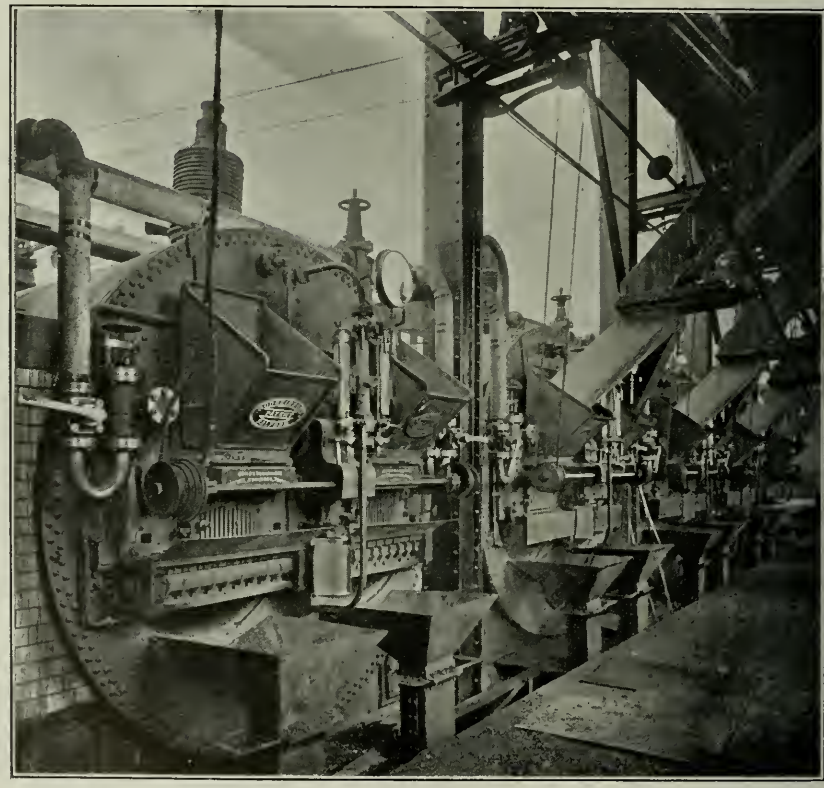
"Numerous attempts have been made to introduce mechanical stoking, with the object of getting a more regular combustion than is possible even with the most methodical hand stoking, and to obviate the heavy work entailed upon the stokers. The most ingenious system amongst the many tried in the French navy was that where the grate was composed of a number of endless chains, known as the Galle system. Chains were placed close together and kept in movement, the coal was distributed evenly over the bars at the furnace door end, and arrived at the bridge completely burned. The cleaning of the fires was also done automatically.

"After repeated trials at sea all the various systems of mechanical stoking have had to be abandoned, and the human stoker with his shovel and rake again installed."



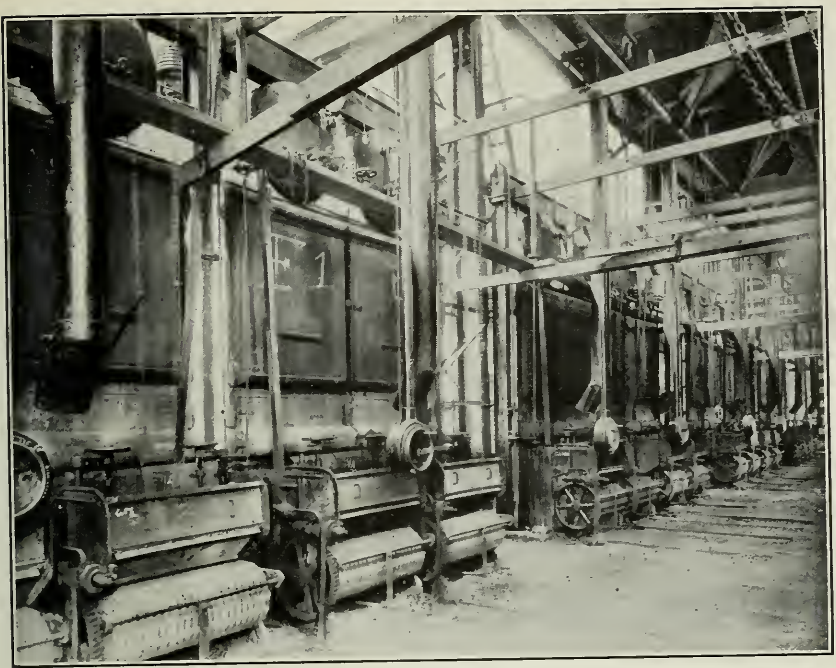
INSTALLATION OF COKER STOKERS, BRISTOL ELECTRICITY WORKS.
Meldrum Bros., Limited, Atlantic Works, Manchester.

One feature in connection with the design of mechanical stokers for marine service must be remembered, namely, that all steam used for blowers, amounting in some cases to as much as 2 to 10 per cent. of the total, is an entire loss, and must be made up with fresh water added to the boiler feed in excess of that returned from the surface condensers. Thus, in the case of a battery of nine boilers equipped with over-feed stokers, under certain conditions of draft, I have seen it necessary to use the entire amount of steam furnished by one boiler to supply itself and the remaining eight boilers.

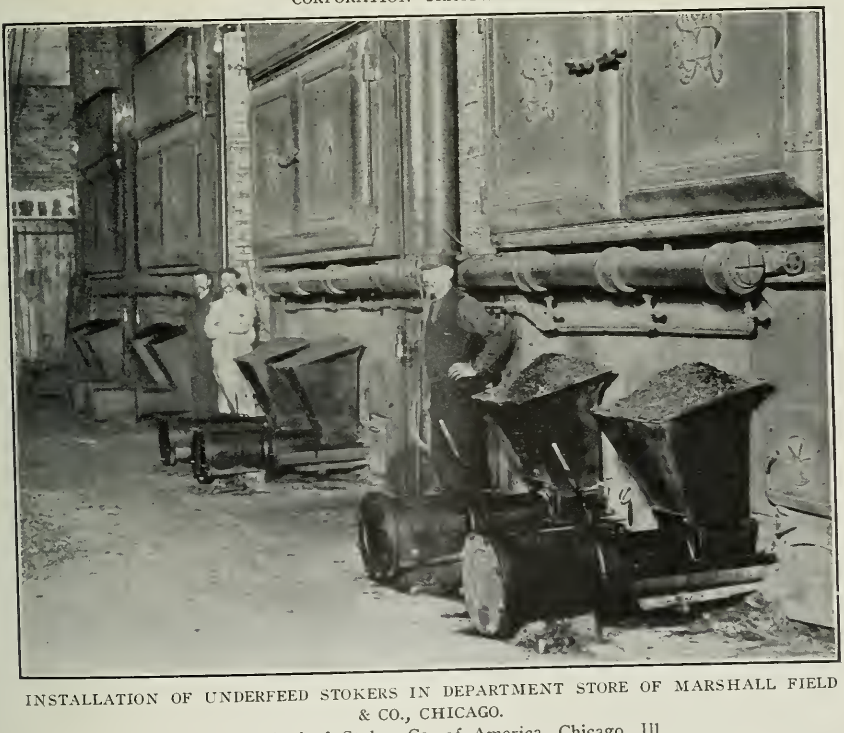


AN INSTALLATION OF HODGKINSON'S STOKERS AT THE NEW SALFORD ELECTRIC-LIGHT STATION.
James Hodgkinson, Salford, Manchester.

With regard to the smoke-prevention value of mechanical stokers, probably the most reliable and important results available are those obtained from the work of the Paris smoke-prevention commission. Out of one hundred and ten devices examined, the greatest amount of smoke was produced by a furnace equipped with an ordinary hand-



BABCOCK & WILCOX CHAIN-GRATE STOKERS, PINKSTON POWER STATION, GLASGOW CORPORATION TRAMWAYS.



INSTALLATION OF UNDERFEED STOKERS IN DEPARTMENT STORE OF MARSHALL FIELD & CO., CHICAGO.

The Underfeed Stoker Co. of America, Chicago, Ill.

fired grate, while the least smoke was emitted by James Proctor's coking stoker. As a result of extended investigations, Mr. W. H. Bryan states that the comparative amount of smoke emitted from ordinary boiler furnaces may be taken at 46.52 per cent., and from improved mechanically fired furnaces, as 9.45 per cent., on a color scale in which absolute black is 100.

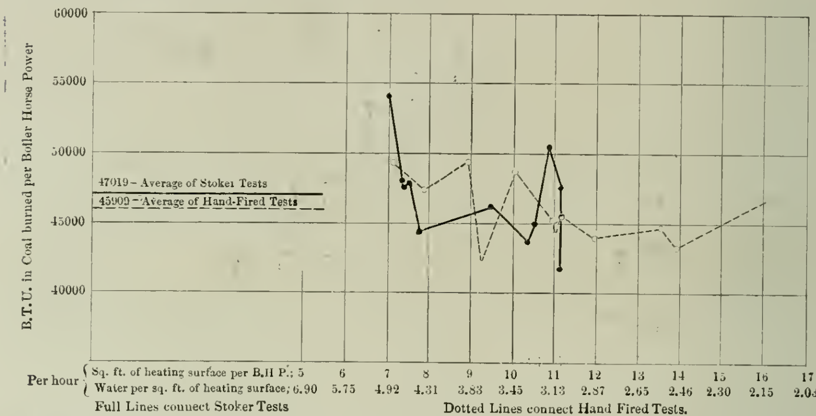
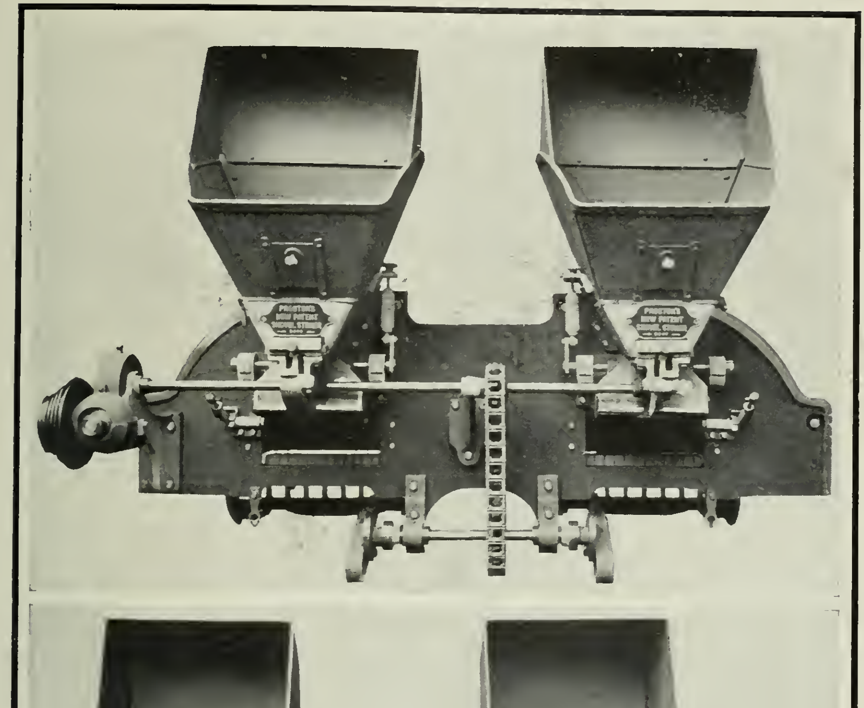


DIAGRAM SHOWING COMPARATIVE ECONOMY OF MECHANICAL AND HAND STOKING.

The comparative economy of mechanical and hand firing of boilers may be obtained from the above diagram, prepared from about twenty tests made by engineers of reputation, these having been selected because the heating values of the fuels had been determined by calorimeter and because all the various proportions were given.

As the mechanical stoker is a part of the boiler furnace, its value should be measured by the proportion of the heat units fed into it in the shape of coal to the heat units taken up by the water in the boiler, or the steam made, reduced to equivalent evaporation from and at 212 degrees F. With that end in view, the ordinates are B. T. U. per pound of coal multiplied by the coal fed to the stokers per boiler horse power developed. The upper row of abscissal figures are water-heating surface per boiler horse power developed. The lower row of abscissal figures are pounds of water per square foot of water-heating surface per hour. Near the left of the plotting will be noticed three points almost in the same place; they are each a different stoker, under-feed, over-feed, and coking types. The dotted line connects the ordinary hand-fired boiler tests; the full line connects the mechanical-stoker tests.

Though the average British thermal units per boiler horse power developed, fed in the shape of coal, is 47,019 for the mechanical stoker tests and 45,009 for the hand-fired tests, I will not say that hand fir-



THE UPPER PICTURE SHOWS PROCTOR'S SHOVEL STOKER; THE LOWER, PROCTOR'S COKING STOKER, DESIGNED FOR SMOKELESS FIRING.

AMERICAN STOKERS, UNDERFEED SYSTEM, AT THE HOMESTEAD MILLS, CARNEGIE STEEL CO., UNITED STATES STEEL CORPORATION, PITTSBURG, PA.
American Stoker Co., N. Y.

ing is the most economical. The diagram brings out some interesting things, and while on the face of it hand firing appears to be the most economical, yet when we consider the labor and repair side of the question, and the investment, interest, taxes, etc., in all probability in plants of over 2,000 boiler horse power in continuous operation, the mechanical stoker, properly selected for the fuel and work to be done, will prove the most economical.

Apart from considerations of economy and of smoke prevention, the introduction of the mechanical stoker is to be advocated for the reason that it supersedes one of the most fatiguing and difficult kinds of work which has been undertaken by human effort. Even in land installations the work of firing boilers is hard and dirty, while on shipboard it has long been considered the heaviest and most exhausting work which can be performed. Of all labor-saving machinery, that which relieves human beings from the stoking of boilers should be welcomed, even if no commercial advantages should result.

MONEY-MAKING MANAGEMENT FOR WORKSHOP AND FACTORY.

By Charles U. Carpenter.

VII.—THE PIECE-WORK SYSTEM AND THE FIXING OF PRICES.

Mr. Carpenter's articles began in THE ENGINEERING MAGAZINE for February, 1902, the first and second papers dealing with factory organization in its general principles and concrete examples, the third with departmentalization and systematization of the works, the fourth and fifth with the stock department and its systems, and the sixth with machining processes and tool equipment. His next paper will deal with the finding and recording of costs.—THE EDITORS.

THE system of pay is without doubt the most important branch of shop systems and management. This fact can be fully realized only by giving the closest consideration to both its direct and indirect influences. In the minds of most manufacturers it is associated only with cheapness of production and lowering of costs. This is but a very limited and narrow view of its functions and fails to include some of its most important features and most powerful influences. This influence is so all-pervading that the system of pay may aptly be termed, not only the keystone to economical production, but also the keystone to efficient factory management in its broadest and highest sense.

In introducing a system of pay the management should have many aims in view. The most important of these are as follows:—The possibility of shop economies and cheap production; the forcing of the shop to a maximum of production quickly; the attraction of expert workmen, and their encouragement to use their skill and wits to the uttermost; the singling out of the slovenly, slow workmen for either development or discharge; the cultivation of a feeling on the part of the men that the company is firm in its determination to be just and fair, and that its insistance on a high rate of production is justified by the rate of wages paid. To this feeling must be added the knowledge that the company will insist upon a full day's work.

To accomplish these aims the one important factor—"the man at the machine," with his human prejudices and his capabilities—must be carefully considered. It is, however, surprising to note how little attention is paid to this. Policies and systems vitally affecting the workman's welfare are put into force with a total disregard to both his willingness and his ability to improve himself and his product under proper conditions, and his power to increase costs and cause other even more serious troubles in the shop when these conditions are not as they should be. Nor should these facts be lightly considered. It is difficult to overestimate the value of having your shop full of skilled, alert, and contented workmen who will give you a maximum of production. The advantage is not alone in the fact that costs of production are low. The feelings of mutual confidence and contentment, in this day of labor difficulties, are in themselves of great value to both employer and employee. The men's suggestions, given as a consequence of this feeling, and their endeavor to better themselves and their product, will not only lead to many improvements but, reacting on them, will make them stronger men and better artisans.

Almost all of the problems to be met with in instituting any system of pay will come under the following heads:

First, the right method of reaching a determination of the proper rate of production, or output, that can reasonably be expected from a workman for a fair day's pay—in other words, the time in which a job should be done.

Second, what plans can or should be adopted for forcing the shop up to this "rate of production."

Third, what will be done in case a man exceeds the estimated "rate of production" and, as a consequence, his wages exceed the accepted idea of a fair day's pay.

Workmen's Interest or Opposition.—The workmen's support or opposition is determined by the employer's action in regard to this last question. In fact, the whole structure of piece work, or a similar system of pay, hangs upon this. The solving of the first and second problems depends directly upon the action taken in regard to this one. Will the price, or rate, agreed upon be guaranteed, and will the workman be permitted to gain the benefit of his skill acquired by persistence and the use of his brains? or will the price, or rate, be cut when the prescribed limit of wages is exceeded?

Advantages of Guaranteeing Prices.—The advantages of guaranteeing the prices, or rates, are clear. Only by so doing will the expert workman be attracted, encouraged and developed. No other plan will give a satisfied and alert body of men. The determination of the proper rates of production will not be so difficult. The workmen will be willing to accept rates much lower than can be determined by either calculation or actual trial. They, knowing that personal skill enters so largely as a factor in turning out quantities of work, will often accept such rates and depend upon this skill to work up to a high rate of pay. A guarantee of this character will, in most cases, cause the rate of production or output to rise quickly to a maximum. On the other hand, this increase to a maximum output will never occur where the policy of "cutting prices" is adhered to.

Effect of Cutting Rates. Workmen's Opposition.—In the mind of the employer there is ever present the danger of setting excessive rates, which, when guaranteed, may result in exorbitant wages to the workmen. If such is the result he considers that he has been cheated by his men in years past. Influenced both by this feeling and his natural desire to reduce costs, he cuts the prices. Now, consider the effect of this reduction upon the minds of the workers. Their first feelings are that they have been treated unjustly. They consider that the same policy of reductions will continue in the future, that they will then be deprived of the fruit of their skill and will be compelled to work at a very high rate of speed to earn a fair day's pay. Their antipathy to piece work comes as a consequence of this method of procedure. They feel that it is a plan first to gauge a man's ability, to persuade him to work as hard and fast as possible to secure a large output, and then to use this output as a basis of production and cut his wages accordingly. Even should a man feel inclined to do his day's work to the best of his ability, his fellow workmen, fearing that his output will be used as a standard and that they will be called upon to do the same amount of work and at a reduced price, will soon bring all their influence to bear to keep his output down. There is also the well-founded fear that, if they produce more work, some of the force must be dropped. Every new price is bitterly contested. The first experience with the cut fixed the workmen's determination to "get square" in the future. As a result, they purposely consume so much time on new work that it is folly to place any dependence on the time.

Determine the rates as closely as possible by calculations, and with few exceptions there will still remain the large element—"the workmen's skill"—upon which it is impossible to calculate with any degree of certainty. Of course, a close estimate can be made on work on automatic or semi-automatic machinery. It is also possible, indeed highly advisable, to determine rates on large machine work by calculation. Knowing the character of the machinery, the nature of the work, and the quality of the material, it is a comparatively simple matter to calculate the time in which the work should be done. A very different problem, however, is presented in setting proper rates for either the machining of large numbers of small parts, wherein quick handling of jigs and pieces enters so largely as a factor, or the assembling of pieces requiring manual dexterity. Here is where "personal skill" is the most important element. Its importance is equalled only by the difficulty with which its value can be calculated. The possibility of the development of a man's skill on repetitive processes, requiring even the greatest care and exactitude, is astonishing.

Defects of the Ordinary Day-Work System of Pay.—Much of the difficulty experienced in introducing any system of pay differing from day work can be attributed to the extremely lax methods existing in many shops of handling the day-work system and the men who work under it. Certain it is that most of the difficulties arising from excessively high prices on work can be traced to this. The amount of time wasted by men working day work is astonishing. With this system of pay as ordinarily conducted, the men have to be very closely supervised and checked up in order to get even an approximation to a fair day's work. The elements of personal interest and advantage are lacking; there is neither hope of reward nor fear of punishment to spur them on. Close investigation will demonstrate that in many cases where day work has been in operation for a long time, not only is supervision lax, but also very little attention is paid to the comparison of records on jobs. Then indeed the situation is as bad as it is possible for it to be. The invariable result is that the shop is working much below its full capacity. The product costs much more than it should. The "pace of the shop" is too slow. The men show but little interest in their work; this lack of interest is often reflected in the inferior quality of the product. The element of cost is very indefinite, for, when work becomes slack, the time taken on the job, and the consequent cost of the product, increases.

The foremen and assistants, even if they are active in attempting to reduce the time on work, are often almost helpless. It is very difficult to detect the men "beating time." In fact, if the entire body of men persist in the practice, it is impossible for any foreman to accomplish much without some system of records giving a comparison of the time taken on jobs at different times. However, a vast improvement can be effected even in cases where the day-work plan is used, by reducing this to a scientific basis.

The Proper Stepping Stone to Piece Work or a Similar System. The first absolute requirement for success in securing the proper output from the works or factory is the determination of the time in which each and every job can and should be done. Some supervisors and foremen will at once declare that this is too large an undertaking; that "it is all right for your shop, but would not do for mine." I have seen this done in the largest shops turning out an immense quantity and variety of work. While it is no simple or easy matter for a shop operating under the old day-work system, the plan when properly developed and used will be found a most effective agency for increasing the output. Granted the importance of this work, it is next necessary to consider, first, who should be intrusted with it; second, how should it be done? The work will require the greatest care, calculation and exactitude. Nothing should be left to chance or wild estimates. The method of procedure must be carefully considered and should be uniform for the entire shop. The usual plan is to put the work in the hands of the foremen. The results of adopting this policy are usually very unsatisfactory. The importance of the matter is such that it should have the attention of the best informed men in the establishment. The foremen are seldom prepared to handle the question in the most intelligent manner, as their information concerning the subject is usually neither wide nor exact. They often can not give it the attention it deserves. They are too prone to indulge in "estimates" that are far from being exact. Again, each foreman will adopt a different method of establishing rates and, consequently, there will exist as many standards and methods as there are foremen. Some will be entirely to liberal, others too close, and as a result, dissatisfaction will be rife in one department because the men in another do not experience the same difficulty in making their wages. In fact, such a method is unscientific, very uneconomical, and unsatisfactory to both employer and employee.

Establishment of a Rate-Fixing Department.—This work should be handled by a picked body of men. These men should be prepared to give the greater part of their time to a study of the best means of carrying out the general plan. I have, however, always found it advisable to consult the different foremen, as their practical information will be of great value. Their co-operation also should be secured, as, otherwise, the path to success may be found very rough. Needless to say, most of the members of this body should be expert mechanics and good judges of work. It is usually advisable to select also a few expert workmen in whom you can trust, to whom you can, if necessary, submit the work for actual trial. These men should be paid good wages, made a part of this rate-fixing department, and kept always on this work; otherwise little confidence can be put in their results.

Plans for Determining Proper Rates for Production.—The most scientific and in the end the most satisfactory manner of determining the time in which work should be done is that devised by Mr. F. W. Taylor.* Mr. Taylor advocates reducing each job down to its fundamental or elementary operations, securing the time for these elemen-

* A full description of Mr. Taylor's plan can be found in THE ENGINEERING MAGAZINE for January, 1901—the WORKS MANAGEMENT NUMBER.

tary operations, and using these data both for this and for future jobs containing many of the same elements. In this particular lies the precision of the plan. The elementary operations can be determined within a surprising degree of accuracy. When considering new work it will often be found that by making a comparison of the elementary operations, many of them will prove very similar and the others easy to calculate. The plan is invaluable for determining the time that should be taken on a new piece of work the first time it appears in the shop. Even in cases where a manufacturer will not go to this extreme, the argument for a separate department still holds good. Whether the rates are determined by calculation, observation, or actual trial, the work should be carried on as suggested. An efficient, well-posted man in charge of a few expert workmen will secure good results.

Methods of Securing Data.—The character of the data, the manner in which they should be collected, and the difficulty with which they are secured, will depend upon the nature of the work. In many cases it is a question of calculation. Knowing the character of the work to be done, the quality of the metal, the nature of the machine to be used, the quality of the cutting tool, and the possible feed and speed, the time in which the work can be done can be calculated with a surprising degree of accuracy.

The next problem to consider is the time that should be taken in handling the work through the shop. It is difficult to do this with any degree of accuracy. The workmen, knowing this, will take advantage of this fact and will consume all the time possible between the operations. When no incentive beyond their regular day-work pay exists it will always be difficult to get this time down to the point where it should be. However, it can be estimated within fairly good limits, and the workmen, knowing that reasons will have to be forthcoming for any unreasonable excess of time, will generally keep it somewhere near the allowable time. It is a large factor in the rate of production.

It is far more difficult to determine the proper rate of production where that uncertain element, "personal skill," is the largest factor. In many shops the nature of the work is such that the time required to handle a jig or fixture forms a very large percentage of the total. In very many cases only actual trial will afford a proper basis. It must be borne in mind, however, that even then this will not afford an exact estimate of the time in which the job can be done by the workman after he has developed his skill by constant work.

The proper sequence of operations for each piece of stock and the tools to be used for each operation should be carefully determined. All of these data should be tabulated and put upon a card in such form that the workman will readily understand exactly what is wanted. He will thus have before him a complete list of operations, each machine and tool to be used, the time in which the work can and should be done, and the time allowed to handle the work. Space should be left where his actual time can be entered. Naturally, the character and extent of the data will depend upon the nature of the work.

If any manufacturer has any doubts as to the wisdom of such a plan as herein outlined, I would suggest that he give the method a thorough trial upon a few costly jobs. After these have been subjected to a thorough analysis and calculation or trial, the conclusion will be reached that this method will warrant all the time and money necessary to carry it through.

Instruction Cards.—The plan of giving "instruction cards" in connection with the bonus system outlined before the American Society of Mechanical Engineers by Mr. Gantt, is an admirable one. This instruction card contains all possible information that would be of assistance to the workman. It has upon it a description of the machine tool to be used, machine number, quality of cutting tool, order and forging numbers, class of metal, man's name and name of speed boss. Below this is a list of the operations in their sequence, the type of cutting tool to be used, full data as to size of cut, feed, time the work should take, the time it did take, and the rate. Below this, is put a sketch of the job giving the finished sizes and below this are data for drawing number, date, and signature. The note is put on the bottom: "When machine can not be run as ordered, speed boss must at once report to man who signed the slip." The instructions on these cards must be followed out to the letter. The workman should also be expected to call the foreman in case he notes that he is falling behind the time stated on the card. If the data on this card are wrong, the best time to settle the matter is at the very moment it is discovered. If the work is not progressing as it should, the foreman can then ascertain whether the fault lies in the previous calculation or in the workman. The man should be held to these rules rigorously. After these records have been secured a plan must be adopted which will compel the men to hand in the correct time on their work. Too often they indulge in guesses, or adjust the time on several jobs so as to falsify the records and mislead the foreman. This "juggling time" is very common. Naturally, it renders the records practically worthless. There are various ways in which this can be avoided. In some cases the time when jobs are begun or finished is either punched or written on the time ticket by the department foreman, assistant, or clerk. A form of clock by means of which the time of commencing and finishing work is stamped on the job or time ticket is also being widely used.

Use to Make of Time Records.—Naturally, the next step is a comparison of the actual time consumed with the record time. Here the value of the instruction cards in the form outlined is apparent. The comparative data are provided upon one and the same card. This comparison, however, can easily be made even though the usual form of day-work ticket be adhered to. Permanent records of this nature, showing each man's performance on the different jobs, will be found to be of great value, especially when any system of pay other than day-work is to be introduced.

All instances in which more time is taken than is allowed must be called immediately to the attention of the foreman, who should at once demand an explanation from the workman. It is certain that these "explanations" will be forthcoming. If, however, the excess of time shows in the machining operation, it is a comparatively simple matter for the foreman to prove the accuracy of the records and the possibility of the work being done in the time set down. He is then in a position to demand that this be done in the future. As soon as this method of procedure is adopted few workmen will be found who will not at least approach the record time so far as the machine operations are concerned. It is certain that some method must be adopted which will not allow room for argument, and which will automatically check each man on every job upon which he works. This plan will accomplish this result. It is a fact, though, that however closely the men are supervised, a great difference between the records and the actual time will appear in the time taken to handle the work betwen operations. It is very difficult to reduce this variance materially on the day-work system of pay. However, a very great economy will be accomplished in the effectual reduction of the actual working time.

Character of Reports to Superintendent.—Reports should be made at least every month to the head of the factory showing just what is being accomplished in this direction. Departments in which a number of bad records are shown should be investigated. A system of rewards to the foreman and assistants whose departments show the best results will often be found advantageous. It will quicken their interest and make them much more alert. The effect will be that they will continually push their men to make better time, and the inefficient workmen who continue to make bad records will soon be either dropped or taken in hand and taught how to handle the work.

This plan of the day-work system of pay differs radically from the slipshod, inefficient, costly methods usually in vogue. It is an infinitely more precise and scientific method. Labor costs on the day-work system of pay can not be controlled to any degree whatever unless by a plan along these or similar lines. If the average manufacturer could but realize the amounts lost by inefficient systems of time keeping, time comparison, and wage paying, he would be willing to incur any expense in order to better the conditions.

Systems of Pay Based on Rate of Production.—The great advantage of a system of pay wherein the wage to the workman is based upon his individual effort and output is, of course, apparent. The day-work system of pay, compared with such a plan, is obviously inefficient. Consequently, the manufacturer must next consider what plan of pay he should adopt for his particular factory. I do not believe that any one plan is the best for all establishments. All the conditions of a shop should be studied with extreme care before deciding.

In shops where the machinery is of a very expensive type and the actual time that should be consumed on work can be calculated to a nicety, the greatest advantage would be found in that system which will push the shop to its maximum capacity the quickest. That is undoubtedly Mr. Taylor's differential system, which guarantees prices. In other shops where this "intensity of production," as it has been termed, is not so great an advantage, and where the work is of such a character that it is impossible to determine how much work a man should turn out, the premium plan devised and developed by Mr. Halsey can be used to very great advantage. The old plan of straight piece work is still widely used, and is very successful when the prices are based upon exact data and are guaranteed.

Introduction of Piecework and Similar Systems.—It is nothing short of folly to start any system of pay unless a very complete and exact series of records exists, from which the proper rates can be calculated with safety. The assertion can also be made that unless these records are the result of some series of careful investigations and trials, they will prove to be a very weak and treacherous foundation to build upon. Unless the rates are carefully determined they will be wrong. If they are wrong the men will soon earn exorbitant wages. At this juncture the manufacturer will begin to cut his prices, and eventually the entire system will fail to accomplish its purpose.

Before any change is made from day work to piece work or a similar system, the entire list of jobs should be thoroughly investigated along lines similar to those given in this paper. The data thereby secured should be applied vigorously with a view to increasing the efficiency of the day workers. After this has been accomplished, the workmen will be perfectly willing to accept some other basis of pay.

They know that they can increase the output; they realize that this has been demonstrated, and they also know that there is a basis that is proper and just upon which to set prices and rates. They see before them a prospect of an immediate reward that it behooves them to accept. On the other hand, the employer knows that his prices will be sufficiently correct to justify him in guaranteeing them. Unless the workmen understand that he is thoroughly posted as to what the output should be, they will decrease this very materially as soon as they know that piece work is to be introduced.

Systems of Pay.—The most prominent systems of pay used at present will come under one of the following heads:—

The Day-Work Plan, with no incentive to or provision for the exceptionally skillful and fast workman.

The Premium Plan, as devised by Mr. Halsey. This has already been fully described in the January, 1901, issue of THE ENGINEERING MAGAZINE. Mr. Norris here describes how, though using this plan, he accomplishes the feature of punishing the slow worker.

Piece Work, by which the workman receives a certain amount of pay per piece, be his product small or large.

The Differential Plan, by which the price varies according to the rate of production—the greater the amount of production, the greater the price per piece.

The Bonus Plan, as described by Mr. Gannt in the paper already referred to. The workmen are provided with cards giving full data concerning tools to be used and the time in which the work should be completed. Should they reach the mark they are paid a substantial bonus for the performance; should they fail they receive pay according to their regular day rate.

The Gang Plan; work which it is very difficult to separate into distinctive operations and which requires the labor of a number of men, can be paid for by putting a price on the entire job and then paying the men in proportion to their day rates and the time each one spent on the job. This plan can be used with any system of pay.

Inspection.—The lack of a proper system of inspection very often brings these systems into disrepute. It is very necessary that some plan be adopted that will result in the work being held up to a high standard of quality and the workmen receiving pay only for that which is perfect. This was treated in a previous article.

Introduction of a Simple System of Piece Work.—While simplicity is greatly to be desired in a piece-work system, the necessity for careful counterchecks and ample protection must never be overlooked. Before starting a new system I strongly advocate a method of pro-

Form No. 724

Dept. .... PIECEWORK TICKET Machine No. ....

Name of piece ....

Operation ....

No. Ordered	No. Finished	LOSS	No. Accepted	PRICE	AMOUNT		Time Commenced	Time Finished
					$	Cts.		
							Total Time	

Box No.

Workman ....

Foreman ....

Inspector ....

Check No.

1-3-00-10m p-F 12

cedure similar to that already laid down in this paper, namely, the increase of the efficiency of the day worker and the careful collection of reliable data giving the time in which work should be completed and, from this, the price that can be paid. These prices should be tabulated according to the work done in each department, each foreman and piece-work clerk having copies. A ticket similar to the one presented on this page, or a form affording practically the same information, should be used. All work should be assigned by the foreman. He can very easily keep a simple record showing to whom work was given, the order number, the amount of stock, and the time of starting on the job. The workman can fill out the most of this ticket when the work is completed. The columns, "Lost" and "No. Accepted" are to be filled in by the inspector, and the price by the clerk or the foreman. The foreman, after referring to his records, signs the ticket certifying that the work on this job has been done, and the ticket together with the stock-tracing card is sent to the stock tracer. The stock tracer will then turn to the proper stock-tracing and cost sheet, which can be found very easily by order number and box number. These important sheets, already described in the June issue, page 420, should be arranged together either according to order number or according to the name of the part. In most works the former arrangement will be the better. In this way all the stock going to make up one order is grouped together, making it easy to trace and to secure costs and other information. Making the proper entries both upon this sheet and upon the stock-tracing card, he will stamp the ticket with his name indicating that this has been properly entered upon the sheet. He will then turn all of the tickets and cards over to the head inspector, who will see that the work is properly done. The inspector can locate all the stock from the data on the piece-work ticket and stock-tracing card. After he has made the proper inspection and signed his name to the ticket and card, he then turns these over to the stock tracer. If there are any losses the clerk will make the proper entries on the stock-tracing and cost sheet. The stock tracer then has all the necessary data to determine whether or not this probably unexpected loss will endanger the chances of filling the entire order on time. If so, he will secure another order for similar stock from the stock-order clerk and will rush this through so as to prevent delays. It will also be noted that an extra cost caused by a loss of this kind will be charged against the proper job and will show in the final report. The stock tracer then returns the stock card and the duplicate of the piece-work ticket to the proper foreman, who will place the card in the proper box of stock and deliver the duplicate ticket to the workman. The foreman and workman are thus notified of the condition of work as found by the inspector and, if any objections are raised, the job can be investigated before it goes farther.

The original of this piece-work ticket is sent to the piece-work clerk, or the paymaster. This depends upon the size of the concern. An inflexible rule must be made to the effect that no ticket will be considered valid without the signature of the foreman, certifying that the work was done, that of the clerk, indicating that such entries have been made that no duplication of tickets is possible, and that of the inspector, signifying that the work has been carefully examined and found correct to the extent shown on the ticket.

There may be times when it is impossible to inspect the work properly between a number of operations, and yet it is desirable to pay the man for his work. In such a case the piece-work ticket and card must be sent in by the foreman with a special notice. The piece-work ticket should be stamped "Not Inspected; Hold" and an entry made on the stock-tracing and cost sheet to the effect that the stock has not been inspected for this operation. The ticket should then be separated and sent out as originally outlined. The workman's name and all data pertaining to the work should be entered on a special sheet. A special form containing the same data should be given to the inspector. It will be noted that the proper entry on the stock-tracing and cost sheet will call the tracer's attention to this stock when the next entry is made. He will also have a full list showing the condition of affairs on all "not inspected" stock. This list should be followed up closely. If a further provision is made that every discharge slip should be OK'd by this stock tracer the protection will be complete. When this discharge slip comes to him, he must glance over his record to see if the man's name appears thereon. If it does, the stock must be inspected at once and any losses taken from the pay due the man. On the other hand, when the inspector does examine the stock he makes the proper entries on the special form and sends it to the stock tracer, who strikes out the entry "Not Inspected" on his sheet and sends this form to the piece-work clerk, who, according to instructions, has been holding the original of the piece-work ticket. Any deductions and "back charges" for poor work can then be made.

Practically the same method of procedure should be followed when day work is done. The ticket will naturally be practically the same.

Day Work by Piece Workers.—There should be a distinct line drawn between the work done by regular day workers, or men who never work piece work, and the day work done by piece workers. Tickets printed in different colors will prove very satisfactory.

It will thus be seen that this collection of time tickets will afford all necessary data for compiling the pay roll. It is, however, strongly advisable to adopt some system of records so that these data can be compiled in a systematic manner, affording not only a basis for the pay-roll calculations, but also for a system or series of records which will prove of the utmost value in making comparisons of the time consumed on the different jobs and in compiling reports indicating the condition of affairs in the different departments.

The record herewith given can be gotten up in card form, each man having his individual card. These cards should be grouped by departments. The columns under the heading "classifications" should be noted carefully. These columns should be headed by the various subjects used to indicate the different classes of work. The piece-work ticket will clearly indicate the class of work the man has been working on, and the time and total cost of this job will then be transferred to this card in the proper column. Taking the total of the amount there will show the total time consumed by this particular workman and his total wages. From this, the pay roll naturally will be made up. The advantage of this classification will be shown in the next article under the head of Cost. It will be noted, of course, that by adding all the totals shown on the different workmen's cards you

NAME........................ CHECK NO............. DEPT. ....

Date	Name of Part	Operation	Quantity	Rate	Classification														
					Type A			Type B			Type C			Type D			Type E		
					Time	$	Cts.	Time	$	Cts.	Time	$	Cts.	Time	$	Cts.	Time	$	Cts.

Totals ....

Total Time..............................

Total Earnings..............................

Total Day-work Hours..............................

Total Piece-work Hours..............................

Day-work in Red ink.............

Average Piece-work Earnings..............

DAY WORK AND PIECE WORK RECORD CARD.

will be able to tell immediately the number of hours worked and the amount expended in wages upon the various classes of work.

The next records are those showing the time consumed by the different workmen on the same class of work. This might properly be called job classification. It is naturally of the greatest value, as it affords all the necessary information for making comparisons of the time consumed by different men at different times. The form of this classification will be shown in the next article under Cost.

It is easy to see how simple a matter it is to classify the time tickets according to the jobs, and so collect these data. Consideration should also be given to the fact that the stock-tracing and cost sheets will show the total time consumed and the labor cost on any one article. All the sheets collected under one order number will give the total time and the total labor cost for the entire product of that order.

In a small manufacturing concern it is possible for several of these duties to be performed by one person. For instance, the paymaster can attend to the duties of the piece-work clerk, or the piece-work clerk and the stock-order clerk can be one person. This system as outlined can be worked admirably with very few men and will provide all necessary protection and a collection of invaluable data.

EDITORIAL COMMENT

THE steam-ship combination, though written upon to the point of exhaustion, one would think, still seems to command scarcely lessened attention. And with it all, it remains quite unproved that England has lost anything or America gained anything. The play was spectacular, the effect on national feeling highly emotional ; a number of shareholders have received astonishingly good prices for their holdings, or have exchanged their old certificates for new ones with larger figures on them; but it is not altogether apparent how British trade is to be any worse served or American trade very much better served than it was before.

Mr. Morgan is so great a financier that any criticism—or even any lukewarmness of belief in his infallibility—seems audacious; but there is this striking difference between Mr. Morgan's earlier financiering and his later—between Morgan the re-organizer and Morgan the organizer—that his former tendency was as strongly contractionist as his latter policy is expansionist. He gained his name and power chiefly as a skilful doctor for overblown ventures which needed the knife, and his knife was ably handled, but unsparing. He cut to the bone, and never paused because blood flowed. Everything that was not sound tissue came away. He pricked the last bubble and squeezed out the last drop of water. He reduced capital and cut down dividends. Holders of six per cent securities learned that they must exchange them for three per cent securities. High-interest bond holders were given low-dividend stock, or the privilege of a fruitless contest. It was heart-rending to the reorganized, often, but it was sound, and the result was usually a sturdy, healthy, and steadily growing corporation. That was the Morgan of the nineteenth century.

* * *

But the Morgan of the twentieth century is of a different temper. His hobby appears to be the other half of financial mathematics — addition and multiplication, not subtraction and division. His joy is to swell, not to shrink, total capitalization. He delights to bring together in his laboratory vast inflated bodies which expand still further when they combine. The change is so striking that curious minds can hardly keep from asking "Why?" Has chance led Mr. Morgan latterly into contact only with undertakings whose owners had underestimated their value, as formerly it led him into association chiefly with overestimated values and possibilities? Has a new era of unmeasured prosperity set in, of which he sees the expansive power better than others do? Or has he simply grown more optimistic with the passing of years? It must be a pleasanter *rôle* than his older one for a sympathetic nature to play—much pleasanter to organize the United States Steel Corporation than to re-organize Northern Pacific, for instance. But will it stand as well? The tendency of the steel stocks, even in this time of unprecedented activity in the steel trade, suggests that it will not. And, to the non-Napoleonic mind, the shipping trust seems to belong in the same class with the steel trust.

It is with much regret that we notice the action of the American Section of the International Association for Testing Materials, practically severing its connection with the European parent association and becoming the American Association for Testing Materials. The mere fact that individual membership in the International Association is held as a requisite for membership in the American Association counts for little in the face of the action of the American members in practically declaring their independence, an independence which really amounts to a secession, destroying in great measure the usefulness of the section.

The whole affair appears to be a perversion of the purpose of the association from scientific to commercial ends, destructive alike of its methods and its main purpose. The fundamental object of the original association was distinctly international, the intention being, not only to settle the best scientific methods of determining the true strength of materials of construction, but also to unify those methods so as to render the work of all the testing laboratories over the world directly and immediately comparable.

Up to the time of the organization of the International Association the methods of testing, the dimensions and form of test pieces, the manner of holding the specimen, of applying the load, and of recording the result, varied so widely as to render the results of many painstaking observers in different parts of the world almost useless except for the application immediately in hand. Many wearisome repetitions of work were necessary, when there were in existence records which would have been invaluable had they been intelligently applicable.

It was to do away with all this waste of time, labor, and thought, and to place all results and methods of testing on a comparable basis that the International Association was formed, and to the furtherance of this invaluable end the ablest scientists and engineers of many lands have given their best work. The formation of an American section, acting in harmony with and under the direction of the parent Association was hailed at first with satisfaction by many, it being believed that the result would be to place testing in the United States upon a higher plane, and remove from it the commercial aspect which too often clouds the scientific value of work otherwise creditable.

Unfortunately, however, the American Section has assumed that its most important function is the framing of specifications for use in commercial contracts, and, failing to divert the attention of the International Association from its primary purpose to this commercial issue, it has announced its separation, changing its name by dropping the word "International," and thus revealing the fact that it is its intention to act in independence of the rest of the scientific world. The result can readily be foreseen. The American Association can be valued no higher than it values itself, and if it elects to devote itself to specification framing instead of harmonious efforts to further the fundamental work of the International Association, its place will be fully understood and accepted.

Methods of testing are not to be devised and employed at the choice of the individuals most nearly concerned. If they are to possess permanent and scientific value they must be determined by the physical principles involved, and the main object should be the discovery of the truth about substances upon which the fate of individuals and possibly nations may depend.

REVIEW OF THE BRITISH PRESS

Twentieth-Century Locomotives.

In a paper recently presented before the Society of Engineers, Mr. Charles Rous-Marten discussed the general question of modern locomotives in a most interesting manner, calling attention to the characteristics of the locomotives of the past century in comparison with those which are appearing as the salient features of the engines of the new century.

Mr. Rous-Marten practically confines himself to a consideration of railway practice in Great Britain and in the United States, and divides existing locomotives into two classes; those built prior to January 1, 1901, and those constructed since that date. Considering first locomotives surviving from the last century, these forming by far the greater portion of the existing engines, Mr. Rous-Marten calls attention to the great difference between British and American practice as regards the working life of a locomotive engine.

"It is always a source of wonder to visiting engineers from America or from the British colonies to find so many locomotives still at work in Britain bearing building-dates going back 30, 40 or even 50 years. In the United States an engine is deemed old at 10 years of age; ancient at 15; and utterly antediluvian at 20 years—archaic and virtually obsolete. In Britain, however, locomotives only 20 years old are looked on as quite modern, and vast numbers of them are in use. Indeed, one well-known writer on locomotive engines has deliberately adopted "the past 20 years" as the construction period which should entitle an engine to be styled a modern locomotive.

But if it be surprising to the American and the Colonial visitor to find 20-year-old engines regarded as modern and almost new fangled, it is simply paralysing to this typical guest to see locomotives still doing regular duty whose ages range up to 30, 40 and 50 years. Yet this spectacle greets him on most of the British railways. In a single case, indeed, he may behold an express locomotive bearing the date 1847—55 years ago—taking a fast train in the year 1902; for the old London and North Western 8 ft. 6 in. single-wheeler "Cornwall," which was built by Trevithick in 1847, still works, or did until very lately, expresses between Liverpool and Manchester, and once last year brought up a boat special from Liverpool to Euston, to the great edification of the American passengers. That of course is an exceptional, if not unique, case, but it is also the fact that on the same railway, the premier British line in point of importance, sixty other express engines are still running whose ages range between 40 and 43 years, the earliest having been built in 1859, while a large number more only just miss being 40 years old. Indeed, out of the total number of express engines working on the London and North Western at the present day—not quite 500—no fewer than 327, just about 65 per cent., are from 20 to 43 years old. One, as already mentioned, is 55; but that solitary case, being treated more as a curiosity than on normal lines, may be ignored. The strangeness is to find 65 per cent. of the express locomotive stock of the richest and most important British railway to be from 20 to 43 years old, leaving only 35 per cent. as aged less than 20 years. On the railways ranking next in importance, such as the Great Western, North Eastern, Midland and Great Northern, large numbers of engines are still to be found aged from 20 to 30 years, and a few whose construction dates back even to 40 years. Yet they are still running as twentieth century locomotives. This forms a curiously striking contrast to the American method."

Such a variance in operative practice must necessarily involve a great difference in constructive methods, and an examination of the locomotives shown at the Vincennes Annexe at the Paris exposition of 1900 revealed a far higher degree of finish and permanence in construction for the British engines over the American. A general inspection only was needed to convince the visitor that the American engine would be old at 15 years while the British locomotive would still be young at 25. At the same time the engines shown at Paris may all be considered as twentieth-century locomotives. All were freshly out of the shops and none was put to work until the new century's first year. It was a diametrical opposition of views and aims; two directly opposite modes of promoting the same end —efficient and economic working of the railway to which each belonged. One of the most important questions in locomotive engineering which will have to be settled in this new century is—which of these two plans is the preferable one for general adoption?

So far as actual design is concerned, the differences which formerly characterized British and American practice are tending to disappear. Outside cylinders have reappeared on English engines, and cranked axles have been recently used on American locomotives. The bogie truck is no longer distinctively American, and discussion as to the relative merits of bar or plate framing excites but little interest. The main question is whether British or American methods generally shall prevail on the broader ground of commercial competition, since America has entered into Britain's own ground not only in other parts of the world but even in British colonies and dependencies.

Thie matter is not one of a decision as to the actual superiority of British or American engines per unit of actual power. It is whether American or British practice is preferable under all the circumstances of the present day. British engines are conceded to be admirable in workmanship and performance, and are so durable that they will run for 30 or 40 years without being worn out. American locomotives are efficient workers which can be delivered at very short notice, but which are not expected to last more than half as long as the British engines. Thus, in one instance, a British firm took 18 months to complete an order for locomotives given by an English colony, while an American firm required but 5 months, the American locomotives costing £400 less apiece than the British. It is obvious that when this sort of thing can be done the interests of British trade imperatively demand that the merits of the case should be clearly discerned, in order that, if the British methods be really out-of-date and unsuitable for modern needs, no time may be lost in amending them in the respects shown to call for reform.

This question naturally calls for an examination of the relative advantages of the two methods. Are long-lived engines so desirable? Is there a real gain in working engines to death in 10 to 15 years? Replying to the first, Mr. Rous-Marten says that experience shows that the older engines are not fully capable of filling existing working conditions. In many instances piloting is necessary, two engines being required to haul modern loads up gradients or to maintain speeds. Taking the practice of the Midland road, on which the old engines are given 20 per cent. less load than the newer locomotives, it is evident that a corresponding increase in general expense must be charged to them; in addition to which must be considered the reduction in the carrying capacity of the road.

For the short-lived engines there appears the fact that they are less economical in fuel consumption, although it is a question to what extent fuel consumption enters into the total cost of service. The system of early "scrapping" permits full advantage to be taken of all the latest improvements in design or construction.

There is also much less proportion of the working life of the engine spent in the repair shop, so that on the whole, much is to be said on the side of the cheaper, and shorter-lived engine.

Mr. Rous-Marten gives interesting details of the dimensions, proportions, and performances of a number of recent engines, and the excellent behaviour of the most recent locomotives in England, France and America, certainly emphasises the advantages of having roads wholly equipped with locomotives of the latest type. He makes no attempt to decide the question himself but he has certainly presented both sides in a manner which should evoke discussion as well as present material for it on both sides of the Atlantic.

Draughtsmen and Works Administration.

There has been recently some interesting correspondence in the columns of *Engineering* concerning the position of draughtsmen and their relation to the other departments of works administration and operation, and the subject appears to be one of sufficient importance to demand comment and discussion.

The real position of the draughtsman is one of some uncertainty, since the term includes a whole range of capacities, from the chief designing engineer down to the tracer. It is this very fact which doubtless causes some confusion in the course of the correspondence referred to, since it is apparent that in some cases the contributors are not all talking about the same thing. At the same time the fundamental principles concerned are clear enough, if the question is approached impartially and without personal bias.

In some establishments it appears that a draughtsman is supposed to have nothing to do with the work except to make drawings under specific directions from his chief. He is not permitted to go into the works, to know anything about costs of materials, labour, or finished product, and the drawings which he makes pass into the shop and disappear from his view and control. In other places the man who is entrusted with such responsible work as the making of the drawings from which the workmen get their principal instruction is held to be something more than a mere machine himself, and is given more or less insight into the conduct of the establishment and its detailed administration.

The reason generally given for the former course is that the draughtsman's work is essentially the making of drawings, and that it only takes up his time unnecessarily for him to be permitted to go into the works. He may learn too much there about departments of the business with which his particular work is not concerned, and, terrible to relate, he might possibly find out what the various products of the establishment really cost, and so learn the extent of profit made. Still more, he might, after acquiring all this forbidden knowledge, leave the service of his intelligent employers, and carry this wisdom to a rival establishment! That such disastrous contingencies may not arise, therefore, it is held most important that the draughtsman be barred altogether from the works, and that no hint of the cost of materials be allowed to reach his dangerous neighbourhood.

The other point of view, however, is beginning to receive some consideration, and it is really becoming understood that some familiarity with the immediate methods by which his plans are to be executed really forms a portion of the commercial value of a draughtsman to his employer.

There can be no possibility of question that a thorough knowledge on the part of the draughtsman of the capacity and capabilities of the tools with which the machining is to be done will materially affect the design of work, while the possession of a record of material of standard sizes and shapes in stock is essential, if he is to work intelligently.

Practical experience with the methods of pattern maker and foundryman will also guide the designer to a great extent in the drawing of plans for castings, and there is no doubt that consultations in important cases between these departments would frequently result in economy and advantage in the execution of work in the foundry and machine shop.

So far as the question of costs is concerned, experience has shown that cost clerks and estimaters must of necessity be able to read drawings intelligently and rapidly, and that while the actual work of the draughtsman in estimating may be limited to the taking out of weights and quantities, at the same time men who have had experience in the drawing room often make the best men for the cost department. Indeed it has been maintained by engineers of large experience that all the estimating and cost keeping should be in the hands of the engineering department, and that there should be no draughting room, especially so-called, but that it should be an engineering department in the fullest meaning of the term, the commercial department attending strictly to the commercial end of the business, correspendence, finances, etc.

The old-time idea of maintaining secrecy as to the shop-cost of various products is now given less consideration than formerly. Indeed when it is understood that only by careful and systematic combination of the various elements of cost can the office administration find the true shop cost, it appears absurd to object to the draughtsman being put in possession of the cost of the detailed parts of the work. In fact it is to intelligent consideration of these elements in the design that much of the success of the establishment in reducing costs must depend. More and more is it becoming understood that the true method of cheap production lies, not in the reduction of wages and the cutting down of expense, so much as in the increase of output and the greater efficiency both of men and of every element of the plant. The cost of the product is a ratio between the total operating cost and the quantity of the product, and the best method the design that much of the success of the denominator of the fraction rather than the reduction of the numerator, and in this most important element of shop administration the draughtsman must play an intelligent part if the full value of his services is to be realised.

There is a saying in the United States that "no one ever sees an old draughtsman" meaning that the position of the draughting room is but a stage in the development of the engineer, the superintendent, the manager, in all engineering works. This being the case it is manifestly absurd to restrict the draughtsman to a contracted position and to prevent him from developing into a man of far greater usefulness to himself and to the establishment, and it is cause for satisfaction to observe that more enlightened policy is beginning to prevail.

Progress in Space Telegraphy.

The recent address of Mr. Marconi at the Royal Institution has made public some very interesting facts in connection with the transmission of messages without wires, and from reports of his remarks we make some general abstract.

If there had been any disposition to assume that the development of wireless telegraphy would take a long time to reach a practical and commercial stage, such ideas must have been fully dispelled by the account of the rapid progress which has been made in the past six years during which Mr. Marconi has been converting the laboratory experiments of Lodge, Branly, and Hertz into a working system of long-distance communication. Thus the early transmitter, in which the use of a simple vertical wire connected to a spark coil emitted waves of electric induction, and enabled messages to be received by coherers within a radius of about 100 miles, was replaced, about a year ago, by the syntonic system. In the earlier device each receiver was acted upon by every transmitter within range and secrecy became impossible and interference frequent. The syntonic system includes a receiver adjusted to waves of one particular periodicity, this involving also a transmitter which should emit waves of the same period. This arrangement, described by Mr. Marconi in his previous address before the Society of Arts, replaces the vertical wire with two concentric cylinders of sheet metal, this giving a distinct periodicity to the emitted waves, and permitting the transmission of signals between tuned stations without affecting intermediate stations not so tuned.

A modification of the concentric oscillator is one in which a condenser circuit is placed in proximity with a vertical rod, this permitting of adjustment more readily than the concentric type. This arrangement also permits one vertical wire at the receiving station to operate a number of receiver circuits which are tuned to different waves, while it is also practicable to use one vertical transmitting wire, with connections of different inductance to several differently tuned receivers.

In all these experiments, however, the speed of transmission of messages has been limited by the action of the coherer, and it has been generally supposed that this would effectually prevent the Marconi system from becoming a formidable commercial competitor with the transatlantic cables. In his Royal Institution address, however, Mr. Marconi described his improved detector, which replaces the coherer altogether, and bids fair to work an entire revolution in the transmission of long-distance messages without wires. As described in *Engineering,* this new instrument is based on the fact that on exposing to high-period electric waves a magnet, which at the same time is subject to a varying magneto-motive force, its hysteresis is diminished, and the lag between the magnetism and the force producing it tends to vanish. The sudden corresponding change in the magnet's strength, due to the vanishing of its hysteresis, gives rise to currents in a coil wound around it, and these currents can be detected by means of a telephone.

One form of this detector consists of a permanent magnet which is caused to rotate slowly above a bundle of magnetised wires placed below it. The magnetic inductance through these wires is constantly changing, but from hysteresis this change lags behind its proper position. These magnetised wires are wound with a coil of wire connected with the receiver circuit, and hence when the latter is excited the hysteresis of the wires is diminished and a sound is audible in a telephone connected with a coil placed upon the magnetised bundle. A modified form of the receiver consists of a band of magnetised wires passing around two pulleys, the wires passing through a receiving coil to which the telephone is connected, a powerful fixed magnet keeping the wires magnetised. Experiments with such receivers have shown them capable of taking messages over the telephone easily at a rate of 35 words per minute, and Mr. Marconi maintains that it will be possible, with a recording attachment, to receive messages at a rate of several hundred words per minute.

The experiments conducted on board the steamship Philadelphia recently, when Mr. Marconi received messages from the station at Poldhu, Cornwall, over a distance of 1,551 miles, revealed the curious fact that communication was had over a much greater distance at night than by day. The maximum distance over which daylight signals were received was only 700 miles, and this peculiarity is attributed to the influence of sunlight upon the discharge of the transmitter. Doubtless the distance over which messages can be sent by daylight can be increased by supplying greater energy to the transmitter. It is probable that if the experiments in transatlantic communication between Poldhu and Newfoundland had been made at night, even more decisive results would have been obtained.

There appears to be little doubt that within a few years there will be regular commercial systems of communication over the Atlantic entirely independent of the existing cables, and this will also be accompanied by communication without wires over long distances in many directions. The importance of such progress can hardly be overestimated. Those inventions which abridge distance have rightly been said to add the most to human civilisation, and the ability to maintain communication over otherwise impassable areas must contribute materially to the exploitation of the world.

Thus expeditions to the far north, or to the interior of continents, such as Australia or Africa, need no longer be without communication with the rest of the world, while the facility of communication across the ocean, and the consequent reduction in cost, will tend to draw nations nearer and nearer together, and thus hasten those affiliations which will be stronger than any temporary differences.

The Training of Mining-Engineers.

TECHNICAL education has been the theme of numerous discussions of late, and among these we note the paper of Professor Wertheimer presented before the Institution of Mining Engineers, which, with the discussion following, brought out an interesting comparison between the methods of the United States and Germany with those in vogue in Great Britain.

The general trend of the paper was to the effect that a change had come over the conditions of mining education as well as of operation. The old system included apprenticeship, with all that it implied in time and opportunity of acquiring practical experience; supplemented by such night-school training as could be given upon the limited range of theoretical knowledge required or available. This is no longer practicable. Comparatively few students pursue their evening studies for a sufficiently long period to enable them to acquire an amount of knowledge to render them of greater service to their employers or to the nation. At the same time apprenticeship is no longer what it was, and there is so much more to learn in every department of industry, and the masters and principal assistants are so much busier, that a full practical acquaintance with the subject is more difficult than ever.

The obvious conclusion is that the technical training should be acquired before the entry on industrial life. Such a training should be accepted in place, not of all, but of some part of a young man's apprenticeship in a workshop, a mine, or wherever his sphere of action may lie. This is the fact in Germany and America, where employers in the engineering industries are willing to accept from trained students a much shorter apprenticeship than is asked in the case of untrained men. In the United States especially, in nearly every case, the applications for the services of the members of the graduating classes of the technical colleges by manufacturers and business men exceed the number of graduates. Experience shows that in a few years these young men, having a sound educational basis, have acquired the practical experience far more rapidly and completely than is possible in the case of untrained men, and are then competent for a much better service than the old apprenticeship-trained man could ever have hoped to become.

As matters now stand in Great Britain, in the mining industry, the law compels a man to spend five years underground before he can qualify for his certificate, no matter what the extent of his previous education. Now if preliminary study and training do not count as the equivalent of a part of this time it will always be difficult to induce men to enter courses of study. Few men are in a position to spend the three years required to get their college or university training, and then give another five years in the pit before applying for a manager's certificate. In other countries experience has shown that the men who have had the preliminary training take much less time to acquire the practical knowledge, since they have learned how to think and apply their reasoning powers in a higher degree than the uneducated man, and know how to assimilate their experience. To compel them to spend the same number of years in acquiring the practical portion of their equipment, therefore, is to maintain that the preliminary training of the previous years is worthless. There is but one result which can be expected to follow from this position, a falling behind in the rate of progress in the industry in which it exists. That this is becoming the case in Great Britain appears in the facts brought out by the discussion. Thus, many of the improved methods in mining originated in Great Britain, but have been taken up and pushed into practical use elsewhere to a far greater extent than at home. Nearly all the coal-cutting machines, for example, were invented in England, and British engineers were the pioneers in their use, but such machines are used to a far greater extent in America than in England, and the same is true of other methods and appliances.

While British methods of instruction may be open to some criticism, there is little doubt that the principal difficulty is in the matter of legislation. In other words there must be some inducement to encourage a young man to spend his time in study for practical life. If, for instance, three years of college training were accepted in place of two years underground, there is little doubt that the further three years would produce a far better man than could be obtained by five, or indeed any number of years in the pit without the college training.

The very fact that such a discussion has attracted much attention is evidence that England is waking up to the fact that the methods which have served her so well in the past cannot be relied upon to maintain her position in the face of present competition.

She has the men and the materials, as well as the prestige and the business, but she has no longer a free field without serious competition. Her best men are alive to the situation, both as regards its needs and its dangers, and it is only necessary to awaken her people, and especially her legislators, to the demands of the time to enable proper steps to be taken to enable her to meet the competition which should prove her best stimulus.

Electric Traction on Steam Roads.

We have discussed the question of the possible replacement of steam locomotives by electric traction from various standpoints, and now we have the important paper of Professor Carus-Wilson, presented before the Institution of Electrical Engineers, nominally upon the subject of electrical traction upon steam railways in Italy, but really upon the much broader subject of the economic question of the relation of electric to steam traction in general.

The Italian question is a simple one. In the first place the steam railways are operated under an arrangement with the government, by which the latter gives the companies an annual subsidy in return for a certain proportion of the receipts. Thus, for the year 1900 the Adriatica company, which with the Mediterranean railway operates 80 per cent. of the railways in Italy, received from the government a subsidy of £2,166,000, while it paid to the government a sum equal to 40 per cent. of the total receipts, amounting to £2,040,000, the balance to the credit of the company being £126,000. This arrangement comes to an end in 1905, when the government has the option either of buying out the companies or of coming to a fresh agreement with them.

In the meantime there has arisen a formidable competition in the shape of electrically operated tramways and local lines, which, providing a cheaper and more efficient service, are seriously affecting the traffic on the main lines, and as a consequence the steam railways have introduced a service of short, electrically-driven trains, running frequently at high speeds. Professor Carus-Wilson takes this situation as an occasion of discussing the economic possibilities of the proposition, also comparing the conditions in Italy with those in England.

This is by no means a simple task, since both operating and financial methods in Italy differ so materially from those obtaining in England as to render comparisons difficult. Without going into details, for which the reader is referred to the various papers by Signor Bignami in various issues of The Engineering Magazine, is appears that it has been practicable, on the Lecco-Colino line and on the Milan-Varese line, to supplement steam traction to a point which has resulted in an increase of five-fold in passenger traffic, with a doubling of receipts. The speed and frequency of trains has been doubled, and the fares reduced to 40 per cent. of their original amount. It is confidently expected that this improved service will increase the amount of traffic to such an extent that in spite of the lower rates the former deficit will be converted into a paying business.

Whether this state of affairs could be reproduced in England is a matter for discussion. In any case it is clear that the full advantages of electric traction cannot be obtained without an increase in the total running expenses, and this increase can only be met by a corresponding increase in the passenger traffic, so that the change from steam to electricity should not be made unless the increase in traffic may be reasonably expected at least to cover the increased cost of running and the interest on the capital expenditure.

"Most railway managers would probably admit that the use of electricity on existing railways is worthy of consideration, and some will even go so far as to say, "'If you can show that we should reduce our expenses by adopting electricity we would do so.' It is not, however, by reducing expenses that electricity is going to help the railways, but in enabling them to offer greatly increased travelling facilities to the public at a figure impossible with steam traction, and thus to meet the growing competition of the tramways.

"In answer to the question as to why the Italian railway companies are adopting electrical traction, it is often urged that they are doing so because of the saving effected by the use of water power in place of coal. This is, however, very far from being the case, since even with water power the expenses cannot be met unless the traffic increases. The use of water power simply reduces the increase required to pay, the reduction in the case of the Italian lines being 20 per cent. The prospects of success in England with cheap coal are more favourable than they are in Italy with water power, as is shown by the fact that the increase in the traffic required to pay expenses is less in England than in Italy.

"The figures given above do not take any account of the relative possibilities of travel development in the two countries. Milan has a population of 471,000, about equal to that of Birmingham, but the towns along the line now being electrified are all quite small, Gallarate having a population of 8,000, Varese of 6,000, and Arona of 4,000, the largest being Busto Arsizio with 13,000. Taking the different lines radiating from Birmingham, by way of comparison, we find that the united populations of the two largest towns on each line within a radius of 45 miles amount to 39, 41, 63, 86, 101, 109, 121, and 185 thousand. With these figures before one, it is difficult to avoid the conclusion that the possible increase in travel is far greater in England than in Italy, and that if there is a field of usefulness for electrical traction on Italian steam railways, there is a still greater field of usefulness on the railways of our own country."

While these comparisons are interesting, and to the unbiased reader appear conclusive, it is probable that any change in British railway systems will be brought about only by similar causes as those which have operated in Italy, that is, by the actual competition of electric traction on rival lines. In fact the general trend of the discussion on Professor Carus-Wilson's paper was in the line of showing how impracticable it would be to introduce in England such service as had already been shown to be successful in Italy. Probably precisely similar arguments would have been advanced by the management of the Italian railways had the question been brought before them in a similar manner. When, however, they were confronted, not by an academic paper, but by rival electric lines which were rapidly absorbing the most profitable portion of their business, they accepted the condition which confronted them, instead of opposing it by a theory, and the result has been their financial salvation. Probably it will require similar conditions to produce similar results in Great Britain, but it is possible that the longer postponement of action may materially change the conditions and render it far more difficult to secure equally good results.

The state of affairs which exists to-day in underground traction in London may be repeated on a far more extensive scale, and the appearance of rival electric traction lines for local and suburban service may place certain steam railways in a position not greatly different from that of the Inner Circle.

Shoreditch Electricity Works.

The erection of the additional electrical generating station for Shoreditch is noteworthy mainly because of the interest which attached to the plant erected there five years ago for the burning of refuse and the generation of electricity by the heat of that combustion. Like many new things, the true purport of the earlier plant was misunderstood and exaggerated, and because the refuse was successfully destroyed and the heat of destruction utilised, the conclusion was jumped at that the refuse of a district was sufficient to produce all the electricity needed for lighting the same area.

Now that greater demands for current are made it has been found necessary to erect a new station, and the old plant being capable of taking care of the refuse, it has become necessary to arrange for the use of coal as elsewhere. The old works, opened in 1897, contained three generators of 165 kw. and three of 70 kw. each, and, as is well known, the power has been supplied by the burning of refuse in suitable destructors ever since. The new plant, of which a full account is given in a recent issue of the *Electrician*, is a very complete equipment of boilers, engines, and two multipolar generators of 800 kilowatts each, the whole being in a new power house erected at Haggerston, where every facility for fuel transport and water supply is available.

The fact that the new plant is intended for coal firing only should by no means be considered as any admission of unsatisfactory working of the older refuse-burning plant. The installation of 1897 was constructed primarily for the purpose of refuse destruction, the steam and electricity being by-products, and the measure of the success of the plant should be taken first as the completeness with which the destruction is effected. The utilisation of the heat is a cause for congratulation, but so is the fact that there is not sufficient refuse produced to supply fuel for another plant. The demands for electricity will probably continue to increase, also a healthy indication of prosperity, but any attempt to draw adverse conclusions as to the value of refuse as fuel must be checked by a careful examination of the true conditions of the situation.

Doubtless the installation of the new plant at Shoreditch will furnish occasion for those who discourage the disposal of refuse by incineration to comment upon the fact that the works there have not been extended according to the original plans, but the considerations given above should dispose of any such argument against the sanitary and economic value of properly designed destructor plants.

REVIEW OF THE CONTINENTAL PRESS

Ironmaking and Shipbuilding in Germany.

It has well been said that the finished product of one manufacturer becomes the raw material of another, and indeed it is difficult to name any material which is altogether raw from the moment man has placed his hands upon it to apply it to industrial purposes. At the same time the principal consumers of a material differ greatly in various countries. Thus in Great Britain, ever since the introduction of iron ships, the shipbuilding industries have formed the principal customers of the iron and steel makers, and indeed the great development of the steel making industries of Great Britain has been largely dependent upon the demands of the shipbuilding interests.

In other countries the case has been different, and in Germany and in the United States, for example, the manufacture of structural steel and iron has to a great extent been developed in response to the requirements of the building trade and for civil engineering work, such as bridges and similar structures. The demand for plates has been for boiler construction, and the material required for shipbuilding has formed but a small proportion of the whole.

The changed relation of the iron and steel trades to the shipbuilding industries of Germany formed the subject of a remarkable paper presented before the Düsseldorf meeting of the Schiffbautechnische Gesselschaft, by Herr E. Schroedter and the importance of the subject is such as to warrant an extended review.

Although the iron industries of Germany had existed from an early period the development of shipbuilding with iron and steel dates only from the establishment of the German Empire in 1870. Naturally the first attempts were closely modelled after British practice, and the materials came from British sources. This latter fact was due to two reasons. In the first place the German iron works were not prepared to furnish the desired sections and shapes, and, in the second place the requirements of the British Lloyds, to whose rules most of the vessels had to be built, demanded sections whose dimensions were expressed in English inches and parts. When to these was added the greater convenience of the British commercial methods, in which middlemen, dealing with numerous manufacturers, undertook the delivery of the whole quantity of rolled steel, it will be seen that the introduction of German made material was necessarily slow.

The difficulty of the specifications of the British Lloyds was overcome by the opportunities offered by the Germanischer Lloyd and by the Bureau Veritas, while the association of a number of the more important German iron works in the adoption of standard sections adapted for use in shipbuilding, after many difficulties, has resulted in the production of material, which since 1898, has entered to a great extent into the consruction of German built ships.

In order to grasp the extent of the development of German iron and steel products, Herr Schroedter gives an array of figures showing, not only the increase in output since 1880, but also the growth in dimensions of plates rolled by various leading makers. Broadly it may be stated that the producing capacity of the German works to-day is nine times what it was in 1880, having increased from 105,000 tons in 1880 to 818,000 tons in 1901, the further increase in capacity having followed during the present year.

With the development of German steel manufacture there has come also into practice the question of the differing requirements of the various organizations under whose rules vessels are built. In addition to the English Lloyd there is also the Germanischer Lloyd, the Bureau Veritas, and the Registro Italiano, for shipbuilding and the specifications of the Verein deutscher Eisenhuttenleute, for the iron and steel makers. Partly owing to the predominance of basic steel in Germany, and for other reasons, these requirements by no means agree with each other, and it is in many cases impossible for manufacturers to produce material which will satisfy all requirements. Thus, for instance, it is possible to make furnace plates which will satisfy the rules of the English Lloyd, and will also meet the requirements of the Bureau Veritas, or the Germanischer Lloyd. It is not possible, however, that this material should at the same time fulfill the requirements of the Verein deutscher Eisenhuttenleute, or of the German or Italian Marine. For boiler shell plates the conditions are similar; plates for the English Lloyd can be made use of for the Germanischer Lloyd and for the Bureau Veritas, but not vice vèrsa. The English Lloyd and the Verein deutscher Eisenhuttenleute completely exclude each other, while the English Lloyd and the Registro Italiana disagree to such an extent that any one who atempts to satisfy them both will have a margin of only 3 kilogrammes per square millimetre (4,267 pounds per square inch) to work upon.

In this connection the importance of so modifying the test requirements of various nations as to give substantial agreement may be emphasized and urged. Doubtless each nation has permitted specifications and test requirements to be produced and enacted upon the advice of local manufacturers so as to give sufficient strength and at the same time meet the facilities for local production. The time has now come, however, when the limitations of national boundaries must be overlooked, and specifications and test requirements and methods for all kinds of materials be made to conform to intelligent scientific practice over the entire world. No manufacturing organisation can be content with the local market alone, and yet international markets may readily be closed by the enactment of impracticable specifications. Fortunately there is in existence an important International Association for Testing Materials, including in its membership distinguished engineers from all important manufacturing countries, and devoting itself to the work of unifying and providing standard methods of testing which shall be scientifically correct and reliable, regardless of the source of the material or the methods of its manufacture. It is greatly to be hoped that the work of this important association will be permitted to influence the framing of specifications to such an extent as to avoid conflicting interests, and permit material made in any part of the world to be subjected to tests which will insure its acceptance anywhere.

There has recently appeared in the United States an unfortunate tendency to act in independence of the International Association which is greatly to be deplored, and it is hoped that wiser cousels will prevail in this important matter.

Herr Schroedter's paper is filled with interesting matter relating to the general growth of the iron and steel industries in Germany, as well as the development of German shipbuilding, and apart from its engineering interest it forms valuable reading in connection with an important department of industrial economics.

The Punching of Metals.

We have at various times referred to the excellent work by M. Codron upon the power required to perform different machine operations as the records of his wórk have appeared from time to time in the pages of the *Bulletin de la Société pour l'Industrie Nationale*. In a recent issue of the *Bulletin* we have some interesting accounts of experiments upon punching various metals, including the action of different kinds of punches and the power required to perform the work.

Punching is a modification of shearing, in that the fibres of the material are divided nearly at right angles to the movement of the tool, but the action is modified by the confinement of the severed material in the hole produced by the operation. Shearing takes place up to a certain depth, after which the remainder of the metal breaks away, and the plug is forced out of the hole with a rapid decrease in the resistance to the tool. These successive actions are shown by the strain diagrams, obtained by experimenting with a hydraulic punch, the pressures being ordinates and the penetrations abscissas of the recorded curve. With these direct actions are shown other complicated stresses and strains, including bending, compression, and a flow of metal, often accompanied with the formation of cracks, according to the nature of the material in which the hole is punched. Some of these phenomena are clearly shown in the appearance of the plug which is forced out of the punched hole, this being compressed to much less than the thickness of the original depth, while in the case of iron or steel the ductility of the metal along the line of punched holes is diminished from 10 to 20 per cent.

A record diagram of the operation of punching a hole shows a definite succession of operations very clearly. At first there is a definite and practically uniformly increasing resistance opposed to the entrance of the point of the punch into the metal. Then, when the punch enters the metal, the line becomes steeper, owing to the increased resistance, but still remains straight, showing that the resistance to the shearing is directly proportional to the depth.

The maximum resistance varies according to the nature of the material, and according to the relation of the diameter of the punch to the thickness of the sheet, but some time before he maximum is reached the penetration increases more rapidly than the resistance, until, as the maximum is attained, the resistance falls off very rapidly as the metal breaks down and the plug is forced out.

M. Codron derives from his experiments a coefficient of resistance to punching R, which bears a direct proportion to the coefficient R^1 of tensile strength. This varies according to the material, ranging from 0.60 to 1.00.

A number of diagrams, for iron, steel, cast iron, copper, lead, and aluminum, as well as various alloys are discussed, but for these the reader must be referred to the original paper. From these researches much valuable information may be obtained not only in connection with the working of the various materials, but also for proportioning the material in designing punching machinery, and distributing the stresses.

In this connection some interesting experiments were made upon the action of different kinds of punches. Punches with oblique cutting edges, often advocated as superior to the ordinary square-ended punches, were shown to possess no advanages whatever, the resistance being the same in both cases, while the character of the work was not improved by the modification. Punches with multiple cutting edges were also given thorough trial, and found to be less satisfactory than the ordinary form. The successive cutting edges became choked and clogged with metal, requiring additional effort to force them through the metal, while the dragging of the abraded metal upon the sides of the hole produced inferior results to those attained with the common square punch. This action is shown, not only by the record diagrams of the tests, but also by photographs of the tools and the character of the plugs forced out by them.

In connection with the direct effort exerted by the punch itself, M. Codron discusses the distribution of the resistance throughout the entire movement of the tool, in order to enable data to be obtained for the proportioning of fly wheels for punching machines operated by cams or eccentrics. The result is the development of some valuable information, not hitherto available, as to the angular distribution of the efforts upon the rotating portion of a punching machine, enabling the forces to be laid out upon a diagram in a form suitable for use in machine design.

Too much cannot be said in commendation of the systematic manner in which M. Codron has investigated to various details of the action of different kinds of machine tools, and his researches, not only as regards punching, but in connection with grinding, turning, shearing, and other operations connected with the working of metals, should go far to remove these questions from their hitherto empirical position to a more rational and determinate status.

Russian Railway Systems.

The development of the Russian railway systems in Asia has been along two distinct lines of traffic. The first of these, known as the Trans-Caspian system, extends from the port of Krasnowodsk, on the Caspian sea, through Aschabad, Merv, and Samarkand to Andishan. From Merv there is a branch line to Kuschk, near the frontier of Afghanistan, and there are also branch lines from Tschernjajewo to Tashkent, and from Gortschakowo to Margljan. This whole system, known as the Central Asiatic Railway, has a total length of about 2,670 kilometres (1,660 miles).

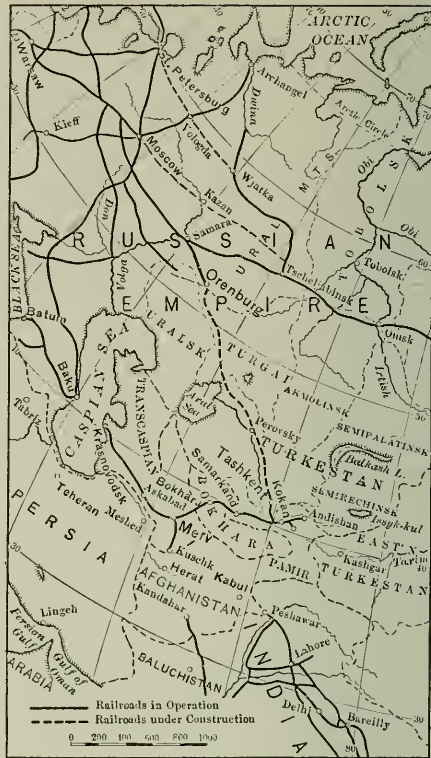
The second system is the well-known Trans-Siberian railway, extending from Tscheliabinsk, on the Ural frontier through to the Pacific, with a total length of about 7,640 kilometres (4,740 miles).

At the present time the outlet of the Trans-Caspian railway system is by means of navigation between the terminus Krasnowodsk, across the Caspian to Baku, from which extends railways communication to Batoum on the Black sea and to Rostow-on-Don, and thus to the entire railway system of European Russia.

In order to connect this entire system of railways in Asiatic Russia with the European lines without requiring the water transport across the Caspian sea, a new line has been planned and is now under construction extending from Tashkent, in Turkestan, to Orenburg, on the Ural frontier and thus directly uniting the railways systems of Europe and Asia, and from a review in *Glasers Annalen* we extract a brief account of the work. The immense commercial and military importance of railway communication between Orenburg and Tashkent will be seen by reference to the map. Passing through the western portion of the province of Turgai, touching the Aral sea, and running through the middle of the province of Syr-Darja, this railway, 1,880 kilometres in length, (1,167 miles) opens up an important region.

The province of Turgai has an area of about 400,000 square versts, (about 175,000 square miles), with a population of only 460,000, mainly Kirghis, occupied in agriculture and grazing, there being also a small proportion of Bashkirs and wandering Russians. At present, apart from agricultural products, the principal production of the province is rock salt, of which extensive deposits exist in the Ilzek district. There are undoubted mineral deposits of value, including silver-lead, copper, and coal, and probably gold, awaiting development. The province of Syr-Darja has an area of 434,444 square versts, (about 190,000 square miles) with a population of about 1,500,000, and is more extensively cultivated than Turgai. Certain industries are also well developed, including the production of wine, silk, and tobacco, especially in the vicinity of Tashkent.

The greatest industrial importance of the railway to Russia, however, is the opening up of the cotton-growing district of Russian Turkestan. Formerly the cotton was packed by hand, and transported on camels by caravan to its destination. At present compressing machinery has been introduced and the railway will permit the cotton to be sent direct by rail to Moscow and Lodz.



RUSSO-ASIATIC RAILWAY CONNECTIONS.

While the opening up of these extensive regions to commercial communication with European Russia is of vast importance, the value of the railway from a military point of view is great. A glance at the map shows more forcibly than words the relation which the development of railways bears to the policy of nations in the preparation for future control. The Trans-Caspian railway, reaching eastward from Krasnowodsk, spreads out its arms to Kuschk, right on the frontier of Afghanistan, and to the edge of the plateau of Pamir, "the roof of the world." At the same time the lines extending up from India to Peshawar, and also up to Kandahar, show how Afghanistan is enclosed between Russia and England as in a vise. The connection of the Central Asiatic Railway system with the main lines of European Russia greatly strengthens the military importance of the network, since Russia will be able to transport men and supplies direct to Tashkent and Kuschk, without the necessity for any water transport across the Caspian.

The Vibration of Propeller Shafts.

In view of the number of mysterious breakages of propeller shafts, under conditions in which it is evident that some other action than of the normal working stresses controlled, any systematic study of the possible causes of such disasters is to be welcomed.

In a recent issue of the *Zeitschrift des Vereines deutscher Ingenieure* is given an account of the experimental researches made by Herr Frahm, for the purpose of examining the extent to which vibrations of propeller shafts actually occur, and to deduce the influence which such vibrations may have upon the reduction in strength of the shafts. The actual torsional stresses exerted upon the shaft by the engine in transmitting the power to the propeller can be accurately determined, and there is no difficulty in so proportioning the diameter of the shaft as to meet these with a large margin of safety. At the same time it must be remembered that a shaft of the length required to extend between the thrust bearing of a marine engine and the hub of the propeller cannot be regarded as a rigid connection, but must rather be regarded as a torsional spring of more or less elasticity, operating under varying stresses.

If the propelling power originated in some uniformly acting machine, such as an electric motor or a steam turbine, the variation in the turning moments would be much less than with a reciprocating engine, in which the impulses of the steam upon the pistons act at successive intervals with a varying effect. These impulses must be transmitted to the propeller through the shaft, as an elastic connection, the result being the production of varying stresses almost impossible of numerical computation. If the action of the engine alone were to be considered, it might be possible to analyse the impulses and obtain data from which computations might be made.

The varying resistances of the propeller, however, are practically impossible of determination, including as they do the action of the waves and currents, as well as the propelling reactions against the water. It therefore becomes necessary to resort to experimental investigations, and the methods and apparatus devised for this purpose by Herr Frahm are both interesting and instructive.

The principle involved in the investigations consisted in the recording of the amount of torsional distortion existing between two points on widely separated portions of the shaft at uniform time intervals during a revolution. This information has been obtained by the following apparatus. Upon the rims of two of the flange couplings of the shaft were placed bands of thin sheet zinc, forming smooth metallic drums upon which record markings could be made by means of platinum contact points. By taking one flange immediately next to the thrust bearing and the other at the extreme end of the tunnel, close to the hub of the propeller, nearly the whole length of the shaft was put under observation. By means of an electric contact apparatus the two platinum points were put into simultaneous contact with the zinc drums at uniform time intervals, and a comparison of the records gave an accurate measure of the torsional vibrations existing in the length of shaft under consideration.

An examination of reproductions of such records, as given in Herr Frahm's paper, while interesting, does not give such an instructive idea of the action as is indicated by the same results when transformed into wave diagrams plotted in connection with the turning moments on the shaft. Such translated diagrams show very clearly the continual vibrations to which the shaft is subject, and it is apparent that such action must result in the production of severe internal stresses.

Herr Frahm gives the results of examinations of the shafts of several large steamers, and from data derived from tests of pieces of the material from which the shafts were made he compares the maximum stresses due to vibration with the mean stresses due to the ordinarily assumed working loads. Without going into details it is sufficient to state that the maximum stresses ranged from two to three times those due to a uniform turning moment, showing the insufficiency of the ordinary methods of proportioning shafts for such service.

It is evident that any increase in the number of steam cylinders must have a material effect in distributing the impulses, and the harmonic period of the length of shaft under consideration must also be taken into account. All these elements point to the advisability of employing materially increased diameters for propeller shafts, and with the use of hollow shafts a greatly increased degree of stiffness can be secured with but little increase in weight.

The above considerations point strongly to the advantages of the steam turbine as a marine engine, and if greater freedom from shaft breakages can be shown to follow the employment of the turbine, owing to its uniform turning moment and absence of vibratory stresses on the shaft, its adoption as a measure of safety can reasonably be urged. At the same time it is important that propeller shafts should be made with a large margin of stiffness, in order to enable the shocks and vibrations due to the action of the waves and to racing to be met with safety.

Such experimental researches as those made by Herr Frahm merit recognition and encouragement, especially in that they act to disturb the too common practice of assuming as a basis for computation data which do not necessarily include all the conditions which actually exist.

Standards for Electrical Apparatus.

About a year ago, the *Verband Deutscher Elektrotechniker* adopted provisional standards for the testing of electrical machines and transformers, which were to remain in force for one year. On the whole, these have proved very satisfactory, and they are now recommended by the machinery committee for permanent adoption, with such changes and additions as experience has shown to be advisable.

The standardization is no longer confined to testing, which latter word has accordingly been dropped from the title of the report, as given in the *Elektrotechnische Zeitschrift.*

There are a few preliminary definitions, which, for the sake of a clearer international understanding, it may be well to reproduce.

A *Generator* or *Lynamo* is a rotating machine which changes mechanical into electrical energy. A *Motor* is a rotating machine which changes electrical into mechanical energy. A *Motorgenerator* is a double machine consisting of a motor and a generator, directly coupled. An *Umformer* is a machine in which the conversion of the current takes place in a common armature. (This definition corresponds particularly to our rotary converter, although a dynamotor with an armature having two separate windings would be included under it.) When the words *elektrische Maschine* or, simply, *Maschine* are used, one of the foregoing kinds of apparatus is to be understood, circumstances determining which one. *Anker* (armature) is that part of an electrical machine in which electromotive forces are generated by the action of a magnetic field.

Transformator (transformer) is an alternating-current apparatus without moving parts for changing electrical energy into electrical energy. The *Spannung* (potential or voltage) of triphase currents is the linked effective voltage between any two of the three principal conductors, or line wires. The *Sternspannung* (star voltage) of triphase currents is the voltage between the zero point and any one of the three principal conductors in a star-connected system. The *Uebersetzung* (ratio of transformation) of transformers is the ratio of the voltages at no load. *Frequenz* (frequency) is the number of complete periods, or cycles, per second.

All machines and transformers are rated by the power delivered. For continuous-current apparatus the capacity is to be given in kilowatts, and for alternating-current, in kilowatts together with the power factor.

Three classes of service are distinguished, intermittent, short time and continuous, and the normal capacity of apparatus is that which can be maintained for the time designated without exceeding the prescribed limits of temperature.

The rise of temperature is to be measured after one hour of uninterrupted operation in the "intermittent" class, and in the "short-time" class after the apparatus has been in uninterrupted operation for the time marked on the plate. In the "continuous" service class, the rise of temperature of machines is to be measured after ten hours' operation, and of transformers after a constant temperature has been reached. Smaller machines, whose temperature will become constant in less than ten hours, may have the rise measured after a correspondingly shorter interval. When the temperature of the air is not higher than 35°C, the rise in temperature must not exceed the following figures:

(a) Insulated windings and collector rings with cotton insulation, 50°C; with paper insulation, 60°C; with mica and asbestos insulation, 80°C. A 10° higher rise is permissible for stationary coils.

(b) Commutators, 60°C.

(c) The iron of generators and motors in which windings are imbedded must not show a rise greater than that allowed for the respective classes of insulating material under (a).

Temperatures of certain parts are to be measured with thermometers, and of other parts by their increase in resistance. In the latter case, the temperature coefficient of the resistance of copper is to be taken as 0.004, when not specially determined.

Generators, motors and converters must be able to stand an overload of 25 per cent. for 30 minutes, and motors, converters and transformers an overload of 40 per cent. for 3 minutes without heating above the limits already designated.

The measurement of the resistance of insulation is not prescribed, but tests of its dielectric strength must be made at the place of manufacture, and, for large parts, also after erection. Tests are to last 30 minutes, and apparatus designed for voltages of 5000 and under must stand twice the working pressure; apparatus for voltages between 5,000 and 10,000 must be tested with 5,000 volts above the working pressure, and apparatus for voltages above 10,000 must stand one and a half times the working pressure.

The efficiency of an apparatus is the ratio of the power output to the power input, and can be determined, directly, by measuring the power, or, indirectly, by measuring the losses. The indirect methods are generally to be preferred. When the efficiency is designated, the method by which it is determined must also be given, and the following methods are prescribed: (1) the direct electric method; (2) the indirect electric method; (3) the direct brake method; (4) the indirect brake method; (5) the "no-load" method; (6) the auxiliary-motor method; (7) the steam-indicator method; (8) the "loss-separation" method, where machines can be run only by the use of "foreign" bearings.

An appendix contains standards which are recommended, but which cannot yet be insisted upon. The frequency recommended is either 25 or 50. Voltages should correspond with the following tables:

CONTINUOUS CURRENT.

Motor.	Generator.
110 volts	115 volts
220 "	230 "
440 "	470 "
500 "	550 "

Motor. Motor or Primary Terminals of Transformer.	Generator. Generator or Secondary Terminals of Transformer.
110 volts	115 volts
220 "	230 "
500 "	525 "
1000 "	1050 "
2000 "	2100 "
3000 "	3150 "
5000 "	5250 "

The Gold Deposits of Madagascar.

Gold has long been known to exist in various parts of Madagascar, and until the French occupation of the island, the absence of means of transport has aided materially to sustain the native reports of the existence of valuable deposits. The paper of M. H. Pérès, recently presented before the Société des Ingénieurs Civils de France, and published in the *Mémoires* of the society, has dispelled most of the uncertainty relating to this matter, and placed the fact before the public in a definite manner.

One of the immediate results of the French occupation of the island has been the conduct of a thorough topographical survey, and this has naturally been followed by an investigation of the mineral riches of the country, partly stimulated by the tales of the natives as to the existence of rich gold deposits. The result of these investigations has been to dispel many of the illusions as to the existence of vast deposits of great value, and at the same time to put th gold mining industry of Madagascar upon a scientific and commercial foundation, freed from the vague and unreliable reports hitherto prevalent.

The island of Madagascar consists mainly of a gneiss formation, heavily plicated and dislocated. In many places this foundation rock is replaced by mica-schist, and permeated by eruptive dykes, and by numerous veins of non-auriferous quartz.

The gold is found in a quartz differing in appearance from the larger veins, appearing rather in thin veins stratified with the gneiss and mica schist. This auriferous rock is rather friable and easily broken up, so that it can be worked by washing, and in this method the gold has been extracted by the natives. Its low value renders this rock of small interest, except as indicating the origin of the placers formed by the action of streams upon the material through long periods of time.

Another kind of auriferous deposit is found in the so-called red earth, formed by the decomposition of the gneiss, and having the mineralogical name of laterite. This is composed mainly of a silicate of aluminum and iron, containing small crystals of quartz and also grains of magnetic oxide of iron.

The various sources of gold have formed the supply for the placers from which the bulk of the precious metal is obtained by washing. The small proportion of gold in the earth renders it desirable to conduct some preliminary concentration work, usually according to the native method, by cutting small artificial channels through the earth and permitting the water to wash the earth into settling pools. In this way much of the lighter earth is carried off, and the auriferous portion rendered rich enough for hand washing. The washing is performed in the pan, much as in the early days in California, and the natives have acquired much skill in the work, experiments showing that about 90 per cent of the gold in a pan of earth is recovered.

While the methods employed are primitive, yet they have the advantages of employing the very cheap native labor; more expensive methods not being warranted by the proportion of gold per cubic metre of earth. Thus a cubic metre of the auriferous gravel, of about 1,500 kilogrammes weight (1½ tons) contains before concentration only about 0.2 gramme of gold, but after concentration, when the lighter mica and clay have been partially washed off, the content is about 5 to 6 grammes per cubic metre, or say 4 grammes to the ton. Taking the value of a gramme of gold as 3 francs, we get an average for the value about 12 francs per ton, and as a native can wash only about 300 to 400 kilogrammes of gravel per day, the return is but 4 to 5 francs for a day's work. It is true that deposits have been found running as high as 30 francs to the ton, but these form but a small proportion of the total.

Since the annexation of the island by France the government has attempted to classify the placers according to their richness and to impose taxes for the benefit of the colony, but the low content of the gravel renders it difficult to do this. Later legislation has fixed the tax directly upon the gold extracted, which is more practicable of determination, although it does not bear a direct relation to the cost of extraction.

Naturally the use of dredges and similar machinery has been suggested since the French occupation, but it is a question whether their use would be profitable. The experience under similar conditions in Guiana has shown that the dredging costs about 2 francs per cubic metre, and as this is the unconcentrated gravel, it is apparent that the Madagascar deposits could not stand such a charge.

The general conclusions drawn by M. Pérès from his investigations of the gold deposits of Madagascar are, that, while gold will long continue to be one of the principal export productions of the island, its exploitation offers little to modern methods of development.

The natives will doubtless long continue to wash the gravel and by their primitive and exceedingly cheap methods will be able to find occupation and support in the industry. While it cannot be expected to form a foundation for great mining companies, therefore, it may yet serve to assist in the general development of the colony and aid in the opening up of the island and its other natural resources to the commerce of France and the world.

Engineering Education.

Among the papers presented before the recent convention of the Society for the Promotion of Engineering Education we notice especially the presidential address of Dr. Robert Fletcher, and the paper of Professor Edgar Marburg, from both of which we make some abstracts.

Dr. Fletcher takes as his subject the efficiency factor in engineering education, while Professor Marburg considers the evil of excessive differentiation in engineering courses, both recognizing that the usual four-year's course is insufficient for the student to acquire the general foundation upon which to build the superstructure which his active practical experience must rear.

We cannot altogether agree with the position taken by Dr. Fletcher, based upon the methods of military academies, and emphasising the importance of drill, rigid discipline, and an extreme of recitation and blackboard work in class. These features appear to savor too much of the school room and of the irresponsible student, who is made to learn the things which he would never have undertaken by himself for the love of them, or because of his own appreciation of their future value to him. If such methods are necessary we cannot hope for much of the future work of the products of such an educational mill.

The true student of engineering needs no prodding, no watching lest he "shirk," he has gotten far past that stage, and is rather watchful lest his professor himself do some shirking, for professors have been known to do such things. The engineering student, for the most part, has a fairly clear idea of the uses to which he intends to put his education, and he looks to his professors to give him the worth of his money and his time, well knowing that the latter is all too short to fit him adequately for the struggle which is before him.

This brings us to Professor Marburg's paper, which is in striking contrast to the school-boy characteristics of its predecessor.

The real trouble with the engineering student is that, having his own plans for his practical career before him, he is too apt to endeavor to secure the special training which he has elected, to the loss of the general foundation which he should have for any department of his profession. Passing over the first two years, which, it is generally agreed, should be devoted to the foundation studies in mathematics, languages, physical science, and mental training, the discussion hinges upon the extent to which the student should be permitted to elect the details of his work. In this connection Professor Marburg makes an observation which every practicing engineer will appreciate, namely, that but few engineering students have their immediate professional future safely predetermined, even three months before graduation. The young man may think he knows just what line of work he intends to pursue, but when he gets out into the world he finds opportunities in quite different lines, and if he does not get into practice in his chosen specialty he may find himself compelled to enter upon a career for which he is but imperfectly fitted.

If the work of the third and fourth years includes all the subjects which it should, there will be little time left for specialization. The number and extent of subjects which should form a portion of every engineer's working equipment, together with the laboratory practice necessary to give a living meaning to the fundamental theoretical principles, demand every moment of the time which is available. Specialization, under these cicumstances, entails the suppression or mutilation of other important subjects, and may constitute a grievous wrong to the student, and one of which he will soon be made aware in after life.

That specialization in engineering education is becoming increasingly important is by no means denied. But in Professor Marburg's view, its place is not in the undergraduate courses. Its legitimate province is to be found in graduate instruction, and there no limits need to be set to its intensity. But schools not thoroughly equipped for this responsible work had better not attempt it. Graduate courses, if offered, should be truly worthy of the name. They should appeal to men in practice as something worth striving for. Their value should be absolutely beyond question. This means that they must be conducted by an adequate corps of able and experienced specialists, as, for example, in our best schools of medicine.

As a matter of fact most of the actual work of specialization must be done after the student has been graduated, and during the immediately succeeding years. All that can properly be done in the educational institution is to select the broad classification, as civil, mechanical, electrical, or mining engineering, and impart a thorough fundamental grounding in the principles of the science and their logical applications. The specialization will follow soon enough, if the foundation principles have been placed broad and deep in the mind of the student, while without a thorough grounding no really valuable degree of specialization can be followed.

In this connection the importance of the possesion of practical experience by the professor may be emphasised. No one is more acute to perceive the shortcomings of his instructors than the earnest and intelligent student of engineering, and with the opportunities which such students have of observing and absorbing current practice it is easy for them to see when their instructor has no working knowledge of his subject and when he is, as is too often the case, a graduate from the class room to the professional chair without any experience in the strenuous school of the shop, the field, or the line. These things cannot be evaded by the instructors under the keen inquisition of their eager pupils, and probably a most interesting paper might be presented to the society, if it could be had, upon the professor as his pupils see him, or as they find him after they have been out in the tussle for a year or two.

The Electric Driving of Machinery.

In the course of an interesting symposium at a recent meeting of the Engineer's Society of Western Pennsylvania, the subject of the electric driving of machinery was discussed in a very practical manner.

The extent to which electric driving is being used in rolling mills and at iron furnaces is clearly indicated in the discussion, and in the former class of work the applications are most numerous. Naturally the most extensive applications are in the operation of traveling cranes, this having been an early field for electric driving. Motors are also successfully employed for operating electric charging machines for open hearth furnaces, and also for driving roller tables. For many minor purposes electric motors are used in rolling mills where formerly small steam engines were employed and these uses are extending. Up to the present time, however, there is no rolling mill in the United States in which the heavy rolls are driven by electric motors, although motors of more than 400 h. p. have been sent to Europe from America for the direct driving of heavy rolls.

In modern blast furnace plants the principal use to which electric driving has been applied is the handling of materials, including unloading and dumping machinery for ore, coke and limestone; electric locomotives, conveyors, and especially hoists for lifting material to the top of the furnaces.

The good work which electric motors have done in this kind of work is shown by the fact that although the failure of a motor would cause the interruption of work to an extent hardly calculable there has been no serious rouble from such cause.

The most interesting portion of the symposium, however, is found in the paper presented by Mr. F. B. Duncan, upon electric driving in machine-shop practice.

At the present time the question of the direct electric driving of machine tools is in a transition state, and many of the combinations in use are such as to give credit to neither electrician or tool builder. Many tool makers look upon electric driving as a sort of fad which it is to their advantage to discourage, while in other instances the electrical portion of the work has been done without a proper understanding of the mechanical requirements of the situation.

Mr. Duncan classifies the difficulties in connection with the introduction of electric driving as follows:

1. The present design of machines for belt operation necessitates new patterns for many parts before they can be electrically driven.

2. The greater first-cost as yet of motor-driven tools.

3. That the present design of many tools is not heavy enough to stand positive motor operation.

4. The large demand as yet for belt driven machines compared with that of electrically operated ones, and the reluctance of manufacturers to be the pioneers in what is as yet commercially an untrodden path.

One of the most serious of all the problems on the electrical side of the question is that of speed variation, the requirements for machine-tool driving being between greater limits than is the case in other lines of work. The two methods most applicable are the use of single voltage, which permits a variation electrically of about 100 per cent. above the normal, and multi-voltage. With the former some mechanical means, such as gearing, must be used to extend the speed variations, but with the latter the desired speeds may be obtained by electrical methods alone.

Mr. Duncan calls attention to the fact that the modern high-duty tools steels, coming into general use, necessitate the redesigning of machine tools in order to enable them to stand the heavy stresses which increased speeds and cuts produce. If, in connection with such changes in form and proportion, the question of direct electric driving is taken into account an important advance would be secured.

The advantages of electrical driving are set forth as follows:

1. Greater output per machine, due to the positive nature of the driving; in many cases equal to fifty per cent.

2. Ability to determine by means of recording instruments centrally situated with a multi-point switch, whether tools are being kept at work in a proper manner, a graphical record of the time each machine is in operation being kept, together with its consumption of power. This will also enable the detection of tools which are in bad condition, due to abnormal friction of bearings or moving parts.

3. The flexibility of placement of machine tools to suit the passage of the work through the shop.

4. Free head room for the operation of traveling cranes, due to the absence of belts and overhead shafting.

5. Ability to shut down or start up any one machine independently of all others.

Mr. Duncan is of the opinion that the individual method of driving will obtain in smaller units until even the very smallest tools can be so obtained, and the crying need of the hour is an electro-mechanical tool establishment which will devote its entire energies to this field, and design and build a complete line of drill-presses, lathes, milling-machines, planers, boring-machines, etc., which will enable manufacturers to install a complete individual motor driven equipment.

Too often the main question which engineers ask about electric driving is the extent of economy in motive power. This, however, is a secondary matter. The main question is the general efficiency of the entire installation with reference to the amount of work turned out, and the final cost of the product should always be kept in view as the great and primary object.

When electrical driving becomes the rule and not the exception, it will be accompanied with the installation of central power generating stations, controlled by, and operated for the manufacturers of any given locality, and thus will be solved many of the problems relating to power production and distribution, smoke prevention, fuel handling, and all that is involved in the generation and use of power.

Tests of Reinforced Concrete.

Although the various methods of reinforcing the strength of concrete by imbedding reinforcements of metal has been in use for a number of years, the variety of so-called "systems" and the apparent crudity of some of them leads the observer to believe that rule-of-thumb has often prevailed in the proportioning of such structures. It is true that elaborate mathematical discussions have been published, some of them from the pens of eminent engineers, but there is little doubt that many forms of reinforced construction in cement and concrete have been, and are being, erected with little or no attempt at scientific determination of the nature and magnitude of the stresses and strains.

For these reasons the experiments of Professor W. Kendrick Hatt, made in the laboratory of Purdue University, and presented before the recent convention of the American Section of the International Association for Testing Materials, are of much interest and value, giving, as they do the data and results of actual trials, with a scientific discussion thereon.

The tests covered only beams of reinforced concrete, the scarcity of recorded data giving results indicative of the behavior of reinforced concrete under flexure, being the motive which led to the investigation. These trials included not only the tests of the beams themselves, but also determinations of the strength of the constituents, including the moduli of elasticity and strength, in tension and compression, of the broken-stone concretes; the strength of the cement in tension and compression; the elastic limit and modulus of elasticity of the iron; analysis of the sand and stone; and tests of the adhesion between the iron and the concrete.

For the details of these and of all the tests the reader must be referred to the original paper. It is sufficient to state here that the concrete was made with a good quality of Portland cement and with broken limestone, 75 per cent. of which was retained on a ¼-inch sieve and all of which passed through a 1-inch sieve. The concrete was mixed with all the care which can be given in a technical laboratory, and there is no doubt that the results are fully as good as could be expected in practical work.

The beams were 8 inches square, and 80 inches between supports, and the tests were made at periods of 6 to 30 days after the mixing of the concrete. The reinforcement consisted of imbedded iron rods of 7/16 and ⅝ inch in diameter, imbedded in the concrete beams at 1-inch and 2-inches from the bottom. In order that comparative results might be obtained, experiments were made upon concrete beams in which no iron rods were imbedded, and thus the effect of the reinforcement was determined. In making the tests a single kind of loading was used, the load being applied in the middle, and the deflections read from both sides of the beams with micrometers. These tests were continued until rupture took place, careful observations being made to discover the point of origination of cracks.

Without going into details, the first thing to be noted is the marked increase in the strength of the beams, caused by the use of the reinforcement of the iron rods. Thus, one per cent. reinforcement, placed one inch from the bottom of the beam, increases the strength of a concrete beam from 2,300 to 7,200 pounds, and increases the flexibility from 0.01 to 0.14 inch center deflection. If the 1 per cent. reinforcement is placed 2 inches from the bottom of the beam the strength is decreased from 7,200 to 5,000 pounds, with a slight decrease in flexibility, hence the advantage of placing the reinforcement as far as practicable from the neutral axis is evident. A cinder concrete beam and a stone concrete beam, each reinforced with 2 per cent. of metal, 1 inch from the bottom face, have comparative strengths of 5,000 and 10,000 pounds respectively, and a comparative flexibility of 0.26 and 0.16 inch respectively. In the case of plain cinder and stone concrete beams, the comparative strength is 600 and 1,800 pounds, and the comparative flexibility is 0.023 and 0.016 inch respectively. It thus appears that reinforcing a beam with even 1 per cent. of steel gives it 10 times its former flexibility and more than 3 times its former strength.

An important fact in connection with the use of reinforced concrete is the increased extensibility which is given to the concrete in tension. Thus, while the plain concrete broke with an average extension of 1:7000, the reinforced concrete broke with an average extension of 1:1140. This fact has been determined by M. Considère, who says that plain concrete breaks in tension with an elongation of one part in 10,000, while reinforced concrete breaks with an elongation of 1 in 1,000. The effect of reinforcement probably is to distribute the maximum elongation over the entire length of the bar, whereas, in case of the plain concrete, the maximum elongation is confined to the fractured section.

The results of the tests was to show that the yield point of the metal was attained before the crushing point of the concrete was reached. In none of the stone concrete beams was there any indication that the compressive strength of the concrete was reached at the load at which the reinforcement failed. Evidently the two strengths, tensile and compressive were not equalized in the beams under test. If steel reinforcement had been used the compressional strength of the concrete might have been realized. The union of the metal and the concrete was sufficient, since, in no case, did the reinforcement pull out from the surrounding concrete. At the same time the cement was amply strong, since the stones themselves were broken in the ruptured section of the beam.

Professor Hatt's paper is accompanied with numerous diagrams, showing the details of the tests, including the deflections under various loadings until purture took place. From the results of the tests he has deduced formulas for the proportioning of reinforced concrete beams, and the whole discussion of the trials is such as to place the results in the best available form for practical use.

Main-Line Electric Traction.

Among the valuable papers presented at the Great Barrington convention of the American Institute of Electrical Engineers we may note one by Mr. Bion J. Arnold upon the application of electric traction to main-line railways.

Ever since the disasters in the tunnel of the New York Central Railroad entering New York city it has been realized that something better than steam locomotives must be used in the tunnel, and with a view of determining the practicability of employing electric traction a number of experiments have been made to secure data as to the amount and distribution of power required for the service.

In order to obtain the necessary data Mr. Arnold conducted a series of tests upon different trains, using for the purpose the dynamometer test car owned by the Illinois Central Railway Company and the University of Illinois. This car, the construction of which is fully described in the paper, is provided with a draw-bar connected to the rod of a piston working in a cylinder filled with oil, the pressure upon the oil being transmitted to a recording device. The pressure at every moment is recorded upon a strip of paper moved by gearing upon the car axle, the time record also being marked upon the same strip by pens operated by clockwork.

Records were made by this apparatus upon every variety of train entering the Grand Central Station, and selected diagrams are given with the paper in order to show the comprehensive character of the information obtained.

The diagrams obtained from the total train service of the railways under consideration were combined and worked up very completely, with the result of demonstrating that the total annual input required for propulsion alone would be 15,768,000 kilowatt-hours. The total number of ton-miles per year for the same service was computed to be 250,285.710 ton-miles, and the ratio of these two quantities gives as the electrical energy required to haul a ton over one mile on this division, 63 watt-hours per ton-mile.

So far as the best available system for use upon this portion of railway is concerned, Mr. Arnold says:

"While it is the writer's opinion that the alternating current railway motor will yet prove to be the most efficient, all things considered, it has not yet, in his opinion demonstrated its ability to start under load as efficiently, or to accelerate a train as rapidly as the direct-current motor. The line under consideration is short, the trains numerous, and rapid acceleration desirable, all of which are considerations favorable to the direct-current motor.

"Furthermore, direct-current motors with their necessary auxiliaries have become fairly well standardized and it is the only class of electric railway apparatus available from the manufacturers of the United States without involving experimental work and large development expense.

"In view of these facts and the probable necessity for rapid construction, the writer refrained from advising anything of an experimental nature, and therefore recommended the direct-current system in combination with the third-rail for the main line, and overhead construction for the yards, all of which have demonstrated fully their ability to meet the conditions imposed by railway operation so far as motive power is concerned, although there has not yet been an electric installation on any existing terminal that is as complex, or into which anywhere near the number of heavy trains enter as on this section of road."

The nature and extent of the investigations conducted by Mr. Arnold may be taken as an indication of the serious consideration which the railway company is giving to the subject of the electric equipment of the terminal section of its lines in New York City.

So far as operating expenses are concerned, a comparison is given between steam and electric traction which is interesting. Thus the operating expenses for steam locomotives is given as 23.05 cents per locomotive mile, and the fixed charges as 1.13 cents. For electric traction the operating expenses are lower, being but 15.80 cents per locomotive mile, but the fixed charges are necessarily higher, reaching 7.83 cents, or a total of 23.63 cents per locomotive mile.

There thus appears a slight advantage in favor of electric traction, but as the costs for electricity are estimated, it is possible that slight variations would appear in practice. At the same time it must be remembered that it is not the question of operating cost which has led to the consideration of the subject, but rather the elimination of the dangers of steam traction in a crowded tunnel. A single disaster may pile up damage suits almost sufficient to pay for the installation of an electric plant, apart from the indirect injury inflicted upon a railway, so that the question really is, not whether the road can afford to make the change, but rather whether it can afford not to do it.

The Driving of Alternators.

We have already reviewed the subject of the parallel driving of alternating electric generators, considered mainly from the point of view of the electrician, and now we have the valuable paper of Mr. Henry E. Longwell, presented before the Engine Builders' Association, and dealing with the question from the position of the designer and builder of the steam engine.

Mr. Longwell very correctly says that the electrician starts out with the requirement that the alternators shall run at the same speed, thus throwing the whole burden upon the engine builder, and taking the case of the reciprocating engine, he shows that the speed cannot be absolutely uniform. It will vary during a single revolution, owing to the irregularity of the tangential effort on the crank pin, and it will vary from revolution to revolution because automatic governing is only a series of approximations above and below the mean speed. This is the actual condition we have to meet and it is time wasted to discuss ideal and impossible conditions. Admitting that these irregularities, which must exist to a greater or less degree, create certain electrical disturbances in the generators, it must be conceded that these electrical disturbances are communicated from one generator to another, and that there is a resultant reaction back on the engine. It is not enough for the engine designer to merely consider the action of his engine as an independent unit; it is equally necessary that he should have knowledge of the character of the reaction from the generator.

An examination of the conditions existing when two engines are arranged to drive two alternators in parallel shows at once that the usual arrangement of governing mechanism is unsuited to the service. If, by reason of small speed variations, which we might as well frankly admit are unavoidable, one generator advances ever so little ahead of the other, it takes more load. To restore equilibrium we ought to be able to reduce the steam supply to the engine that is leading and to increase the supply to the engine that is lagging behind. Now the natural tendency of the governor is just the opposite, i. e., to increase the steam supply to the heavily loaded engine and make it capable of taking more load, and to decrease the steam supply to the underloaded engine and make it less capable of taking its share of load. Furthermore the nearer perfect the governor is as regards the performance of its natural duty, the more promptly and vigorously it does the right things at the wrong time.

Discussing the synchronizing action of the two alternators, Mr. Longwell shows that, so far from being an aid to parallel running, it is really an impediment. That some synchronizing force is necessary he is prepared to admit, but he asserts, decidedly, that in every practical case the effect of the synchronizing force of the alternators is to increase the irregularity of the angular speed of the engine, instead of to diminish it.

The correctness of this position is shown by plotting the forces graphically, and constructing the action of the synchronizinz force in the diagrams, when it becomes clear that this latter force acts in unison with the crank-pin force, and thus increases the inequalities, instead of neutralizing them.

Mr. Longwell's efforts are mainly in the direction of impressing upon the electrical engineers the fact that the electrical and dynamic features in the case are so interrelated that it is essential that they should work heartily together in the solution of the problem.

The whole matter is one of compromise. Let it be freely admitted that the irregularities in the action of the engine, do set up electrical disturbances. The reciprocating engine will always have an irregularity in angular speed and consequently electrical disturbances are inevitable. The engine builder can control the amount of this irregularity to a certain extent, but he is barred by constructional and commercial limits from reaching absolute perfection.

On the other hand, the electrical disturbances react on the engine augmenting the inherent irregularities in the latter, and the intensity of this reaction is within certain limits under the control of the electrical engineer.

It is therefore only when the engine builder and the electrical engineer each recognize the limits beyond which the other cannot go, and each endeavors honestly to make the task of the other as easy as possible, with due regard to the commercial excellence of the direct connected unit as a whole, that we may hope that the parallel operation of direct connected alternators will cease to be a subject for discussion.

Electrical Education.

We have discussed elsewhere in this issue the general subject of engineering education, especially in connection with specialization and post-graduate studies, and in the same connection we cannot do better than to call attention to some passages in the brilliant presidential address of Mr. Charles Proteus Steinmetz, delivered at the recent convention of the American Institute of Electric l Engineers.

After discussing the modifications and transformations which have recently been made in scientific notions concerning observed phenomena, Mr. Steinmetz shows that there is a certain danger to further progress by reason of the disposition to replace facts by theories more or less adequately representing the facts, and indicates the good work which can be done in destructive criticism by the younger generation, which, after leaving college with all the theoretical armament required, is not yet handicapped by personal relations with the men whose names are identified with the ruling theories.

"All future progress in science and engineering depends upon the young generation, and to insure an unbroken advance it is of preeminent importance that the coming generation enters the field properly fitted out for the work.

"Here the outlook appears to me by no means entirely encouraging.

"It is not the object of the college or university to turn out full-fledged engineers who can handle any engineering problem of any magnitude. Heretofore the available time is altogether too short, and especially a very great deal of practical experience is required, which is not available to the educational institution. It is not necessary, either, and the college graduate is not expected to take immediate charge of engineering works of great magnitude. All the educational institution can do and should do is to fit the student so to take up the practical work as efficiently as possible, and that is to give him *a thorough understanding of the fundamental principles of electrical engineering and allied sciences,* and *a good knowledge of the methods* of dealing with engineering problems.

"The average college course at present does not do this.

"One of the reasons of the inefficiency of the present college course is the competition between colleges. By trying to teach more than other colleges, gradually the quantity of material taught by our colleges has increased so that it is not no longer possible to give a thorough understanding. Memorizing takes the place of understanding. Memorizing, however, is an entirely useless waste of energy, since anything that is not perfectly understood, but merely memorized, will be forgotten in a short time if not continuously applied, and if continuously applied, it would be remembered anyway. If of the amount of material in electrical engineering as well as other branches which the educational institution of to-day attempts to teach, one-half or more would be dropped altogether, but the rest taught so as to be fully understood, with special reference to general principles and methods, the product of the institution would be far superior and more successful in practical life. To be dropped, then, are all formulæ, rules, etc., beyond the most simple ones, of the scope of the multiplication table, etc. When needed, formulæ can be derived from the fundamental principles or looked up in the literature, and their memorizing is a mere waste of valuable time, useless since the memory cannot retain them if the understanding cannot reproduce them from their premises. This, for instance, applies to the various formulæ of electromagnetic induction, the equations of the transformer and other apparatus, and theoretical investigations in general."

In common with many practical men of scientific training, Mr. Steinmetz has little or no use for the examination system as a method of determining the knowledge which has really been assimilated by the student. The examination system is not only objectionable in itself, but its use involves the employment of radically defective methods of teaching.

"One of the objectionable features of the instruction of most colleges is the step by step method. One subject is taken up, by application of sufficient time and energy pushed through, and then, after passing an examination, dropped to take up another subject. It is true that by steady application to one subject a great deal can be learned, and so splendid results derived in the examination papers, but all that is learned in this manner is forgotten just as rapidly. To understand a matter thoroughly, so as really to have a lasting benefit therefrom, and not only make a good showing in examination papers, requires several years familiarity therewith. Any subject, therefore, that is not kept up during the whole college course might just as well be dropped altogether and the time spent therein saved."

The much vexed question of the study of the English language and allied branches is dealt with plainly. It is important that the student should know how to express himself in good clear English, but the florid style of the newspaper writer is not wanted. In like manner logic should be taught, not by the mediaeval methods of the schoolmen, but by a scientist, and illustrated by examples in modern scientific investigation and not by the ancient and threadbare illustrations usually employed. Faraday's researches are given as an excellent example of clear logic and plain English, and none better could have been chosen.

"The combination of text book and home work offers a splendid means for incompetent instructors to make an elegant showing in the examination papers and turn out a very inferior grade of men, men who sometimes do not even know what real understanding means. Free lectures on subjects which the instructor himself thoroughly understands (which is by no means always the case now) make it possible to direct the course so that the student's understanding follows the course, and in this case home work becomes superfluous, excepting in connection with the laboratory. Reviewing the lectures and filling out the gaps to absence, etc., appears to be the only legitimate requirement on the student's time outside of the lecture room.

"The present method of examination, which consists in expecting the student to answer ten question or so within a few hours is faulty. It shows what the student has memorized, but not how far he understands it. Furthermore, the brilliant student who usually answers nine out of ten questions correctly, and would have answered the last if he had not made a slight mistake, displaced a decimal point or so, in practical life may be utterly useless, since while doing very rapid work his work is not reliable, while a slow man who can rely absolutely on the correctness of his work will be very successful in practice, while hardly passing a satisfactory examination."

THE ENGINEERING INDEX

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The following pages form a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world,—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

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(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

We supply the articles themselves, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

CIVIL ENGINEERING

BRIDGES.

Foundations.

See Civil Engineering, Construction.

India.

Two Indian Bridges. Describes the single-track, meter-gauge Eastern Bengal State Railway bridge over the Teesta River at Kaunia, India, and the Ehegaon viaduct, Thull Gaut, of the Great Indian Peninsular Ry. 1700 w. Eng Rec—June 21, 1902. No. 48857.

Railroad Bridges.

Bridge Over the Mississippi River at Thebes, Ill. Illustrated detailed description of a double-track railroad bridge soon to be erected. 2000 w. Ry Age—June 20, 1902. No. 49015.

New York, Chicago and St. Louis R. R. Bridges. Albert J. Himes. Illustrated detailed description. 3800 w. Trans Assn of Civ Engrs of Cornell Univ—1902. No. 48595 F.

Reconstruction.

Reinforcing a Railroad Bridge in Service. Illustrated description of the method by which five 139-ft. single-track spans were reinforced, without interfering with traffic, by providing new and independent members to carry the excess of load due to heavy traffic. 1200 w. Eng Rec—June 14, 1902. No. 48787.

We supply copies of these articles. See page 809.

Reinforced Concrete.

Bridge and Concrete Steel Construction. Edwin Thacher. Lecture before the College of Civil Engineering. An account of bridge building from the writer's experience, giving descriptions of systems used and much information of interest. 6800 w. Trans Assn of Civ Engrs of Cornell Univ—1902. No. 48591 F.

Removal.

Moving a Railroad Bridge. Describes the moving of the Raritan River drawbridge, at New Brunswick, N. J. The bridge is double-tracked, with five fixed spans and one draw span. Ill. 500 w. R R Gaz—June 6, 1902. No. 48609.

Moving the Fort Wayne Bridge. Reports details and operations of a work of interest by which a double-track five-span structure is being built in the position of an old bridge which has been moved bodily at one operation to a position along side so as to maintain traffic until the new bridge is completed. 2200 w. Eng Rec—May 31, 1902. No. 48526.

Steel.

An Inquiry into the Bessemer Steel of Our Railway Bridges (Onderzoek van het Bessemerstaal in onze Spoorwegbruggen). J. Schroeder van der Kolk. Data and results of tests of steel used in the principal railway bridges of Holland. 20000 w. 2 plates. Tidschr vh Kljk Inst van Ing —May 26, 1902. No. 48971 E + F.

Suspension.

Method of Stiffening an Inclined Suspension Bridge. From a paper by T. H. Rawson and George H. Broome, presented to the Inst. of Civ. Engrs. Describes the design and erection of an interesting bridge, built as cheaply as possible, consistent with requisite strength. Ill. 1500 w. Ry & Engng Rev—June 7, 1902. No. 48709.

Trolley Bridge.

New Bridge for the Buffalo, Springville & Cattaraugus Ry. Describes the design for what will be the longest and highest trolley bridge in the United States. Plan, elevation and section are given. 700 w. St. Ry Rev—June 20, 1902. No. 49022 C.

Viaduct.

The New Kinzua Viaduct (Die Neue Kinzua Brücke). F. Müller von der Werra. A description of the new Kinzua viaduct, being mainly a discussion of the paper of the engineer, Mr. C. R. Grimm, in the Trans. Am. Soc. C. E. 3500 w. Zeitschr d Ver Deutscher Ing—May 24, 1902. No. 48914 D.

CANALS, RIVERS AND HARBORS.

Banks.

A Method of Bank Construction by Dumping from Movable Trestles. Joseph Wright. Brief illustrated description of a method recently used on the Illinois & Mississippi Canal. 600 w. Eng News—June 12, 1902. No. 48715.

Revetment Work on the Missouri River; Chicago & Alton Ry. W. R. DeWitt. Illustrated description of the design and construction of this work, carried out in accordance with the plan of the U. S. Government with all improvements. 2300 w. Eng News—June 5, 1902. No. 48702.

Breakwaters.

Concrete Breakwater Construction at Buffalo, New York. T. W. Symons. Illustrated detailed description of breakwater construction of the Great Lakes, especially the replacing of the wooden superstructure by concrete, and reasons why it cannot as well be so built at first. 7800 w. Eng News—May 29, 1902. No. 48603.

Brest.

The Commercial Port of Brest and its Immediate Future (Le Port Marchand de Brest et son Avenir Prochain). E. Duchesne. Showing the superiority of Brest over other French ports, and predicting its growth. 6000 w. Mem Soc Ing Civ de France—April, 1902. No. 48909 G.

Canal Hauling.

See Electrical Engineering, Power Applications.

Canal Navigation.

Some Phases of Canal Navigation. Editorial review of paper by Elnathan Sweet, published in the "Transactions" of the Am. Soc. of Civ. Engrs., under the title "Some Important Phases of Canal Navigation." 1600 w. Eng Rec—June 7, 1902. No. 48680.

Danube-Moldau.

The Danube-Moldau Canal Project (Die Donau-Moldau Canal Projecte). Rudolf Ritter v. Gunesch. A review of the plan to connect the upper waters of the Danube and Moldau and open a continuous waterway from the Black Sea to the North Sea. 4000 w. 2 plates. Zeitschr d Oesterr Ing u Arch Ver—May 16, 1902. No. 48930 B.

Dredges.

Cutting Machinery for Suction Dredgers. Ilustrates and describes cutting machinery designed for breaking up beds of clay, or of indurated sand, into lumps small enough to pass through the pipes and pump. 1500 w. Engng—May 23, 1902. No. 48461 A.

New French Dredges. From *La Nature*. Illustrated description of dredges which embrace the most recent improvements, and are moved under their own power. 1000 w. Sci Am Sup—June 7, 1902. No. 48621.

Flow.

Collection of Data Regarding Stream Flow. R. H. Tingley. On the need of more accurate data and methods that may be used to obtain the desired information. 1400 w. Munic Engng—June, 1902. No. 48432 C.

Measurement of the Flow of Water in the Sudbury and Cochituate Aqueducts. Walter W. Patch. Describes the method adopted for computing the flow, which is a combination of current-meter and flow formula. 2800 w. Eng News—June 12, 1902. No. 48716.

See Mechanical Engineering, Hydraulics.

Isthmian Canal.

Notes on the Geology of the Isthmus of Panama. Henry W. Edwards. Brief description of the region, of special interest at the present time in view of the canal project. 1200 w. Eng & Min Jour—June 21, 1902. No. 49026.

Problems and Methods of the Isthmian Canal Surveys. Boyd Ehle. Gives outlines of the various routes, describing the survey work. Map. 4500 w. Trans Assn of Civ Engrs of Cornell Univ—1902. No. 48596 F.

The Panama Route for a Ship Canal. Prof. William H. Burr. A complete review of the history of this route, and all matters relating to it. Ill. 7800 w. Pop Sci M—July, 1902. No. 49061 C.

Loire.

The Navigable Loire (La Loire Navigable). R. Philippe. A historical and technical account of the development of the navigation of the Loire, including the regulation of the stream and the commercial value of the traffic. Three articles. 9000 w. Génie Civil—May 24, 31, June 7, 1902. No. 48901 each D.

Sault Ste. Marie.

The Development of the Sault Ste. Marie Canal. William Gilbert Irwin. A brief review of the history and development. 2000 w. Sci Am—June 21, 1902. No. 49010.

Waterways.

The Influence of Waterways on Railway Transportation. S. A. Thompson. Showing the manner in which waterways act to promote the prosperity of competing railways. 3000 w. Engineering Magazine—July, 1902. No. 48988 B.

CONSTRUCTION.

Acoustics.

Acoustics of Halls of Audiences. C. H. Blackall. Discusses the effect of design giving results derived from personal experience. 3400 w. Technograph, No. 16—1901-2. No. 48446 D.

Beams.

Bending Moments on Beams Partially or Wholly Submerged. Fred. W. Honens. Gives the solutions for the maximum bending moments on beams which are inclined to the horizontal plane and which are either wholly or partly submerged. 1500 w. Technograph, No. 16—1901-2. No. 48452 D.

Building Details.

Extension of the Corn Exchange Bank Building, New York. Illustrated description of the enlargement by the addition of a steel cage extension. 2800 w. Eng Rec—June 14, 1902. No. 48791.

Setting the Heavy Granite Columns on the Hall of Records. An illustrated account of the transportation and setting of 40-ton columns. 600 w. Sci Am—June 7, 1902. No. 48615.

The Twenty-third Street Y. M. C. A. Building, New York. Illustrated description of unusual features in a ten-story building, which will contain an auditorium, gymnasium, swimming tank and running track, and so require heavy construction. 3500 w. Eng Rec—May 31, 1902. No. 48528.

Contracts.

The Engineer in Construction Contracts. John C. Wait. Indicates some defects and weaknesses in contracts, the correction of which will avert much unpleasantness and labor. 8500 w. Trans Assn of Civ Engrs of Cornell Univ—1902. No. 48598 F.

Costs.

Structural Costs. The present article is introductory and shows that designs are often made by men ignorant of practical work, of the costs of different classes of work, and the disadvantages that result. The subject is considered from the British point of view. 2500 w. Engr, Lond—May 23, 1902. Serial. 1st part. No. 48466 A.

Floors.

Fire Tests of Fireproof Floors by the New York Building Department. Gives the construction, with illustrations, of three new forms of fireproof floors which have been submitted with successful results to the standard fire and water tests. 1800 w. Eng News—May 29, 1902. No. 48606.

Test of a Floor System. Digest from the official report of a test made by the Dept. of Bldgs., Borough of Manhattan, of the Lockwoven Metal Concrete Floor Arch. Ill. 1200 w. Ins Engng—May, 1902. No. 48430 C.

Foundations.

Bridge Foundation Work on the Great Northern Railway of Canada. Extract from paper by J. M. Shanly, before the

Canadian Soc. of Civ. Engrs. Describes features of interest in the work. 1800 w. Ry & Engng Rev—May 31, 1902. No. 48505.

Sinking the Caissons for East River Bridge No. 3. Illustrates and describes the sinking of the caissons which form the foundations of the towers for this new bridge at New York. 1900 w. Sci Am—May 31, 1902. No. 48534.

The Pneumatic Foundations of the Battery Place Building, New York. Illustrated description of circular and rectangular caissons sunk by pneumatic methods for foundations of 20-story office building. 2100 w. Eng Rec—June 21, 1902. No. 48855.

Roads.

Broken Stone Roads Near Polo, Illinois. Leslie A. Waterbury. Describes the roads named and discusses some of the principles of road construction. 3400 w. Technograph, No. 16—1901-2. No. 48453 D.

Steel Trackway. R. H. Gage. Describes a trackway recently completed near the Union Stock Yards, Chicago, stating the objections shown by experience. Ill. 1200 w. Technograph, No. 16—1901-2. No. 48450 D.

Skeleton Construction.

The Permanency of Steel Skeleton Construction. J. K. Freitag. An examination of Gen. William Sooy Smith's opinions, and of the causes, if any, which contribute to rapid deterioration. 4200 w. Br Build—May, 1902. No. 48496 D.

Stresses.

A Derivation of Formulas for Stresses in the Curved Bottoms of Tanks. Arthur N. Talbot. Gives derivation of formulas for stresses in the cone, sphere and ellipsoid. 1200 w. Technograph, No. 16—1901-2. No. 48455 D.

The Stresses in a Steel Water-Tower. H. J. Burt. Collects and reduces to convenient working form the formulas required in solving these stresses. 4400 w. Technograph, No. 16—1901-2. No. 48-454 D.

Tunnels.

Hook Mountain Tunnel. Wager Fisher. Illustrates and describes the difficulties overcome and the method of prosecuting the work in constructing this tunnel, which forms a part of the Jersey City Water Supply Co.'s pipe line. 3300 w. Trans Assn of Civ Engrs of Cornell Univ—1902. No. 48594 F.

Simplon Tunnel (Simplon Tunnel). An abstract of the fourteenth quarterly report, showing the progress of the work on the Simplon tunnel up to the end of March, 1902. Nearly 58 per cent. of the boring has been accomplished. 1800 w. Schweizerische Bauzeitung—May 17, 1902. No. 48953 B.

MATERIALS.

Asphalt.

The Asphalt and Bituminous Rock Deposits of the United States. Information from a very full report made by George H. Eldridge, and forming a part of the Annual Report of the U. S. Geol. Survey. 700 w. Eng News—June 5. 1902. No. 48703.

Cement.

Portland Cement. Richard K. Meade. Considers its constitution, properties and manufacture, and the regions where the different materials are found. 3000 w. Mines & Min—June, 1902. No. 48668 C.

Cement Plant.

A Visit to the Plant of the Edison Portland Cement Co., at Stewartsville, N. J. Plan of the works with description. 1800 w. Eng News—May 29, 1902. No. 48604.

Columns.

Practical Strength of Columns or Struts of Wrought Iron and Mild Steel. J. M. Moncrieff. Calls attention to the results of experiments on wrought iron and mild steel and applies to them the final formula deduced in an earlier paper, without dealing with the principles upon which it is based. 3800 w. Engng—June 6, 1902. No. 48772 A.

Paving Material.

Interesting Tests of Pavements in Baltimore. Statement concerning a test of the relative merits of the various materials used, and of the value of old cobble-stones relaid as a sub-base. 1600 w. Brick—June, 1902. No. 48697.

Reinforced Concrete.

Applications of the Hennebique System (Toepassing van Hennebique Constructies). H. F. Beijerman, H. van Oordt, and C. E. W. van Panhuys. An official report upon the Hennebique system of reinforced concrete, showing its applicability to public works. 10000 w. 7 plates. Tidschr v h Kljk Inst van Ing—May 26, 1902. No. 48970 E+F.

The Computations for Reinforced Concrete (Lois de Déformation, Principles de Calcul, et Regles d'Emploi Scientifiques du Béton Armé). M. Rabut. A summary of the laws deduced from experiments over a period of 5 years by M. Hennebique. 1500 w. Comptes Rendus—April 21, 1902. No. 48964 D.

See Also Civil Engineering, Bridges.

Sewer Pipe.

The Strength of Sewer Pipe. Letter from Prof. W. K. Hatt, in reply to an inquiry concerning the strength of sewer pipe and the proper methods of testing. Ill. 1700 w. Brick—June, 1902. No. 48698.

Steel.

See Civil Engineering, Bridges.

Wood Preservation.

Does It Pay To Creosote Wooden Poles for Electric Line Work? W. E. Moore. Read before the Nat. Elec. Lgt. Assn. Describes the treatment given the poles, giving the approximate cost, and the result. 1600 w. Elec Rev, N. Y—May 31, 1902. No. 48540.

MUNICIPAL.

Fire Apparatus.

Dublin's New Central Station and Fire Escape. Concerning the new fire station to cost $125,000, and the improved fire appliances. Ill. 700 w. Sci Am Sup—June 7, 1902. No. 48623.

Pavements.

A Modern Street. Dr. S. F. Peckham. An illustrated article discussing the construction of asphalt pavements, the materials, proper foundations, etc. 3000 w. Pop Sci M—July, 1902. No. 49059 C.

Bituminous Macadam Pavements. William H. Burns. Discusses the principles on which this pavement is built, its construction, treatment, etc. 2700 w. Jour Assn of Engng Soc's—May, 1902. No. 48895 C.

Refuse.

Refuse Destruction: Its Sanitary and Its Steam Raising Aspects. Frank Broadbent. The present article discusses mainly the dangers arising from the improper disposition of refuse. 2000 w. Elec Rev, Lond—May 30 1902. Serial. 1st part. No. 48644 A.

Sanitation.

The Sanitary Measures to be Adopted After Floods. George A. Soper. Extracted from the Am. Jour. of Med. Sci. Suggestions for safeguarding the health and prevention of epidemic diseases. 2800 w. Sci Am Sup—June 14, 1902. No. 48758.

Sewage.

Experiments at Worcester, Mass., on Treating Acid Iron Sewage in a Closed Septic Tank. Leonard P. Kinnicutt and Harrison P. Eddy. Report of careful experimental study, giving much information on the septic tank. Also editorial. 8800 w. Eng News—May 29, 1902. No. 48607.

The Mitchell System of Sewage Disposal. Describes works involving sedimentation followed by rapid filtration combined with aeration. 800 w. Eng Rec—June 14, 1902. No. 48790.

The Purification of Sewage. W. S. Shields. Read before the Illinois Soc. of Civ. Engrs. & Surv's. Information from the writer's experience concerning septic tanks as a means for the purification of sewage. 2500 w. Munic Engng—June, 1902. No. 48434 C.

Treatment of Sewage in a Large Open Septic Tank at Worcester, Mass. Information regarding the experience with this tank as given in Mr. Harrison P. Eddy's report for the year ending Nov. 30, 1901. 900 w. Eng News—May 29, 1902. No. 48605.

Sewers.

Heavv Sewer Construction in Concrete. E. J. McCaustland. Illustrated description of work carried out as a part of the preliminary construction made necessary by the location of the Chicago Clearing Yards. 5000 w. Trans Assn of Civ Engrs of Cornell Univ—1902. No. 48593 F.

Notes on New Orleans Drainage. I. W. McConnell. An illustrated account of this work which is nearing completion. 2000 w. Trans Assn of Civ Engrs of Cornell Univ—1902. No. 48597 F.

Relief Sewer Extension in Brooklyn. An illustrated description of difficult sewer reconstruction. 800 w. Eng Rec—May 31, 1902. No. 48527.

WATER SUPPLY.

California.

Relation of Rainfall to Run Off in California. J. B. Lippincott and S. G. Bennett. Diagrams, tables and data resulting from a study of these watersheds. 2000 w. Eng News—June 5, 1902. No. 48706.

Cast-Iron Pipe.

Preliminary Report of the Committee on Standard Specifications for Cast-Iron Pipe, with Discussions. Report presented Dec. 11,1901, with discussions received up to May 1, 1902. 22000 w. Jour N E Water Wks Assn—June, 1902. No. 48584 F.

Chicago.

Old and New Water-Works of Chicago. An illustrated account of the water system which has cost nearly $36,000,000; the great pumping plants, tunnels and cribs, etc. Reviews the history and development. 4000 w. Fire & Water—June 7, 1902. No. 48701.

Cleaning Wells.

Cleaning Out Water Wells. A. J. Bowie, Jr. Describes the construction of various wells, the troubles encountered and methods of cleaning. Ill. 2800 w. Jour of Elec—May, 1902. No. 48726.

Coloring Matter.

Investigations in Regard to Coloring Matter in Water and Methods of Removal. Discussion by Desmond FitzGerald, R. S. Weston and others. 3000 w. Jour N E Water Wks Assn—June, 1902. No. 48586 F.

Failures.

A Classified Review of Dam and Reservoir Failures in the United States. William R. Hill. Abstract of presidential address at the Chicago Convention of the Am. W. Wks. Assn. Calls attention to faulty construction resulting in disaster. 4000 w. Eng News—June 19, 1902. No. 49030.

Filtration.

Filtration at Lorain. O. H. Jewell. A report on the new iron process, with illustrated description of the plant. 3400 w. Fire & Water—June 7, 1902. No. 48700.

Fire Service.

The Philadelphia High-Pressure Fire Service. Describes a system of mains filled by fire-boats at three points along the river front. 600 w. Eng Rec—June 14, 1902. No. 48789.

Ground Water.

Ground Water (Grondwater). J. v. D. Breggen. An examination of the formation of subterranean water strata, and the methods of reaching them for water supply. 3000 w. De Ingenieur—May 3, 1902. No. 48969 D.

Hamburg.

The Development of the Hamburg Water Works (Das Hamburger Wasserwerk und die Entwicklung seiner Maschinenanlagen). R. Schröder. A fully illustrated description of the plant, including high and low-pressure pumping stations, filter beds, etc. Serial. Part I. 5000 w. Zeitschr d Ver Deutscher Ing—May 31, 1902. No. 48915 D.

Hanover.

The Water Supply and Sewerage of the City of Hanover (Die Wasserversorgung und Kanalisation der Stadt Hannover). A general account of the installation, from the report of chief engineer Bock. 2500 w. Gesundheits-Ingenieur—May 31, 1902. No. 48935 B.

Irrigation.

New Irrigation Works and Methods in Colorado. H. A. Crafts. Describes extensive works for the storage of flood waters and for the interchange of water between different canal owners. 2900 w. Eng Rec—June 21, 1902. No. 48854.

Recent Developments in Punjab Irrigation. Sidney Preston. Explains the details of one of the latest schemes for the irrigation and colonization of a large area of Crown land, which promises to be one of the most productive tracts in the country, though formerly a waterless waste. Also discussion. 10000 w. Jour Soc of Arts—May 30, 1902. No. 48636 A.

Reservoirs.

The Earth Work of the Wachusett Reservoir. Robert M. Pratt. Describes the work as carried out on this reservoir which will furnish water for the city of Boston. 1300 w. Munic Engng—June, 1902. No. 48433 C.

Turbidity.

Standard Methods of Determining Turbidity and Color in Water. Directions issued by the U. S. Geological Survey and compiled by Allen Hazen and G. C. Whipple. 3700 w. Eng Rec—June 14, 1902. No. 48792.

Water-Softening.

The Municipal Water-Softening Plant at Winnipeg. Describes a modified Clark system of softening at a plant furnishing 1,500,000 gallons daily. 1500 w. Eng Rec—June 14, 1902. No. 48788.

Water Works.

The Marlborough Water Works. George A. Stacy. Illustrates and describes the construction of these works in a Massachusetts town.ship. 3700 w. Jour N E Water Wks Assn—June, 1902. No. 48585 F.

MISCELLANY.

Address.

The Engineer of the Twentieth Century. Robert Moore. Presidential address before the Am. Soc. of Civ. Engrs. On the relation between engineering and education in the new century. 3300 w. R R Gaz—June 6, 1902. No. 48613.

China.

Up-to-date Chinese Engineering. L. F. Bellinger. Photographs taken by Prof. G. D. Brill, with brief descriptions. 1700 w. Eng News—June 19, 1902. No. 49027.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cables.

Air-Spaced Cables: Their Treatment and Use. G. E. Fletcher. Read at Manchester meeting of the Inst. of Elec. Engrs. Gives the writer's experience in laying down and maintaining this form of insulated conductor for telegraphic and telephonic lines, which he regards with favor. Ill. 3000 w. Prac Engr—May 23. 1902. No. 48480 A.

Coherers.

The Coherer. William A. Del Mar. A brief review of the historv and theory and an illustrated description of how to make a modern coherer. 2300 w. Sci Am Sup—June 21, 1902. No. 49011.

Competition.

The Magnitude of Telephone Competition. Fred de Land. Gives statistics of the Bell Telephone showing what a powerful competitor the Independents have to meet. 2400 w. Elec Rev, N. Y—June 21, 1902. No. 49009.

Electric Photography.

An Apparatus for Long-Distance Electric Photography (Ueber einen Apparat zur Herstellung von Elektrischen Fernphotographien). A. Korn. Giving the results of the experimental transmission of photographic images. 1800 w. Elektrotech Zeitschr—May 22, 1902. No. 48940 B.

Exchange.

Ventilation and Heating the Twin City Telephone Exchange, St. Paul, Minn. Illustrated description of an installation where considerable attention was given to the problem of removing dust from the fresh air supply. 800 w. Eng Rec—May 31, 1902. No. 48529.

Military Service.

Electricity in the Signal Corps. Lieut.-Col. Samuel Reber. An illustrated article reviewing the applications of the telephone, telegraph and cable in military service. 4400 w. Trans Am Inst of Elec Engrs—May 28, 1902. No. 48882 D.

Submarine Cable Testing in the Signal Corps, U. S. Army. Townsend Wolcott. Describes the regular tests made in modern cable testing. 4300 w. Trans Am Inst of Elec Engrs—May 20, 1902. No. 48883 D.

The Military Cable System of the Philippines. Capt. Edgar Russel. Describes somewhat fully the laying of the cables to connect the various islands. Ill. 4000 w. Trans Am Inst of Elec Engrs—May 28, 1902. No. 48885 D.

Repeater.

The Guarini Automatic Wireless Telegraph Repeater. A. Frederick Collins. Illustrates and describes the construction of this apparatus. 2500 w. Elec Wld & Engr—May 31, 1902. No. 48602.

Space Telegraphy.

Long-Distance Wireless Telegraphy and Hertzian Waves. Edward P. Thompson. An argument tending to prove that long-distance wireless telegraphy is not operated by aerial Hertzian waves. 1800 w. Elec Wld & Engr—June 14, 1902. No. 48860.

The Braun and Siemens and Halske Wireless Telegraph System. A. Frederick Collins. Illustrates and describes Dr. Braun's invention, explaining the general points. Of interest because of a recent suit in which the Braun contentions have been sustained. 3000 w. Elec Wld & Engr—June 14, 1902. No. 48858.

Wireless Telegraphy. Brief review of the history of this discovery and the method by which messages are sent great distances without the intervention of a wire. Ill. 1300 w. Can Engr—June, 1902. No. 48633.

Wireless Telegraphy—United States Navy. Lieut. A. M. Beecher. Explains how electric waves are produced and describes the apparatus employed in wireless telegraphy. 3200 w. Trans Am Inst of Elec Engrs—May 28, 1902. No. 48888 D.

Storage Batteries.

Care of Storage Batteries in Telephone Plants. S. P. Grace. Describes the batteries used, discussing their efficiency and maintenance. 8000 w. Telephony—June 1902. No. 48564.

Telegraphy.

Rapid Telegraphy. George S. Macomber. An interesting account of the inventions for this purpose by Patrick B. Delany and of the multiplex telegraphic apparatus invented by Paul La Cour, of Copenhagen, Denmark. Ill. 2800 w. Sib Jour of Engng—May, 1902. No. 48831 C.

Telephone Lines.

Placing Telephone Lines Underground. John S. Huntoon. Illustrates and describes the work as carried out at Davenport, Iowa. 1500 w. Technograph. No. 16—1901-2. No. 48448 D.

Telephony.

Telephony. W. H. Radcliffe. The first of a series of articles, commencing with the fundamental principles and presenting in full the most advanced practice in construction, the exchange and its equipment, and recent important developments. Ill. 1400 w. Elec, N. Y—June 4, 1902. Serial. 1st part. No. 48625.

The People's Telephone and Telegraph Company's Exchange. Illustrated description of a model independent plant at Knoxville, Tenn. 2400 w. Elec Rev, N. Y—June 21, 1902. No. 49008.

The Railroad Telephone. C. A. Hammond. Discusses the advantages of the telephone in railway operation. 1600 w. R R Gaz—June 13, 1902. No. 48750.

DISTRIBUTION.

Aluminum.

Electrical Conductivity of Aluminum. W. Murray Morrison, in *Aluminum World*. Information concerning the conductivity of aluminum, and showing that under certain circumstances aluminum cables are considerably cheaper than copper. 1800 w. Am Mfr—May 29, 1902. No. 48495.

Cut Out.

The Use of the Long-Distance High-Pressure Cut-Out (Der Hochspannungs

Fernschalter und Seine Verwendung). J. Schmidt. Describing an apparatus for cutting out transformers in a distribution system, when not required. Serial. Part I. 2000 w. Elektrotech Zeitschr—June 12, 1902. No. 48949 B.

Switches.

Some Points in Switch Construction. Alf. H. Mayes. Calls attention to easily remedied faults. 700 w. Elec Rev, Lond —June 13, 1902. No. 48871 A.

ELECTRO-CHEMISTRY.

Accumulators.

Influence of Temperature on the Capacity of Accumulators. W. Hibbert. Discusses figures obtained in extensive series of experiments confirming that a rise of temperature causes a marked increase in capacity. 1100 w. Elec Rev, Lond—May 30, 1902. No. 48643 A.

The Perfect Light-Weight Storage Battery. Illustrates and describes the Perret cell, stating its desirable features. 1000 w. Sci Am Sup—May 31, 1902. No. 48538.

Carbon.

The Fusion of Carbon (Die Schmelzung der Kohle). Dr. A. Ludwig. A discussion of the efforts which have been made to effect the fusion of carbon, and the conditions which should be fulfilled. 3000 w. Zeitschr f Elektrochemie—May 8, 1902. No. 48962 G.

Electro-Chemistry.

The Development of Electro-Chemistry. R. H. Johnston. Reviews the history, considering the more important applications. 8400 w. Sch of Mines Qr—June, 1902. No. 48842 D.

Electro-Galvanizing.

Some Notes on Electro-Galvanizing. Sherard Cowper-Coles. Illustrates and describes a recently erected plant for this work, and suggests the means of securing successful work. 700 w. Elec Rev, Lond —May 23, 1902. No. 48475 A.

Ions.

The Ion Theory. F. G. Wiechmann. A brief account of this theory upon which electro-chemistry is largely based. 6000 w. Sch of Mines Qr—April, 1902. No. 48841 D.

Tin Recovery.

The Electrical Recovery of Tin from Tin-Plate Wastes (Die Elektrochemische Entzinnung der Weisblechabfälle). Dr. H. Mennicke. Discussing the practicability of recovering the tin from tinplate wastes by use of a solution of caustic soda and an electric current. Serial. Part 1. 2500 w. Zeitschr f Elektrochemie—May 22, 1902. No. 48963 G.

Transforming.

The Electro-Chemical Transformation of Alternating to Continuous Currents (Beiträge zu dem Problem der Elektrochemischem Umformung von Wechselstrom in Gleichstrom durch Aluminium Elektrolytzellen). Dr. E. König. Recording experiments upon the method of Graetz, using aluminum anodes, platinum cathodes, and an electrolyte of alum solution. 2000 w. Elektrotech Zeitschr—May 29, 1902. No. 48044 B.

ELECTRO-PHYSICS.

Alternating Currents.

How Alternating Currents Vary with the Shape of the E. M. F. Wave. Alexander Russell. Mathematical investigation showing how the shape of the current wave depends on the resistance in the circuit, and how its effective value depends on the shape of the E. M. F. wave. 1400 w. Elec Rev, Lond—May 30, 1902. No. 48647 A.

Armatures.

The Theory of Equalizing Connections on Continuous Current Armatures. Abstract of an article by Prof. E. Arnold, in the *Elektrotechnische Zeitschrift*. Mathematical discussion of the connection of the equipotential points of the armature winding. Ill. 2700 w. Elec Engr, Lond—June 13, 1902. No. 48866 A.

Electrical Discharges.

Some Experiences With Powerful Electric Discharges. John Trowbridge. Report of observations made upon a spectrum of an exceedingly powerful discharge through the ordinary vacuum tube used in the study of the spectro of gases. Also editorial note. 700 w. Elec Rev, N Y—May 31, 1902. No. 48539.

Hysteresis.

Notes on Rotary Hysteresis (Beitrag zur Kenntniss des Verhaltens der Rotirenden Hysteresis). M. Schenkel. Data and results of experiments made in the electrical laboratory of the Technical High School at Dresden. 1500 w. Elektrotech Zeitschr—May 15, 1902. No. 48937 B.

Induction.

On an Inductive Circuit with a Harmonically Varying Resistance. T. Mizuno. Mathematical investigation. 400 w. Elect'n, Lond—May 30, 1902. No. 48650 A.

Iron Testing.

A New Apparatus for Testing Iron (Vorschlag zu Einem Neuen Eisenprüfapparat). R. Richter. Describing a simple apparatus for determining the permeability of sheet iron, and its suitability for use in electrical machinery. 1500 w. Elektrotech Zeitschr—June 5, 1902. No. 48946 B.

Laboratory.

I. The National Physical Laboratory. Albert Campbell. A brief description of some of the electrical apparatus. II. Wiring for Experimental Work. W. P. Steinthal. Illustrates and describes the general scheme. 3000 w. Elec Rev, Lond—June 6, 1902. No. 48770 A.

Periodic Curves.

Lag and Lead. W. G. Rhodes. An explanation of the phase relationship between periodic curves. Mathematical. 900 w. Elec Rev, Lond—June 13, 1902. No. 48870 A.

Radiography.

On the Radio-Activity of Matter. Henri Becquerel. Facts in regard to obscure radiations which traverse opaque bodies, and other phenomena. An interesting report of experimental investigations. 4800 w. Sci Am Sup—June 7, 1902. No. 48620.

Waves.

Electric Waves and Their Effect on the Human Brain. A. Frederick Collins. An illustrated detailed account of experiments made for the purpose of establishing the nature of the relationship existing between electric storms and certain forms of nervous diseases. 2300 w. Elec Rev, Lond—May 23, 1902. No. 48474 A.

The Effect of Electric Waves on the Human Brain. D. McIntosh and J. Graham-Willmore. Experimental investigations disagreeing with the results given in an article by A. Frederick Collins, claiming that brains exhibit the "coherer effect" and drawing conclusions. 2500 w. Elec Wld & Engr—May 31, 1902. No. 48601.

GENERATING STATIONS.

Alternators.

The Determination of Alternator Characteristics. L. A. Herdt. A discussion considering, both theoretically and experimentally, the E. M. F. induction and current relations under different conditions as to load and power factor in the armatures of several types of alternating current generators, and indirect methods for obtaining the regulation of a particular machine developed and applied to those of other types. Ill. 5000 w. Trans Am Inst of Elec Engrs—June 18, 1902. No. 49053 D.

Chaudiere Falls.

Canadian Electric Light Company's Water Power Development at Chaudiere Falls. Describes this power and its development and transmission. 4200 w. Ill. Can Elec News—June, 1902. No. 48690.

Compounding.

A Method of Compounding Alternating Current Generators and Motors, Direct Current Generators, Synchronous Motor Generators and Synchronous Converters. Frank George Baum. Gives methods which, if intelligently applied, will give a system with very satisfactory regulation. 2800 w. Trans Am Inst of Elec Engrs—June 18, 1902. No. 49050 D.

Dynamos.

Designs for High-Speed and Slow-Speed Electrical Machines (Ueber den Entwurf Sehr Rasch—und Sehr Langsamlaufender Maschinen). Dr. F. Niethammer. A discussion of the principles of proportion and winding for dynamos and motors for various extreme speeds. 10000 w. Elektrotech Zeitschr—May 15, 1902. No. 48938 B.

Note on American Practice in Dynamo Design. Calls attention to points in design, and makes some comparison with British work in this field. 4000 w. Elec Engr, Lond—May 23, 1902. No. 48476 A.

The Design of Continuous Current Dynamos. Rankin Kennedy. Discusses an appropriate formula for a machine that will run efficiently and sparkless. 600 w. Elec Rev, Lond—May 30, 1902. No. 48646 A.

Helena, Montana.

The 50,000-Volt-Transmission Plant of the Missouri River Power Company. W. G. McConnon. An illustrated account of the project with description of the plant and line near Helena, Montana. 2000 w. Elec Rev, N Y—June 7, 1902. No. 48679.

Manchester.

Extension of the Manchester Corporation Electricity Works. An illustrated description of the new power station at Stuart-street, Bradford, an industrial suburb of Manchester, and its equipment. Also outlines the schemes in connection with this station. 5000 w. Elect'n, Lond—June 6, 1902. No. 48759 A.

Niagara Falls.

The New Generating Plants of the Niagara Falls Power Company. H. W. Buck. Illustrated description of the second plant of this company, now nearly completed, and its equipment. 3500 w. Trans Am Inst of Elec Engrs—June 18, 1902. No. 49043 D.

Parallel Driving.

Engine Requirements for the Parallel Operation of Alternators. E. M. Tingley. Read before the Engine Builders' Assn. of the U. S. Gives the specification of the Westinghouse Elec. & Mfg. Co., discussing it in detail. 2000 w. Elec Rev, N Y—May 31, 1902. No. 48541.

Some Notes on Synchronizing. Joseph Martin Roman. Discusses methods of indication, desirable conditions, the synchronizing circuit, etc. Ill. 2200 w. Elec Wld & Engr—June 14, 1902. No. 48859.

The Parallel Driving of Alternators (Ueber den Parallelbetrieb von Wechselstrommaschinen). E. Rosenberg. With especial reference to the use of gas engines as prime movers, and the necessary methods of speed regulation. 3 articles. 10000 w. Elektrotech Zeitschr—May 15, 22, 29, 1902. No. 48936 each B.

The Paralleling of Alternators. Abstract of a paper by Henry E. Longwell presented at the Pittsburg meeting of the Engine Builders' Assn., in which certain theories on the method of governing engines driving alternating generators are advanced. 1800 w. Eng Rec—June 14, 1902. No. 48793.

The Requirements for the Paralleling of Alternators as Viewed by the Engine Builders. H. E. Longwell. A discussion of this subject and the need of the electrical and mechanical engineers co-operating in solving the difficulties. 6600 w. Engr, U S A—June 2, 1902. No. 48624.

Polyphase Machinery.

Some Notes on Polyphase Machinery. A. C. Eborall. Read before the Manchester Sec. of the Inst. of Elec. Engrs. Discusses the construction and operation of standard types, giving full constructional details of modern plant of standard design. Ill. 8500 w. Engng—June 6, 1902. Serial. 1st part. No. 48776 A.

Quebec.

The Quebec-Jacques-Cartier Electric Company. Illustrated description of the power house and transmission line, etc. 1000 w. Can Elec News—June, 1902. No. 48689.

The Quebec Railway, Light and Power Company. Illustrated description of the hydraulic development, generators, stations, etc. 3000 w. Can Elec News—June, 1902. No. 48688.

Storage Batteries.

The Storage Battery in Small Central Stations. Describes the conditions in Milan, Mich., showing that by the installation of a storage battery a profitable twenty-four hour service was obtained. Ill. 1600 w. Central Station—June, 1902. No. 48699.

HEATING AND WELDING.

Electric Furnaces.

Electric Furnaces—Separation of Metals. Clinton Paul Townsend. Illustrated brief descriptions of various furnaces and methods. 700 w. Elec Wld & Engr—June 7, 1902. No. 48687.

LIGHTING.

Arc.

The Effect of Metallic Salts in the Electric Arc. G. W. Wilder. A quantitative study upon the effect of putting metallic salts into the core of the positive electrode and possibly to account for the large drop in potential at the electrodes. Ill. 3000 w. Wis Engr—May, 1902. No. 48587 D.

Incandescent.

Effect of Frequency on the Light of an Incandescent Lamp. H. Seaman. Extract from a thesis investigating the limits of frequency that will give good service. The object was to ascertain the variation in light from a 110 volt incandescent filament, for various frequencies, and to derive curves showing what is the lower limit of frequency for good incandescent lighting. 1100 w. Wis Engr—May, 1902. No. 48590 D.

Mercury Lamp.

The Cooper-Hewitt Mercury Lamp (Ueber die Quecksilberdampf-Lampe von P. C. Hewitt). Dr. Max v. Recklinghausen. A general description of the mercury vapor lamp, with data and results of tests. 4000 w. Elektrotech Zeitschr—June 5, 1902. No. 48947 B.

Rates.

Rates. Louis A. Ferguson. Read before the Nat. Elec. Lgt. Assn. A discussion of methods of charging. 1800 w. Elec, N Y—June 4, 1902. Serial. 1st part. No. 48626.

Reconstruction.

New Electric Lighting Plant for Ottawa, Canada. A. A. Dion. An illustrated description of the several stations as they are since the reconstruction made necessary by the destructive fire in 1900. 5600 w. Elec Wld & Engr—June 7. 1902. No. 48684.

Search Lights.

Modern Search Light Practice. Frank C. Perkins. An illustrated article describing various types of search lights. 1400 w. Marine Engng—June, 1902. No. 48556 C.

Street Lighting.

Street Lighting by Meter. T. D. Allin. A suggestion for the consideration of those buying electrical energy for street lighting. 1000 w. Jour of Elec—May, 1902. No. 48727.

MEASUREMENT.

Curves.

A New Curve Tracing Instrument. Prof. R. B. Owens. Illustrated description of an instrument for accurately tracing current curves in circuits of small resistance and inductance without appreciable altering their time constants, explaining its action and stating its advantages and uses for general laboratory work. 1300 w. Trans Am Inst of Elec Engrs—June 20, 1902. No. 49057 D.

Apparatus for Constructing Alternating-Current Curves (Apparat zur Aufnahme von Wechselstromkurven). R. Goldschmidt. Describing a simple instrument for drawing the curves of alternating currents. 1200 w. Elektrotech Zeitschr—June 5, 1902. No. 48948 B.

M. Hospitalier's Ondograph. Illustrated detailed description of an apparatus which registers the curves representing periodically and rapidly changing phenomena. 1800 w. Elec Rev, Lond—June 13, 1902. Serial. 1st part. No. 48869 A.

Notes on the Plotting of Speed-Time Curves. C. O. Mailloux. The object of the paper is to facilitate the use of speed-time curves as a "method of precision" by contributing certain notes of theoretical and practical observations bearing upon its analysis, or the study of its characteristics, and upon its synthesis, or the principles involved in plotting it. 14800 w. Trans Am Inst of Elec Engrs—June 19, 1902. No. 49047 D.

The Computation of the Characteristic Curves of Induction Motors (Berechnung der Charakteristischen Kurven des Induktionsmotors). A. Lindström. A discussion of the methods of Steinmetz and of Heyland and the development of an additional one. 1500 w. Elektrotceh Zeitschr—June 12, 1902. No. 48951 B.

Dynamometer.

An Electric Brake-Dynamometer (Ein Elektrisches Bremsdynamometer). A. Grau. Describing a brake used in the Technological Institute at Vienna. The energy is absorbed by the action of electro-magnets upon a rotating disc. 1800 w. Elektrotech Zeitschr—May 29, 1902. No. 48942 B.

Electrometer.

The Capillary Electrometer. G. J. Burch. On the insulation resistance of the capillary electrometer and the minimum quantity of electricity required to produce a visible excursion. Read before the Royal Soc. 2000 w. Elect'n, Lond—May 30, 1902. No. 48651 A.

Insulators.

The High-Voltage Testing Laboratory of the Hermsdorf-Klosterlausnitz Porcelain Works (Die Hochspannungsversuchsstation der Porzellanfabrik Hermsdorf-Klosterlausnitz). G. Ritter. Describing the methods of testing porcelain insulators for high-transmission lines. 3000 w. Elektrotech Zeitschr—May 29, 1902. No. 48-943 B.

Precision Instruments.

Notes on Modern Precision Measuring Instruments (Bemerkungen betreffend die Benutzung der Neueren Elektrischen Präcisions-Messinstrumente). W. Marek. A discussion of the calibration and use of direct-reading electrical measuring instruments. 4000 w. Elektrotech Zeitschr—May 22, 1902. No. 48939 B.

Standardization.

Report of the Committee on Standardization of the American Institute of Electrical Engineers. A revised series of recommendations on the standardization and testing of electrical apparatus. These embrace the committee's report of 1899, amended and brought up to date, and have not yet been adopted by the Institute. 6000 w. Trans Am Inst Elec Engrs—May, 1902. No. 49049 D.

Standards for Electrical Machinery and Transformers (Normalien fur Elektrische Maschinen und Transformatoren). Text of the standards proposed at the Düsseldorf meeting of the Verband Deutscher Elektrotechniker; also editorial comment. 10000 w. Elektrotech Zeitschr—June 5, 1902. No. 48945 B.

Testing Set.

A 12,000-Volt-Direct Current Testing Set. William Ambler. Illustration, with description of the apparatus recently installed in the dynamo laboratory at Sibley College. 1400 w. Sib Jour of Engng—June, 1902. No. 48834 C.

Wattmeter.

The Electrostatic Wattmeter in Commercial Measurements. Miles Walker. States the advantages of the electrostatic wattmeter, discussing the principles that underlie the design and some of its uses. Ill. 2700 w. Trans Am Inst of Elec Engrs—June 20, 1902. No. 49058 D.

POWER APPLICATIONS.

Canal Hauling.

Electrical Installation for the Soulanges Canal. Illustrates and describes the electric plant for the operation of the locks, sluices and bridges, and to light the canal throughout its entire length of about 14 miles. 2000 w. Can Elec News—June, 1902. No. 48691.

Cranes.

Electrical Wharf Cranes. Illustrated description of a set of cranes recently supplied for the Limekiln Dock, in London. 1400 w. Engr, Lond—May 23, 1902. No. 48471 A.

Haulage.

Some Notes on Electric Haulage for Mines. Discusses the plant, system, cost, locomotive haulage, etc. 2800 w. Elec Engr, Lond—June 13, 1902. No. 48868 A.

Hoisting.

Continuous-Current Motors and Apparatus for Electric Hoists (Gelijkstroommotoren en Bijbehoorende Apparaten voor Elektrisch Gedreven Hijschwerktuigen). H. Lohr. A general, illustrated discussion of the electrical equipment of cranes and other hoisting machinery. 4500 w. De Ingenieur—April 19 1902. No. 48967 D.

Induction Motors.

Some Notes on Induction Motors. H. S.

Meyer. Calls attention to points of importance in regard to asynchronous or induction motors. 2700 w. Elect'n, Lond—June 13, 1902. No. 48865 A.

Machine Driving.

Electric Driving for Mining and Workshops (Die Elektrizität im Berg und Hüttenwesen). Dr. H. Hoffmann. A review of the examples of electric driving shown at the Düsseldorf exposition. Serial. Part 1. 2500 w. Zeitschr d Ver Deutscher Ing—May 31, 1902. No. 48918 D.

Electric Equipment in Modern Machine Shop Practice. F. B. Duncan. Discusses the equipment of shops and the obstacles at present to a complete installation of electric power, indicating methods to overcome some of these obstacles. Appended is a sheet giving motor power required by a number of the standard makes of tools in general use. Brief discussion follows. 5500 w. Pro Engrs' Soc of W Penn—May, 1902. No. 48838 D.

I. The Electric Motor in Mill Work. S. S. Wales. II. Some Characteristics of Direct Current Motors. Norman Wilson Storer. Two papers somewhat connected. The first discussing applications of the electric motor, the difficulties met, etc. The second in regard to the proper selection of motors for the work required, rating of motors, etc. 5000 w. Pro Engrs' Soc of W Penn—May, 1902. No. 48836 D.

The Power Plant at the Elizabethport Shops of the Central Railroad of New Jersey. Illustrated description of an electric and compressed air station to furnish power to shops for repairing locomotives and cars. 2400 w. Eng Rec—June 21, 1902. No. 48853.

The Question of Power for Railroad Repair Shops. Paper by R. W. Stovel, read before the Ry. Club of Pittsburg, with part of the discussion, and editorial giving further information on the subject of electrical driving of machine tools and the amount of energy required for machines of different types. 5500 w. Ry & Engng Rev—June 14 1902. No. 48849.

The Use of the Electric Motor in Modern Blast Furnace Plants. Andrew Ellicott Maccoun. Considers the applications made and the advantages gained. 2000 w. Pro Engrs' Soc of W Penn—May, 1902. No. 48837 D.

Mine Hoists.

Electrically Driven Mine Hoists (Elektrisch Betriebene Hauptschacht-Fördermaschinen). C. Köttgen. Data and results of experience with electrically operated mine hoists at Karwin, in Silesia and at Thiede, in Brunswick. Serial. Part I. 5000 w. Zeitschr d Ver Deutscher Ing—May 17, 1902. No. 48925 D.

Naval Service.

Electricity in the Navy. Lieut. Harry George. Reviews the development, noting the numerous applications for lighting and power. 14700 w. Trans Am Inst of Elec Engrs—May 28, 1902. No. 48886 D.

Electricity in the Navy. Walter M. McFarland. Discusses the adaptability of alternating current apparatus to use on shipboard, the use for lighting, power, installations on shore, etc. 3200 w. Trans Am Inst of Elec Engrs—May 28, 1902. No. 48889 D.

The Reasons for the Change of the Navy Standard Voltage from 80 to 125. Lieut. W. V. N. Powelson. Reviews briefly the history of the voltages used by the navy, and discusses the considerations that led to the recent adoption of 125 volts as the standard for all new installations on board U. S. ships. 5000 w. Trans Am Inst of Elec Engrs—May 20, 1902. No. 48884 D.

Navy Yard.

Electric Transmission of Power for Navy Yards. William S. Aldrich. An argument to show that to secure the highest efficiency electric-power transmission is best adapted to the work required. 3500 w. Jour Am Soc of Nav Engrs—May, 1902. Serial. 1st part. No. 48442 H.

Power Plant.

Power Plant of the Schwarzchild & Sulzberger Company, Chicago. Illustrated detailed description of a fine modern plant for a meat-packing establishment. 2800 w. Eng Rec—June 7, 1902. No. 48681.

Pumping.

Improvements in Electric Pumping Machinery (Neuere Ausführungen Elektrischer Wasserhaltungen). W. Philippi. Describing especially the electrically driven high speed pumps of the Riedler and Bergman type. 2500 w. 2 plates. Glückauf—June 7, 1902. No. 48961 B.

Submarine Mines.

Electricity in Its Application to Submarine Mines. Capt. John Stephen Sewell. Describes the planting of mines and the electrical arrangements. 2000 w. Trans Am Inst of Elec Engrs—May 20, 1902. No. 48887 D.

Synchronous Motors.

Notes on the Theory of the Synchronous Motor, with Special Reference to the Phenomenon of Surging. Charles Proteus Steinmetz. A mathematical study of synchronous motors and converters, in which two independent variables exist: load and field excitation. Diagrams and curves. 3000 w. Am Inst of Elec Engrs—June 18, 1902. No. 49052 D.

TRANSMISSION.

Alternating Currents.

Formula for Calculating the Electromotive Force at Any Point of a Transmission

Line for Alternating Current. M. Leblanc. Establishes a formula for giving the voltage at any point. 500 w. Trans Am Inst of Elec Engrs—June 20, 1902. No. 49051 D.

Insulation.

Energy Loss in Commercial Insulating Materials when Subjected to High Potential Stress. Charles Edward Skinner. Discusses the effects of this loss, describing some of the methods employed, and giving some of the characteristic results obtained from tests made on various materials used in commercial manufacture, and also on the insulation of finished apparatus. 5000 w. Trans Am Inst of Elec Engrs—June 20, 1902. No. 49056 D.

Lightning Arrester.

Atmospheric Electricity and Lightning Protectors. Begins a careful review of the progress made in the study of atmospheric electricity, and the various theories regarding thunderstorms. 3800 w. Engng—May 30, 1902. Serial. 1st part. No. 48656 A.

The Function of Shunt and Series Resistance in Lightning Arresters. Percy H. Thomas. A description of a method of enabling an arrester to suppress the arc which tends to follow a simultaneous discharge to ground from two legs of a circuit. 5500 w. Trans Am Inst of Elec Engrs—June 18, 1902. No. 49055 D.

Protection of Electric Plants from Atmospheric Discharges (Schutz Elektrischer Anlagen gegen Atmosphärische Entladung). A description of the Gola lightning arrester, used in Italy. 2000 w. Elektrotech Zeitschr—May 22, 1902. No. 48941 B.

Long-Distance.

The Cauveri Falls Electrical Power Transmission. An illustrated account of a long-distance transmission scheme, by which the power of these falls in Mysore, will be applied to driving mining machinery in the Kolar goldfields, nearly 100 miles away. 3000 w. Engr, Lond—June 6, 1902. No. 48778 A.

Polyphase Circuits.

An Experiment with Single-Phase Alternators on Polyphase Circuits. C. O. Mailloux. Report of an experiment at Phœnix, Arizona, April 7, 1902, demonstrating the possibility of using single-phase alternators to produce two-phase, three-phase, and direct currents. 3200 w. Trans Am Inst of Elec Engrs—June 20 1902. No. 49-048 D.

Protection.

Protection of Long Distance Transmission Lines. F. A. C. Perrine. Read before the Nat. Elec. Lgt. Assn. Calls attention to means for giving the best possible protection, while admitting the imperfections. 1600 w. Elec, N Y—June 4, 1902. No. 48627.

MISCELLANY.

Education.

Concerning Uniformity in the Electrical Engineering Courses in the United States. Dr. Samuel Sheldon. Discusses the selection of the curricula, gives a table showing the maximum, the minimum and the average time devoted to various subjects in various institutions, and the aims of technical education. 1400 w. Trans Am Inst of Elec Engrs—June 21, 1902. No. 49044 D.

Presidential Address. Charles P. Steinmetz. A short outline of the writer's views of an electrical engineering course. 2000 w. Trans Am Inst of Elec Engrs—June 21, 1902. No. 49046 D.

The Education of the Elecrical Engineer. H. W. Buck. Discusses the training needed. 1300 w. Trans Am Inst of Elec Engrs—June 21, 1902. No. 49045 D.

Electric Shocks.

Electric Shocks at 500 Volts. Alexanded P. Trotter. A record of experiments and a discussion of the conditions under which shocks of 500 volts are devoid of danger. The subject is divided into three parts. (1) The physiological and electrical conditions; (2) the dangers connected with trolley wires; (3) the dangers of third rails of electric railways. 3700 w. Aust Min Stand—April 24, May 1, 1902. Serial. 2 parts. No. 48642 B.

Finances.

Massachusetts Electrical System in 1901. Alton D. Adams. A review of the finances of the electric lighting companies. 2300 w. Elec Wld & Engr—June 7, 1902. No. 48686.

Legislation.

Electricity and Legislation. The first of a series of articles proposing to show what has been the effect of legislation on the development of commercial electricity in England. 2500 w. Engr, Lond—May 30, 1902. Serial. 1st part. No. 48663 A.

Military Service.

Civilian Co-operation in the Development of Electrical Devices for Military Purposes. Caryl D. Haskins. An appeal for closer co-operation between civilian electrical engineers and the army and navy, indicating fields where they might be of service. 1200 w. Trans Am Inst of Elec Engrs—May 28, 1902. No. 48881 D.

See also Electrical Engineering, Communication.

Administration.

Some Results of American Gas-Works Administration. Discussions of American methods and the present situation of the industry. 2000 w. Jour Gas Lgt—May 20, 1902. No. 48486 A.

Bench Fuels.

Experience with Bench Fuels. W. A. Baehr. Read at meeting of the Western Gas Assn. An account of a series of experiments in Denver with the object of finding a suitable bench fuel to replace coke. Also discussion. Ill. 5300 w. Pro Age—June 2, 1902. No. 48493.

By-Product Ovens.

Cheap Gas and Fuel Without Smoke. Alton D. Adams. Describes the results obtained in gas and coke production by by-product ovens at Everett, Mass. 2700 w. Mines & Min—June 1902. No. 48673 C.

Condensation.

The Condensation of Coal Gas. Harold G. Colman. Views of the writer derived from a study of the literature of the question and his own experiments. 3000 w. Jour Gas Lgt—June 3, 1902. No. 48736 A.

Gas Coals.

Analytical Valuation of Gas Coals. Particulars from a paper by G. P. Lishman, read at London meeting of Inst. of Min. Engrs. Discusses the difficulties attending the testing of gas coal, and explaining the writer's system. 1700 w. Jour Gas Lgt—June 3, 1902. No. 48737 A.

Gas Oils.

Beaumont Oil for Gas Making. John H. Fitzgerald. Paper and discussion before the Western Gas Assn. Favorable report of its gas making qualities, with analysis. 4800 w. Am Gas Lgt Jour—June 9, 1902. No. 48695.

The Constitution of Gas Oils. Raymond Ross and J. P. Leather. Reports investigations made of the four principal oils on the market. viz., Russian, American, Borneo and Texas. 4000 w. Gas Wld—June 7, 1902. No. 48768 A.

The Prospects of the Gas Oil Trade. A statement based upon the best and latest information relating to the petroleum fields from which gas oils are drawn. 2200 w. Jour Gas Lgt—June 3. 1902. No. 48-734 A.

High Pressure.

Distributing Gas at High Pressure. George F. Goodnow. Read at meeting of Western Gas Assn. Gives a comparison showing the uses to which a high pressure system may be put. General discussion. 2500 w. Am Gas Lgt Jour—June 23, 1902. No. 49006.

Distributing Gas at High Pressure. Extracts from the discussion on F. H. Shelton's paper at meeting of the Ohio Gas Lgt. Assn., in which Dr. Pole's formula was questioned. 3500 w. Gas Wld—May 24, 1902. No. 48477 A.

Hong Kong.

Hong Kong and Its Gas Works. A. J. Kennedy. An illustrated description of the works of the Hong Kong and China Gas Co., 2300 w. Gas Wld—May 24, 1902. No. 48478 A.

Legal Relations.

The Legal Relations Between Gas Supply Undertakings and Consumers. The first of a series of articles summarizing the various sections of the several Acts of Parliament which bear upon the legal relations existing between a gas undertaking and a consumer. 3000 w. Jour Gas Lgt—June 3, 1902. Serial. 1st part. No. 48-733 A.

Meters.

Inspection of Gas Meters. Alton D. Adams. Reports the requirements in the state of Massachusetts, and gives the records of meters tested by the State inspector. 1000 w. Sci Am—May 31, 1902. No. 48533.

Purifiers.

Current Purifier Practice, and a New Form of Construction. F. H. Shelton. Paper before the Western Gas Assn. Briefly reviews purifier construction practice in the United States, and describes an easily made form that under some conditions will reduce the expense of construction about one-half. Ill. 6500 w. Am Gas Lgt Jour—June 9, 1902. No. 48696.

Reconstruction.

From Old Conditions to New at the Walsall Gas Works. An illustrated description of extensive improvements in these works, which have a maximum output of 2¼ million cubic feet of gas per day. 4000 w. Jour Gas Lgt—May 29, 1902. Serial. 1st part. No. 48487 A.

Retort-Houses.

Retort-Houses for Inclined Retort Settings and Their Development. Edward Drory. An account of experiments and illustrated description of the Getschiver Strasse Gas Works, and the Mariendorf Retort-House, Berlin. 2 plates. 3200 w. Jour Gas Lgt—June 3, 1902. No. 48735 A.

Water Gas.

Water Gas Manufacture in Theory and Practice. Dr. J. Kramers. Abstract translation of a communication published last year in *Het Gas*. 2500 w. Jour Gas Lgt—May 20, 1902. Serial. 1st part. No. 48488 A.

INDUSTRIAL ECONOMY

Commerce.

Commercial Expansion. Mr. James J. Hill on the development of the United States, and the influence of the Lake Superior iron country. 4400 w. Marine Rev—June 12, 1902. No. 48843.

Dwellings.

Workmen's Dwellings at the Paris Exposition of 1900 (Das Arbeiter-Wohnungswesen auf der Weltausstellung in Paris, 1900). L. Simony. A general discussion of modern dwellings for workmen in various countries, as indicated by the exhibits at Paris. 6000 w. Zeitschr d Oesterr Ing u Arch Ver—May 23, 1902. No. 48923 B.

Education.

See Electrical Engineering, Miscellany.

Factory Office.

The Factory Office as a Productive Department. Kenneth Falconer. The concluding paper of the series, showing the close relation and special value of the factory office to the executive. 3500 w. Engineering Magazine—July, 1902. No. 48987 B.

Food Supply.

American Control of England's Food Supply. J. D. Whelpley. Concerning the dependence of England upon the United States for food, giving information of interest concerning the value of meat, grain, etc., exported, and the causes that have brought about the present conditions. 4000 w. N Am Rev—June, 1902. No. 48438 D.

Hygiene.

Shop Hygiene and Accident Prevention (Unfallverhütung und Gewerbehygiene). Dr. W. Heffter. A general discussion of the proper methods of securing the health and safety of workmen. Serial. Part I. 2000 w. Zeitschr d Ver Deutscher Ing—June 7, 1902. No. 48922 D.

Strikes.

Demands of Anthracite Coal Miners. Analysis of the causes leading to the present great strike in the Pennsylvania anthracite region. 2200 w. Eng & Min Jour—May 31, 1902. No. 48512.

Industrial History of the Anthracite Regions. R. W. Raymond. A brief review of the history of the last forty years, which furnishes the explanation to many things in present conditions. 1200 w. Eng & Min Jour—June 14, 1902. No. 48844.

Providence and Pawtucket Railway Strike. An illustrated account of the trouble caused by the ten-hour law enacted by the last Legislature. 1700 w. St Ry Jour—June 21, 1902. No. 48896 D.

Strikes in the United States. Carroll D. Wright. Reviews the history of strikes, especially those of the last twenty years, no attempt having been made until 1880 to collect data relative to labor controversies. 4000 w. N Am Rev—June, 1902. No. 48436 D.

The Anthracite Strike. R. W. Raymond. Statement of questions of permanent importance relating to this strike, some of which will be discussed in later articles. 1500 w. Eng & Min Jour—June 7, 1902. No. 48676.

Trusts.

How to Curb the Trusts. Henry Michelsen. Explains the existing state of affairs in the United States and considers the nationalization of the railways the remedy. 2800 w. N Am Rev—June, 1902. No. 48437 D.

Mr. Hill on the Railways and the Trusts. Extracts from an address before the Illinois Manufacturers' Assn., Chicago, by Mr. J. J. Hill, president of the Great Northern Ry. Thinks there is safety rather than danger in the combination of railways. 2500 w. Ry & Engng Rev—June 7, 1902. No. 48708.

Wages.

The Inefficiency of the Wages System. Discusses the inefficiency of the wages system in England and the possibility of improving or superseding it. 2800 w. Jour Gas Lgt—May 27, 1902. No. 48632 A.

Works Management.

Money Making Management for Workshop and Factory. C. U. Carpenter. Mr. Carpenter's sixth paper treats of the machining processes and the tool department, showing the productive advantages of system and method. 4000 w. Engineering Magazine—July, 1902. No. 48986 B.

The Organization of a Workshop (Organisation des Services d'une Usine). Jules Simonet. A discussion of the details of works organization with a complete scheme for the arrangement and administration of a manufacturing establishment. 10,000 w. Revue de Mécanique—May 31, 1902. No. 48911 E+F.

MARINE AND NAVAL ENGINEERING

Armor.

Artillery *versus* Armor. Tabular report, illustrations and editorial relating to the fact recently demonstrated, that armor plate manufactured according to the latest process, has been defeated by modern guns and projectiles. 3500 w. Engng—May 30, 1902. No. 48658 A.

Barges.

Large Wooden Barges. Illustrated description of two big barges being built at Taunton, Mass. 700 w. Marine Engng—June, 1902. No. 48559 C.

Battleships.

Louis Nixon on the Battleship of the Future. Extracts from a recent article concerning the things that may affect the types of battleships. 2500 w. Marine Rev—June 19, 1902. No. 48897.

Boilers.

See Mechanical Engineering. Steam Engineering.

Cruisers.

The Steam Trials of H. M. S. "Leviathan." Gives particulars of the vessel and equipment with report of trials. 1200 w. Engng—May 23, 1902. No. 48464 A.

Docking.

The Docking of Battleships. M. Asaoka. Paper read at meeting of the Soc. of Nav. Archts. of Japan. Gives an outline description of the different operations. Interesting because of the comparison possible between Japanese and English methods. 2000 w. Engng—June 13, 1902. No. 48874 A.

Experimental Tank.

Equipment for Experimental Work on Resistance and Propulsion of Ships Installed at the Hydraulic Laboratory of Cornell University. W. F. Durand. Illustrates and describes the equipment thus far installed, stating its purpose. 2800 w. Marine Engng—June, 1902. No. 48554 C.

The Machinery of the Model Testing Tank of the U. S. Navy Department. Waldon Fawcett. An illustrated detailed description of this interesting machinery. 3000 w. Mod Mach—June, 1902. No. 48583.

The Proposed Experimental Tank for Testing Ship Models for Resistance. Gives an outline of the method of investigation by models, as devised by Mr. William Froude, and brief illustrated description of the tank at Washington. 2200 w. Nature—June 5, 1902. No. 48762 A.

Freighter.

Large American Freighter. Illustration, with description of the Alaskan, a vessel of 8671 tons, now on her way from the Pacific to the Atlantic. 1300 w. Naut Gaz—June 19, 1902. No. 48898.

Launch.

Launch with Daimler Motor for the British War Office. Illustrated description of a launch built for the British War Office, intended for use in towing targets to and from their stations during artillery practice. 700 w. Engng—May 23, 1902. No. 48462 A.

Monitors.

Early British Double-Turreted Monitors. Illustration, with an account of how these vessels, intended for the Confederate States during the Civil War, became the property of the British Government. 500 w. Sci Am—June 14, 1902. No. 48753.

Naval Warfare.

Recent Scientific Developments and the Future of Naval Warfare. William Laird Clowes. An address before the Inst. of Nav. Archts. Discusses submarines, water-tube boilers, gunnery, etc., and the importance of the trained *personnel.* 2800 w. Sci Am Sup—June 7, 1902. No. 48622.

Oil Engines.

The Application of Oil Engines to Light Marine Work. C. C. Longridge. Discusses the advantages and defects of oil motors for marine work, reversing motors, gears and propellers, bi-unial propellers, range of horse-power, etc. 2500 w. Engng—May 23, 1902. No. 48459 A.

Propeller Shafts.

Investigations upon the Dynamic Conditions in Propeller Shafts (Neue Untersuchungen über die Dynamischen Vorgänge in den Wellenleitungen von Schiffsmaschinen). H. Frahm. Describing apparatus and methods employed for the experimental record of torsional vibrations in propeller shafts. Serial. Part I. 3000 w. Zeitschr d Ver Deutscher Ing—May 31, 1902. No. 48916 D.

Repairing.

The Repairing of the Steamship Etruria. From some unknown cause the vessel lost her rudder, rudder-post, propeller and the external portion of the propeller shaft in mid-ocean. By the use of pneumatic power the repairs were executed in about two weeks. Illustrated description of the work. 1100 w. Engr, Lond—June 6, 1902. No. 48779 A.

Rolling.

The Rolling of Ships (Roulis sur Houle). H. Chaigneau. A mathematical study of the stresses upon the hulls of ships under the rolling action of waves. Two articles. 7500 w. Revue Technique —May 25, June 10, 1902. No. 48907 each D.

Shipbuilding.

A Comparison of Specifications for Shipbuilding Material. E. Schroedter. Abstract of a paper read before the International Shipbuilding Congress at Düsseldorf. A comparison between the conditions in Germany and Great Britain. 2000 w. Ir & Coal Trds Rev—June 13, 1902. No. 48879 A.

Shipbuilding in the United States. Alexander R. Smith. Introduction to the Census Report on Shipbuilding with continuation of last week's article. 3200 w. Naut Gaz—May 29, 1902. Serial. No. 48491.

Shipyards.

Shipyard Draughting Rooms. Theodore Lucas. An account of the work done there; the general designing of the vessels and machinery, recording, etc. 2500 w. Naut Gaz—June 19, 1902. No. 48899.

Steamboat.

New Passenger Steamboat. Illustration with description of the William G. Payne, the latest addition of the Long Island Sound fleet, built for service between New York and Bridgeport. 2500 w. Naut Gaz —June 5, 1902. No. 48635.

Steamers.

Chesapeake and Ohio Railroad Passenger Steamer Virginia. Illustrated detailed description of a twin-screw passenger boat of about 700 tons displacement. 2300 w. Marine Engng—June, 1902. No. 48553 C.

Stern Wheel River Steamer. An illustrated description of the fine steel steamer, City of Fayetteville, built for service on the Cape Fear River of North Carolina, and representing the latest type of shallow draft river steamers. 600 w. Marine Engng—June, 1902. No. 48555 C.

Steamship.

The Pacific Mail Steamship Korea. Charles K. Mallory. Illustrated description of the vessel and its equipment with report of trial. 5000 w. Jour Am Soc of Nav Engrs—May, 1902. No. 48439 H.

Wharves.

The North German Lloyd Pier-Sheds, Hoboken. Illustrated description of the steel work of the three most important piers in America, 860 to 908 feet long, and 80 to 90 feet wide. 2900 w. Eng Rec—June 21, 1902. Serial. 1st part. No. 48-852.

Yachts.

Steam Yacht Oswegatchie. Brief illustrated description of a yacht for the lake region. 900 w. Marine Rev—May 29, 1902. No. 48492.

Turbine-Driven Steam Yacht "Tarantula." Illustrates and describes a very interesting yacht recently built, which is propelled by steam-turbine machinery, and fitted with Yarrow boilers. 3500 w. Engng—June 6, 1902. No. 48775 A.

MECHANICAL ENGINEERING

AUTOMOBILES.

Alcohol Motors.

Trials of Alcohol Motors. Discusses the trials from Beauvais to Paris, and alcohol as compared with petrol. 2500 w. Engr, Lond—May 23, 1902. No. 48467 A.

Alcohol Race.

The Northern Alcohol Race. An account of this race which proved that alcohol could be used with safety for vehicles running at high speeds. Ill. 4600 w. Autocar—May 24, 1902. No. 48485 A.

Alcohol Tests.

The French Alcohol Tests (Circuit du Nord). An account of the racing tests and the results, and the consumption trials and results. Also brief notice of the alcohol exhibition. 3000 w. Auto Jour—May 31, 1902. No. 48641 A.

Burners.

Bunsen and Injector Burners. J. S. V. Bickford. Experimental investigation of the class of burners in which the jet of vapor mixed with air passes through a length of tube before being ignited. Ill. 2500 w. Horseless Age—May 28, 1902. No. 48519.

Digest of Kerosene Burner Patents. F. W. Barker. Brief illustrated outlines of patents treating the subject of vaporizing kerosene and burning the vapor under a boiler. 3200 w. Horseless Age—May 28, 1902. No. 48523.

Kerosene Carburettors and Burners. L. Berger. Illustrates and describes various carburetters and burners and their principles of construction. 1200 w. Horseless Age—May 28, 1902. No. 48520.

Petroleum Vapor Burners—General Principles. J. S. V. Bickford. Aims to give the principles on which petroleum apparatus may be designed. Ill. Horseless Age—May 28, 1902. No. 48518.

Some Kerosene Burners. Illustrations

and particulars of eight types of burners. 4000 w. Horseless Age—May 28, 1902. No. 48524.

Carburetters.

Carburetters at the Paris Alcohol Show. Brief illustrated descriptions of interesting devices. 1200 w. Auto Jour—June 7, 1902. No. 48767 A.

Fuel.

The Fuel Question. Albert L. Clough. Discusses gasoline and kerosene as fuels for automobile use. Also editorial. 2800 w. Horseless Age—May 28, 1902. No. 48-515.

The Physical Properties of Gasoline and Kerosene. L. Berger. Investigation of the various properties of the two fuels. 2700 w. Horseless Age—May 28, 1902. No. 48517.

Gasoline Carriages.

The Trend of American Gasoline Carriage Practice. Albert L. Clough. A review of recent changes and the present American practice. 2500 w. Horseless Age—June 11, 1902. No. 48719.

Kerosene.

Kerosene and the Important Factors in Its Combustion. Harrington Emerson. Information concerning this product and its use in engines. 4000 w. Horseless Age—May 28, 1902. No. 48516.

Kerosene in Exploding Engines. Charles E. Lucke. The operation of the explosive kerosene engine is discussed, the importance of the maintenance of proportion in the mixture, and the effects of changes, and typical means proposed and used for obtaining mixtures of kerosene and air. 2800 w. Horseless Age—May 28, 1902. No. 48522.

Miscellaneous Methods of Kerosene Combustion. J. S. V. Bickford. Gives a description of petroleum blow-pipes, and of two types of apparatus for applying the principle of introducing steam in petroleum Bunsen burners, etc. Ill. 2200 w. Horseless Age—May 28, 1902. No. 48521.

Light Carriage.

The Georges Richard Light Carriage. Illustrates and describes a design presenting some interesting peculiarities. 1400 w. Auto Topics—June 21, 1902. No. 48-851.

Omnibus.

The Fischer Omnibus. Illustrations, with description of a machine propelled by a petrol motor but having the power transmitted to the rear wheels electrically. Also account of a run. 2500 w. Auto Jour—June 14, 1902. No. 48864 A.

Petrol Cars.

The Humber 8 and 12-h. p. Petrol Cars. Illustrated detailed description of two different sized cars of a new type. 2800 w. Auto Jour—June 14, 1902. Serial. 1st part. No. 48863 A.

Prussia.

Automobilism in Prussia. Concerning the motor carriage exposition at Berlin, giving general description, and discussing progress made. 2000 w. U S Cons Repts No. 1377—June 26, 1902. No. 49032 D.

Racing Car.

The Baker Electric Racing Automobile. Illustrated description of the electric racer that was the cause of a serious accident at the Staten Island speed trials. 800 w. Sci Am—June 14, 1902. No. 48-755.

Storage Batteries.

The Possibilities for a Light Weight Storage Battery. A. L. Marsh. Points out some theoretical considerations which may throw a little light on this problem so important to the electric automobile industry. 2500 w. Elec Wld & Engr—June 7, 1902. No. 48685.

Touring Cars.

Touring Car Bodies. Leon Auscher. Read before the Automobile Congress at Dijon. Considers the touring vehicle with seats for three to five persons. Ill. 2400 w. Horseless Age—June 11, 1902. Serial. 1st part. No. 48721.

Trials.

Bexhill Speed Trials. An illustrated account of these trials which recently took place at Bexhill-on-Sea, in England. 7000 w. Auto Jour—May 24, 1902. No. 48-484 A.

HYDRAULICS.

Air Compressor.

The Hydraulic Air Compressor at Norwich, Conn. Herbert M. Knight. An illustrated description of this installation for the compression of air by what is known as the "Taylor System." 2800 w. Eng News—June 12, 1902. No. 48711.

Flow.

Measurement of Flow of Water in Pipes. Edward S. Cole. Describes a method devised for economically measuring the flow of water in pipes. by the use of the Pitot tube. Also a description of the photo-pitometer for recording the deflections. Ill. 1600 w. Sib Jour of Engng—May, 1902. No. 48832 C.

See Civil Engineering, Canals, Rivers and Harbors.

Pumping.

Pneumatic Pumping Appliances. W. C. Popplewell. The present article gives an illustrated description of various types of displacement pumps. 2200 w. Mech Engr—June 14, 1902. Serial. 1st part. No. 48862 A.

See Mining and Metallurgy, Mining.

Rudder Boom.

The Rudder Boom. Halbert Powers Gillette. Describes this device, which has been applied to the diverting of the drift-wood from the intake of the pipe at Snoqualmie Falls power plant, and calls attention to other uses that may be made of it. 1500 w. Eng News—June 12, 1902. No. 48712.

Turbines.

The Action of Water in Free Jet Turbines (Ueber die Wirkungsweise des Wassers in Laufrädern der Freistrahl-turbinen). Arthur Budau. An examination of the influence of the motion of a turbine wheel upon the flow of water through the buckets. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—May 30, 1902. No. 48924 B.

Turbine Test.

Brake Tests on a New American Turbine (Bremsversuche an einer New American Turbine). A comparative test by Professor Pfarr of Darmstadt, with data of trials made in the flume at Holyoke, Mass. 3000 w. Zeitschr d Ver Deutscher Ing—June 7, 1902. No. 48921 D.

Water Power.

Large Water Power Plants. Gives facts concerning important plants now erected or building. 1600 w. Mach, N Y—June, 1902. No. 48629.

MACHINE WORKS AND FOUNDRIES.

Accounting.

Foundry Accounting. J. G. Stewart. Examines in detail methods of keeping records and remarks on the importance of knowing accurately the cost of work, etc. 5000 w. Jour Am Found Assn—June, 1902. No. 48805.

Bearings.

Anti-Friction Bearings. Henry R. Lordly. Gives facts relating to this subject obtained in an investigation lasting nearly one year. Ill. 5200 w. Trans Assn of Civ Engrs of Cornell Univ—1902. No. 48599 F.

Brass.

Brass Melting. Charles Vickers. Suggestions for economical melting with remarks on troubles and their remedies. 1100 w. Jour Am Found Assn—June, 1902. No. 48803.

Brass Foundry.

The New Brass Foundry of the Chicago, Rock Island & Pacific Railway Company, Chicago. Illustrated detailed description. 2200 w. Foundry—June, 1902. No. 48497.

Castings.

Foundry Tests and Malleable Iron Castings in the United States. Information in response to inquiries as to matters of detail, brought out by a series of articles recently published in this paper. 2400 w. Engr, Lond—May 23, 1902. No. 48472 A.

Scrap Metal Castings. Walter J. May. Suggestions for the use of scrap, the sorting, treatment, etc. 2400 w. Prac Engr—June 13 1902. No. 48861 A.

Chains.

The Strathern Weldless Chain Manufacture. An illustrated description of the machine and process of manufacture. 3000 w. Prac Engr—May 23, 1902. No. 48-481 A.

Cores.

Cores and Core Arbors. Edward B. Gilmour. Discusses the making of cores and core arbors. the best practice, kind of material, etc. Ill. 2000 w. Jour Am Found Assn—June, 1902. No. 48808.

Cost-Keeping.

Cost Keeping and Wage Systems of the Stillwell-Bierce & Smith-Vaile Co. Descriptive articles outlining the system of the purchasing department. 2300 w. Ir Trd Rev—June 5, 1902. No. 48563.

Foundry Costs. R. C. Cunningham. Suggestions for improving the output and diminishing the costs, by supplying needed tools, careful over-sight, etc. 1700 w. Jour Am Found Assn—June, 1902. No. 48801.

Cranes.

Notes on Crane Design. A. D. Williams. Discusses the loads, stresses, strains, bending moment, etc., and the types in use. 2400 w. Am Mach—June 12, 1902. No. 48725.

The Giant Crane at Bremerhaven. Illustrated description of the crane built for the Kaiser dock in Germany. 800 w. Sci Am Sup—May 31, 1902. No. 48536.

See Electrical Engineering, Power Applications.

Cupolas.

The Effect of Melting Steel with Iron in the Cupola. H. E. Diller. Tabulated results of tests made to determine the best proportion of steel to use, and to trace the connection between the percentage of total carbon and the tensile strength. 800 w. Jour Am Found Assn—June, 1902. No. 48806.

The Metallurgy of the Cupola. H. E. Field. A study of the effects of melting upon iron, and upon the metalloids therein contained. 4000 w. Jour Am Found Assn—June, 1902. No. 48800.

Dies.

A Punching, Drawing and Forming Die. Illustrates and describes a die in constant use in a small brass factory, doing work at the rate of 12,000 to 15,000 pieces in nine hours. 1100 w. Am Mach—May 29, 1902. No. 48501.

Drawings.

Average Drawing Room Practice. C. E. Coolidge. Gives questions sent out by Prof. Barr, of Sibley College, and the replies received, with a view of forming an average system. 1600 w. Am Mach—June 19, 1902. No. 49005.

Economy.

Economy. P. R. Ramp. Calls attention to things that cause waste, and to false economy often practiced. 1400 w. Jour Am Found Assn—June, 1902. No. 48809.

Engineering Works.

Detroit Steel Car Works of the American Car & Foundry Company. Illustrated description and information concerning this recently completed plant. 2300 w. R R Gaz—June 13, 1902. No. 48738.

The Emlyn Engineering Works. Illustrated detailed description of the works at Gloucester, England and their equipment. Repairs and renewal work are carried on, and the manufacture of mortar mills, steam winches, travelling jib cranes, etc. 900 w. Engr, Lond—May 30, 1902. No. 48664 A.

The German Niles Tool Works, Berlin. Begins an illustrated detailed description of these interesting works, where American and German systems of engineering are combined. 5600 w. Engng—May 30, 1902. Serial. 1st part. No. 48655 A.

The General Scheme of the New Milwaukee Plant of the Allis-Chalmers Company. Illustrates and describes the leading features of the general scheme of one of the finest plants for machine building. 2000 w. Am Mach—June 12, 1902. No. 48724.

The Structural Steel Car Company. Brief description of the works at Canton, Ohio, and of the cars made. 2000 w. R R Gaz—June 13, 1902. No. 48746.

The Tool Equipment of French Locomotive Shops. Information from the "Official Journal of the French Republic" concerning their superannuated tools. 2200 w. Am Mach—May 29, 1902. No. 48502.

Factory Office.

See Industrial Economy.

Forgings.

Forgings for Engines. H. F. J. Porter. Read before the Engine Builders' Assn. Considers the steel-forging industry, the operations, annealing, changes in metal, crank shafts, hollow forgings, engine fittings, etc. 4500 w. Ir Trd Rev—May 29 1902. No. 48503.

The Oil-Tempering of Mild-Steel Forgings. Thomas Burt. Read before the Shanghai Soc of Engrs & Archts. A report of tests showing the marked improvement of the steel by oil-tempering, and general discussion of the subject. 3400 w. Engng—June 13, 1902. No. 48875 A.

Hoisting.

Hoisting Machinery (Die Hebezeuge). Ad. Ernst. A deschiption of the cranes and other hoisting machinery shown at the Düsseldorf exposition. Serial. Part 1. 2500 w. Zeitschr d Ver Deutscher Ing—May 24, 1902. No. 48913 D.

See Electrical Engineering, Power Applications.

Machine Tools.

Some Yorkshire Machine Tools. Illustrates and describes representative tools of some nine separate firms. 10900 w. Engr, Lond (Sup)—June 13, 1902. No. 48876 A.

Molding.

The Molding Machine Flasks. S. H. Stupekoff. The importance of good flasks and flask pins is discussed. 1400 w. Jour Am Found Assn—June, 1902. No. 48810.

The Molding Machine. S. H. Stupakoff. Jigs. Describes in detail the preparing of pattern plates and patterns for plate molding, giving drawings. 2500 w. Jour Am Found Assn—June, 1902. No. 48807.

Production.

Some Methods of Increasing Foundry Production. David Reid. Describes methods tried and proved successful. 1500 w. Jour Am Found Assn—June, 1902. No. 48804.

Reamers.

Hardening Long Reamers. E. R. Markham. An explanation of the method used by the writer with good results. 1800 w. Am Mach—May 29, 1902. No. 48500.

Repetition Work.

The Advantage of Working to Patterns and Gauges. Walter J. May. Calls attention to the advantages derived from the use of carefully made patterns and gauges in all cases where repetition work is likely to occur, especially in the foundry and smithy. 2000 w. Prac Engr—May 30, 1902. No. 48638 A.

Shop Practice.

Some Points in Shop Practice from the Cincinnati Milling Machine Company. Illustrated description of methods of interest. 2500 w. Am Mtch—June 19. 1902. No. 49004.

Shop Tools.

Shop Tools and Rigs. James A. Murphy. Calls attention to the economy of having properly equipped shops, well designed tools, etc., giving illustrated description of useful tools. 1500 w. Jour Am Found Assn—June, 1902. No. 48802.

Specifications.

Specifications for Steel Forgings and Steel Castings. William B. Webster. Offers these specifications for discussion. Gives table from Mr. C. H. Ridsdale's paper, and in appendix, the Standard Specifications for Steel Forgings and Castings. 2200 w. Trans Am Inst of Min Engrs—May, 1902. No. 48825 C.

Speed Control.

Mechanical Speed Changing Devices. Driving Machine Tools from Constant Speed Motors. H. M. Palmer, G. E. Flanagan and others. A discussion of these subjects. 4200 w. Pro Engrs' Soc of W Penn—May, 1902. No. 48839 D.

Turning.

The Flat Drill as a Turning Tool. F. W. Shaw. Describes the use of the flat drill as a turning tool, illustrating the methods for straight and circular work. 2500 w. Am Mach—June 5, 1902. No. 48562.

Tools.

Machine Tools (Die Werkzeugmaschinen). H. Fischer. A detailed review of the various machine tools shown at the Düsseldorf exposition. Serial. Part 1. 2500 w. Zeitschr d Ver Deutscher Ing—June 7, 1902. No. 48919 D.

Works Management.

See Industrial Economy.

MATERIALS OF CONSTRUCTION.

Cast Iron.

Cast Iron. Percy Longmuir. Reviews the constituent elements and their effect on the quality and the purpose to which the iron is adapted. 2800 w. Jour Am Found Assn—June. 1902. No. 48811.

The Constitution of Cast Iron, with Remarks on Current Opinions Concerning It. H. M. Howe. A discussion of this paper presented at the Richmond meeting. 2500 w. Trans Am Inst of Min Engrs—Feb. 1901. No. 48818 D.

Hardness.

Brinell's Method of Determining Hardness (Méthode de M. Brinell pour la Détermination de la Durete des Corps). A discussion of the report of Axel Wahlberg upon Brinell's method of determining hardness by the penetration of a steel ball under pressure. 3000 w. Revue Technique—June 10, 1902. No. 48908 D.

Lubricants.

Graphite Lubrication. Hugh D. Meier. Discusses various lubricants and gives tabulated results of a test made by Prof. R. H. Thurston. 1000 w. Horseless Age—June 11, 1902. No. 48722.

Piping.

Piping Materials for Steam Plants. John B. Berryman. Gives the results of a series of tests, principally covering the field of high pressure steam piping. 3300 w. Ir Trd Rev—May 29, 1902. No. 48504.

Rubber.

Recovered Rubber. Information concerning this material. 1800 w. Engng—May 23, 1902. No. 48460 A.

Testing Machine.

A Belt and Pulley Testing Machine. C. M. Allen. Describes a machine used in the engineering laboratory of the Worcester Polytechnic Institute for making a series of comparative pulley tests. 1100 w. R R Gaz—June 6, 1902. No. 48614.

MEASUREMENT.

Estimating.

Estimation of Weight and Volume. J. G. A. Meyer. Gives simple methods of finding the weights and volumes of irregular bodies. 1500 w. Mach, N Y—June, 1902. No. 48631.

Flexure.

The Determination of Unit Stresses in the General Case of Flexure. L. J. Johnson. Calls attention to methods by which the distribution of stress can be determined for any case of flexure in a straight bar. Gives fully worked numerical examples. 8500 w. Jour Assn of Engng Socs—May, 1902. No. 48893 C.

Stresses.

Stress in Chain Links. G. A. Goodenough. Gives results of an analytical investigation of the stresses in oval links, outlining the method used. 1800 w. Technograph, No. 16—1901-2. No. 48449 D.

Vibrations.

Torsional Vibrations of Shafts. L. Gümbel. Read before the Inst. of Naval Archts. A mathematical demonstration of the application of Fourier's theorem to the study of torsional vibrations of shafts of marine engines. 4200 w. Jour Am Soc of Nav Engrs—May, 1902. No. 48-441 H.

POWER AND TRANSMISSION.

Air Compressors.

Types of Foreign Air Compressors. J. Walter Pearse. Illustrates and describes types from a number of foreign plants. 4000 w. Compressed air—June, 1902. No. 48891

Belt-Drive.

Belt Drive for Shafts at Right Angles. Forrest R. Jones. Illustrates and describes a graphical method of laying out a reversible, three-pulley drive. 4400 w. Mach, N Y—June, 1902. No. 48630.

Gearing.

Paper and Iron Friction Gearing. Edward C. de Wolfe. Information concerning the power, applications and service peculiarities, with diagrams to facilitate computations, and directions for their use. 2200 w. Am Mach—May 29, 1902. No. 48499.

Pulleys.

Comparative Tests of Plain and Para Pneumatic Pulleys. H. Diederichs. Reports a series of tests made in the mechanical laboratory of Sibley College. 700 w. Sib Jour of Engng—June, 1902. No. 48835 C.

Safety Devices.

Protection of Light Shafts and Safety Devices in Connection with Lift Doors and Controlling Gears. Henry C. Walker. An illustrated article considering the cases most frequently met, and the form of safety appliance best to adopt in each case. 2500 w. Prac Engr—May 23, 1902. Serial. 1st part. No. 48479 A.

Stage Mechanism.

Mechanical Engineering at the Royal Opera House, London. Illustrates and describes the stage mechanism and theatre engineering work. 2000 w. Mech Engr—June 7, 1902. No. 48763 A.

SPECIAL MOTORS.

Alcohol Motors.

See Mechanical Engineering, Automobiles.

Diesel Motor.

The New Diesel Engine. Illustrated description of a new 30-B. H. P. Diesel oil engine and its operation. 3500 w. Engr, Lond—May 30, 1902. Serial. 1st part. o. 48465 A.

Gas Engines.

Recent Developments in the Gas Engine. T. Hudson Beare. Lecture to the Graduates' Assn. of the Inst. of Mech. Engrs. Considers the improvements since 1889 in detail, and their effects. 4500 w. Engng—May 23, 1902. Serial. 1st part. No. 48465 A.

The Development of Large Gas Engines (De Opkomst der Groote Gasmotoren). Chr. Muller. A discussion of the advantages of the large gas engine, supplied with producer gas, as adapted to the industries of Holland. 3000 w. De Ingenieur—May 3, 1902. No. 48968 D.

Gasoline Engines.

Care and Management of the Marine Gasoline Engine. E. W. Roberts. Describes briefly the two types in use for marine purposes, the points bearing upon efficient working, ignition, exhaust, etc., in the present article. 2000 w. Marine Engng—June, 1902. Serial. 1st part. No. 48560 C.

Gas vs. Steam.

Gas vs. Steam Engines. Albert Stritmatter. Discusses information given on this subject in recently published articles. 1700 w. Am Mfr—May 29, 1902. No. 48494.

Ignition.

Electric Ignition. Donald M. Bliss. Remarks on the methods of ignition for gasoline motors and their merits, and the care needed in their use. 1200 w. Marine Engng—June. 1902. No. 48558 C.

Oil Engine.

See Marine Engineering.

Piston Rings.

Piston Rings of Explosive Engines—Two Methods of Manufacture. Hugh D. Meier. Describes methods of manufacture that will give perfect piston rings. Ill. 1600 w. Horseless Age—June 18, 1902. No. 49001.

Piston Rings in Gas Engine Construction. J. Edward Baldwin. Reports a series of tests made on the effect of various degrees of compression and various mixtures. 900 w. Horseless Age—June 11, 1901. No. 48720.

STEAM ENGINEERING.

Boiler Explosion.

The Penberthy Boiler Explosion. R. C. Carpenter. An account of the investigations which led to the discovery of the cause of this disastrous explosion in Detroit, Mich. 1200 w. Sib Jour of Engng—May, 1902. No. 48830 C.

Boiler Settings.

Brick Settings for Steam Boilers. From *Building News*. Calls attention to details of importance in the flues, settings, foundations, design, etc. 1600 w. Prac Engr—May 23, 1902. No. 48482 A.

Boilers.

A Defense of the Niclausse Boiler. J. & A. Niclausse. A statement correcting errors published in an earlier article concerning these boilers. 2800 w. Jour Am Soc of Nav Engrs—May. 1902. No. 48-443 H.

Rational Design of Locomotive Boilers. D. Van Alstine. Calls attention to important points in the design of locomotive boilers. 700 w. Am Engr & R R Jour—June, 1902. No. 48573 C.

Review of Water-Tube Boilers Now Used for Marine Purposes, with a Comparative Reference to the Ordinary Cylindrical Type. Ernest N. Janson. Descriptive review, comparison and conclusions. 7000 w. Jour Am Soc of Nav Engrs —May, 1902. No. 48440 H.

Water-Tube Boiler for Locomotives. An illustrated description of a boiler of the locomotive type, with modifications, in use on the London and South Western Ry., England. Also describes spark-preventing apparatus. 2200 w. Engng—May 30, 1902. No. 48657 A.

Water-Tube Boiler Installations of the World's Navies. Compiled by Charles W. Dyson. A collection of all data concerning water-tube boilers that have been published, arranged in tabular form for reference. 2500 w. Jour Am Soc of Nav Engrs—May, 1902. No. 48444 H.

Corrosion.

Corrosion of Boiler Tubes. Prepared from a report made by Lieut. W. H. Chambers of a series of tests made to ascertain the relative corrodibility of lap-welded Bessemer steel, lap-welded iron, seamless cold-drawn steel and seamless hot-drawn steel boiler tubes. 4000 w. Ill. Jour Am Soc of Nav Engrs—May, 1902. No. 48445 H.

Engine Frames.

Stresses in Vertical Engine Frames (Die Ermittlung der Spannungen in den Ständern Stehender Dampfmaschinen). G. Schwarz. An analytical and graphical discussion of the stresses in the framework of vertical engines of the marine type. 3000 w. Zeitschr d Ver Deutscher Ing—May 17, 1902. No. 48926 D.

Engines.

A Comparison of Five Types of Engines. W. E. Dalby. Read before the Inst of Naval Archts. A comparison with respect to their inertia forces and couples, their increases in weight due to the addition of balance weights and the variations of turning moment on their crank shafts. 4000 w. Mech Engr—May 31, 1902. No. 48639 A.

Experiments on a Steam Engine. Bryan Donkin. An account of experiments made to test an engine in working conditions, while varying within certain limits the speed, power, pressure of steam, and amount of vacuum, and to determine the effect on the consumption and economy of the engine. 2800 w. Engr, Lond—May 23, 1902. No. 48469 A.

Growth and Development of the Steam Engine. Prof. A. W. Richter. Lecture delivered at the Buttermakers' Assn. Illustrated historical review. 4500 w. Wis Engr—May, 1902. No. 48588 D.

On the Determination of the Irregularity Factor of Engines. Dr. Rudolf Franke. A paper read before the Verband Deutscher Elektrotechnicker at Dresden. Translated from the *Elektrotechnische Zeitschrift*. Considers the disturbances to which the irregularity gives rise, the methods for determining the degree of irregularity and the meaning of this term to the electrical engineer. 2200 w. Elec Rev, Lond—May 30, 1902. Serial. 1st part. No. 48645 A.

Engine Test.

Investigations upon a 1000 H. P. Tandem Compound Engine (Untersuchung einer Tandem-Verbundmaschine von 1000 PS.) M. Schröter. Data and results of a test upon a Sulzer engine, using saturated and superheated steam. A steam consumption of 11.3 pounds per h. p. hour is shown. Serial. Part 1. 3000 w. 1 plate. Zeitschr d Ver Deutscher Ing—May 31, 1902. No. 48917 D.

Feed Water.

The Purification of Feed Water. From the report of C. E. Stromeyer to the Manchester Steam Users' Assn. dealing with results of an examination into the results obtained in practical working with various types of purifiers for feed water. Also his remarks on the cleaning of boilers worked without purifiers. 6500 w. Sci Am Sup—May 31, 1902. No. 48537.

Firing.

Rational Boiler Firing (Rationelle Kesselfeuerungen). F. Krull. Referring especially to internally fired boilers showing the advantages of the admission of air at the bridge wall. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—May 16, 1902. No. 48932 B.

Heating.

Low Pressure Steam and Warm Water Heating from the Same Boiler (Niederdruckdampf und Warmwasserheizung von einem und demselben Kessel aus). H. Heider. With diagram showing the connections to radiators and returns to boiler. 1000 w. 1 plate. Gesundheits-Ingenieur—May 31, 1902. No. 48934 B.

Liquid Fuel.

Liquid Fuel—Boiler Firing with Oil. James W. Warren and H. T. Edgar. On the advantages of liquid over solid fuel for steam generating, method of burning, etc. 2200 w. Elec Rev, N Y—June 21, 1902. Serial. 1st part. No. 49007.

Oil as Fuel. Data from New Orleans, Mobile and other cities regarding the utility and efficiency of Beaumont oil as fuel in street railway power stations. Considers the saving secured and the oil-burning apparatus. 5800 w. St Ry Rev—June 20, 1902. No. 49021 C.

Packing.

Steam Engine Packing. A. McSwiney. Abstract of a paper read before the Birmingham Assn. of Mech. Engrs. Discusses the various classes of packings and their influence on this economy of the engine. Ill. 5500 w. Mech Engr—May 31, 1902. No. 48640 A.

Piping.

Feed Water Mains and Branches. Illustrates and describes several arrangements, discussing their advantages. 1800 w. Power—June, 1902. No. 48509 C.

Powdered Fuel.

Pulverized Fuel for Power Plants. F. G. Gasche. Stating the advantages of pulverizing low grade fuels, and giving experimental results. 2500 w. R R Gaz—June 20, 1902. No. 49036.

Steam.

Steam: An article suggested by Mr. Stromeyer's paper on "Distortion of Boilers due to Overheating." Considers the existing state of the theory of the formation and nature of steam. 4800 w. Engr, Lond—May 30, 1902. No. 48660 A.

Steam Consumption.

The Estimation of the Steam Consumption of Engines. Explains methods of determining the quantity of steam required to develop any given horse-power. 1800 w. Prac Engr—May 23, 1902. Serial. 1st part. No. 48483 A.

Steam Heating.

A Time Limit and Dry Walls Necessary in Testing a Heating Plant. John Gormly. Read at meeting of the Am. Soc. of Heat. & Ven. Engrs. A report of data obtained while making heating tests in a new building. 1100 w. Met Work—June 21, 1902. No. 48880.

Heating a New York Residence. Illustrated description of the steam heating plant, mainly indirect, in a large house. 1700 w. Eng Rec—June 14, 1902. No. 48795.

The Heating of a New York Turkish-Russian Bath Establishment. Illustrated description of a plant, noteworthy for the filtration of the water from the swimming pool and its subsequent use in needle baths and laundry. 1500 w. Eng Rec—June 21, 1902. No. 48856.

Warming and Ventilation as Available for Public Buildings. Read at London meeting of the Inst. of Heat. & Ven. Engrs. Discusses the motive power used and the requirements of various classes of public buildings. 3300 w. Plumb & Dec—June 2, 1902. No. 48729 A.

Steam Turbine.

A Study of the New de Laval Steam Turbine (Etude Générale du Rendement des Nouvelles Turbines de Laval). M. Delaporte. A mathematical discussion of the discharge of steam and its action upon the buckets of the steam turbine. Serial. Part 1. 4000 w. Revue de Mécanique—May 31, 1902. No. 48912 E+F.

Notes on the Parsons Steam Turbine (Mitteilungen über Parsons-Dampfturbinen). With especial reference to the Parsons turbine as built by Brown, Boveri & Co. for use in Switzerland. Two articles, 2500 w. Schweizerische Bauzeitung—May 31, June 7, 1902. No. 48952 each B.

Stoking.

The Economy of Mechanical Stoking. W. W. Christie. Mr. Christie's first paper describes the leading types of mechanical stokers in actual use in Europe and America, with the principles of their operation. 3500 w. Engineering Magazine—July, 1902. No. 48984 B.

Superheating.

The Heating Value of Superheated Steam (Zur Frage des Wärmewertes des Ueberhitzten Wasserdampfes). C. Bach. Derivation of formulas for the computation of the heating power of steam superheated to various temperatures. 1000 w. Zeitschr d Ver Deutscher Ing—May 17, 1902. No. 48927 D.

The Schmidt System of Superheating Steam. Illustrated description. 2200 w. Elec Engr, Lond—June 13, 1902. No. 48867 A.

See Railway Engineering, Motive Power.

Valve Gears.

Beam Engine Valve Gears. Theodore Lucas. Calls attention to the remarkable accuracy and perfection of the steam distribution of the American beam engine, by a form of valve gear remarkably free from possibilities of derangement. Ill. 2200 w. Marine Engng—June, 1902. No. 48557 C.

MISCELLANY.

Aeronautics.

Aerial Navigation: the Progressive Development of Air Ships. Carl E. Myers. Reviews the early history of aerial navigation, tracing the progress and giving illustrated descriptions of various machines. Also describes the rain fall experiments, and gives other interesting information. 5500 w. Sib Jour of Engng—June, 1902. No. 48833 C.

Air-Ships and Flying-Machines. A. Santos Dumont. The author's views on the superiority of the air-ship to the flying-machine, and on the subject of aëronautics in general. 3400 w. N Am Rev—June, 1902. No. 48435 D.

The Severo Air Ship Catastrophe. An account of the accident in Paris, which resulted in the death of the Brazilian inventor Severo and his aid, Mr. Saché. 1300 w. Sci Am—June 7, 1902. No. 48616.

Flow.

A Discussion of Ledoux' & Unwin's Formulæ for the Flow of Air in Pipes, with Special Reference to Heating and Ventilating. H. Diederichs. 1300 w. Sib Jour of Engng—May, 1902. No. 48829 C.

High Temperatures.

The Law of Stéfan and the Measurement of High Temperatures (La Mesure des Températures Elevées et la Loi de Stéfan). M. Féry. Describing a method of determining high temperatures by the elevation in temperature of a body exposed to radiant heat. 1200 w. Comptes Rendus—April 28, 1902. No. 48965 D.

Liquid Air.

D'Arsonval on Liquid Air. An account of the interesting conference before the Société des Electriciens upon preparation and properties of liquid air, and the experiments shown. 1700 w. Sci Am Sup—June 14, 1902. No. 48757.

Refrigeration.

Recent Refrigerating Plants in Germany (Nouvelles Installations Réfrigérantes pour Brasseries en Allemagne). Describing the plants of the breweries at Ohlig, Nuremberg, Dortmund and Brunswick. 1800 w. 1 plate. Génie Civil—May 24, 1902. No. 48902 D.

Refrigeration and Refrigerating Mixtures (Kältemischungen und Kälteerzeugung). M. Grellert. A comparison of the relative advantages of refrigerating mixtures and refrigerating machinery for breweries. 2500 w. Gesundheits Ingenieur—May 31, 1902. No. 48933 B.

Water as a Refrigerating Agent. F. E. Mathews. Compares the evaporation of ammonia to that of water, giving table of comparative properties, etc. 2200 w. Ice & Refrig—June, 1902. No. 48582 C.

Seismograph.

Earthquake Recorders in America. Describes the instrument at Baltimore, and the records made by it. 500 w. Sci Am—June 7, 1902. No. 48619.

Ventilation.

The Ventilating of Domestic Dwellings. E. W. Mayner. Read at London meeting of the Inst. of Heat. & Ven. Engrs. How to obtain the best results. Discussion follows. 4500 w. Plumb & Dec—June 2, 1902. No. 48728 A.

MINING AND METALLURGY

COAL AND COKE.

Briquetting.

The Fuel Briquetting Industry in the United States. William G. Irwin. On the importance of utilizing waste coal and the methods employed, the practice in Europe and America, cause of early failures and recent progress. 5300 w. Ir Age—June 19 1902. No. 49000.

Canada.

Alberta Territory, Canada. Coal Fields on Crow's Nest Pass, Branch of the Canadian Pacific Railway. William M. Brewer. Describes the two distinct coal fields of this region, the development, extent, quality of coal, etc. 1600 w. Eng & Min Jour—May 31, 1902. No. 48513.

Coal Industry.

Development of the Coal Industry. William Gilbert Irwin. Reviews the history of this industry, the improvements in mining methods, the railway development due to this industry, the coking industry, etc. 2500 w. Gunton's Mag—June, 1902. No. 48431.

Coal Properties.

Legislation and Ownership of Coal Properties. Daniel Jones. Abstract of a paper before the South Staffordshire and East Worcestershire Inst. of Min Engrs. Discusses what legislation is needed to enable the nation to avail itself of the coal supplies existing under numberless small properties. 2700 w. Col Guard—June 6, 1902. No. 48771 A.

Coal-Washing.

The Campbell Coal-Washing Table. Clarence R. Claghorn. An illustrated description of an American washer. 1100 w. Ir & Coal Trds Rev—June 6, 1902. No. 48783 A.

Faults.

Overthrust Faults in the Somerset Coalfield. Abstract of paper by F. A. Steart, and of the discussion. Describes the disturbance and gives conclusions drawn from the study. 1500 w. Col Guard—May 30, 1902. No. 48653 A.

Illinois Coals.

The Coals of Illinois; Their Chemical Analysis and Calorific Value. S. W. Parr. A compilation of accumulated information arranged for reference. 1600 w. Technograph, No. 16—1901-2. No. 48-451 D.

Inspection.

Coal Mines Inspection in 1901. A report of the Midland district. 1800 w. Col Guard—May 23, 1902. No. 48457 A.

Coal Mines Inspection in 1901. A report of the Newcastle district concerning persons employed, output, accidents, etc. 1600 w. Col. Guard—May 30, 1902. No. 48652 A.

Japan.

Notes on the Takasima Coal Mines, Nagasaki, Japan. E. W. Nardin. Read before the Australian Inst. of Min. Engrs. Describes the occurrence and working of these coal seams, which comprise four islands near the entrance to Nagasaki harbor. Ill. 1300 w. Ir & Coal Trds Rev—June 13, 1902. No. 48878 A.

Peat.

The Utilization of Peat as Fuel. Describes a recently developed process for the making of peat coke, patented by Oscar Daube, and known as the "Economic Carbonization Process." Ill. 2000 w. Eng News—June 12, 1902. No. 48714.

Prospecting.

Prospecting for Coal in the Western States. Prof. Arthur Lakes. Points of resemblance and points of difference between he western and eastern coal fields. 2500 w. Mines & Min—June, 1902. No. 48672 C.

COPPER.

Assay.

The Cyanide Assay for Copper. Harry Huntington Miller. A discussion by Edward Keller of this paper which was presented at the Mexican meeting. 9000 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 48822.

The Litharge Process of Assaying Copper-Bearing Ores and Products, and the Method of Calculating Charges. Walter G. Perkins. Describes this method which has been severely tested and has never failed hitherto, in the assay of any ore or product to which it has been applied, though it may not be universally applicable. 1600 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 48824 C.

New Brunswick.

Copper Production in New Brunswick. An illustrated account of this promising mining industry near Dorchester. 1200 w. Can Min Rev—May 31, 1902. No. 48542 B.

Northern California.

The Copper Region of Northern California. J. S. Diller. Read before the Geological Soc. of Washington. An account of this region, which ranks fourth in importance in the copper-producing regions of the United States and of its ore deposits. 2500 w. Eng & Min Jour—June 21, 1902. No. 49025.

Ziervogel Process.

The Reactions of the Ziervogel Process and Their Temperature Limits. Robert Henry Bradford. Investigations of this process for extracting silver from copper mattes, to determine the conditions most favorable to the formation and those which cause the decomposition of the sulphates of iron, copper and silver respectively; and to finding out if these processes might not be made much easier by adding ferrous or cupric sulphate or an alkaline sulphate. 10200 w. Trans Am Inst of Min Engrs—Feb. and May, 1902. No. 48812 D.

GOLD AND SILVER.

Amalgamation.

The Patio Process for Amalgamation of Silver-Ores. Manuel Valerio Ortega. Notes offered as a contribution to the discovery of an exact theory concerning the patio process. 3500 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 48817 D.

Arizona.

Gold Deposits of Arizona. Joseph Hyde Pratt. Concerning the recent advance in the development of gold mining properties. Map. 1700 w. Eng & Min Jour—June 7, 1902. No. 48678.

Bendigo.

Gold Milling Practice at Bendigo. H. C. Boydell. Gives the main features of local gold milling practice, pointing out in what respects it differs from other large mining camps. 2500 w. Aust Min Stand—April 17, 1902. Serial. 1st part. No. 48628 B.

Brazilian Ores.

Notes on Brazilian Gold-Ores. Orville A. Derby. Describes features of special interest for students of the genesis of ore deposits. 2200 w. Trans Am Inst of Min Engrs—Feb. and May, 1901. No. 48819 D.

British Columbia.

The Present Position and the Potentialities of Mining in the Dry-Ore Belt of the Slocan District. W. D. McGregor. Information concerning these ores, considering them very promising. Map. 2500 w. B. C. Min Rec—June, 1902. No. 48761 B.

Cupelling.

The Losses of Silver in Cupelling with Varying Amounts of Lead and Silver. W. H. Kauffman. Reports results obtained in series of experiments made to determine losses. 600 w. Eng & Min Jour—June 14, 1902. No. 48845.

Dawson.

Conditions in Dawson. Information concerning transportation, mining, etc. 2200 w. U S Cons Repts, No. 1365—June 12, 1902. No. 48600 D.

Idaho.

The Geology of Thunder Mountain and Central Idaho. Robert Bell. An outline of the geology and topography of the region and the easiest means of access to this new gold field. 3000 w. Eng & Min Jour—June 7, 1902. No. 48677.

Klondike.

Gold Mining in Klondike. Prof. Henry A. Miers. Descriptive of the country, methods of mining, cost of living, etc. 5000 w. Pop Sci M—July, 1902. No. 49060 C.

Madagascar.

The Development of the Gold Deposits of Madagascar (Exploitation des Gisements Aurifères à Madagascar). H. Pérès. Discussing the geology of the

Madagascar placers and the present methods by which they are worked. 8000 w. Mem Soc Ing Civ de France—April, 1902. No. 48910 G.

Nome.

Mining Conditions in the Nome Region, Alaska. Arthur J. Collier. The decreased production and the causes are discussed. 700 w. Eng & Min Jour—May 31, 1902. No. 48514.

The Gold Sands of Cape Nome. A. L. Queneau. A fully illustrated description of the beach at Cape Nome, showing the methods of working the auriferous sand. 3500 w. Engineering Magazine—July, 1902. No. 48982 B.

Placers.

Placer Mining. Nelson Blount. Describes placers and methods of working. Ill. 2200 w. Yale Sci M—June, 1902. No. 48892 C.

Transvaal.

Gold Mining in the Transvaal, South Africa. John Hays Hammond. (Revised Edition). Discusses the mining titles, general features, history and financial conditions, etc., geological features, genesis of the auriferous banket, milling, treatment, etc. Ill. 1300 w. Trans Am Inst of Min Engrs—Feb., 1901. No. 48828 D.

Gold-Mining in the Transvaal, South Africa. John Hays Hammond. A discussion of this paper contributed by Thomas Haight Leggett, London, Eng. 4400 w. Trans Am Inst of Min Engrs—Feb., 1901. No. 48816 D.

The Transvaal Mines Under the New Regime. John Hays Hammond. An estimate of the probable value of the deposits, discussing the economic and mining conditions and probable industrial life under British rule. 3000 w. Engineering Magazine—July, 1902. No. 48981 B.

IRON AND STEEL.

Antwerp.

The Antwerp Iron and Steel Works. Illustrates and describes fine works in the course of erection, to consist of a blast furnace plant, a steel works, and a complete roll-train. It will include an iron and steel foundry, workshops, a large boiler house, smithy, etc. 3000 w. Ir & Coal Trds Rev—May 30, 1902. No. 48665 A.

Blast Furnaces.

Tests of the New Blast Furnace at Askam. A report of tests made of this furnace which is designed on what are popularly known as "American lines," although various modifications were introduced to meet the conditions. 900 w. Ir & Coal Trds Rev—June 6, 1902. No. 48781 A.

Lake Superior.

The Original Source of the Lake Superior Iron Ores. J. E. Spurr. An account of the writer's investigations and the conclusions drawn. 5400 w. Am Geol—June, 1902. No. 48710 D.

Re-Heating.

The Effect of Re-Heating Upon the Coarse Structure of Over-Heated Steel. K. Frederik Göransson. States what has been accomplished in the study of this subject and reports personal investigations. 3000 w. Trans Am Soc of Min Engrs—Feb. and May, 1902. No. 48826 C.

Rolling Mill.

The New Rolling Mill Plant of the Dortmund Union (Die Neue Walzwerksanlage der Dortmunder Union). H. Brauns. A very completely illustrated description of the large reversing mill recently erected at Dortmund. 3000 w. 1 plate. Stahl und Eisen—June 1, 1902. No. 48954 D.

Slags.

Slag-Constitution. Studied by Means of the Tri-Axial Diagram with Rectangular Co-ordinates. Harrison Everett Ashley. A discussion suggested by Prof. H. M. Howe's paper, "The Tri-Axial Diagram," and Prof. H. O. Hofman's paper, "The Temperatures at which Certain Ferrous and Calcic Silicates are Formed in Fusion." 7000 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 48814 D.

Steel Rails.

A Few Remarks Concerning Steel Rails. Albert Sauveur. Remarks on paper by Sir Lowthian Bell concerning strength of rails. 1100 w. R R Gaz—June 6, 1902. No. 48610.

The Present Situation as to Specifications for Steel Rails. William R. Webster. A detailed statement of the present situation, showing the work thus far done. 1800 w. Trans Am Inst of Min. Engrs—May, 1902. No. 48820.

MINING.

Arizona.

The Tombstone, Arizona, Mining District. John A. Church. A description of this most puzzling mining district. Maps and illustrations. 10300 w. Trans Am Inst of Min Engrs—Feb. & May, 1902. No. 48813 D.

Auditing.

Auditing a Mining Company's Accounts. Charles V. Jenkins. On the importance of an audit, the difficulties met and methods applicable. 6000 w. Mines & Min—June, 1902. No. 48670 C.

Bauxite.

Bauxite Mining in Georgia. A. W. Evans. Description of methods employed in mining, washing and drying the ores. Also analyses of Georgia and French ores.

1700 w. Mines & Min—June, 1902. No. 48667 C.

Drilling.

Core Drilling with the Davis Calyx Drill. L. V. Emanuel. Illustrates and describes this drill and the method of operating. 3500 w. Sch of Mines Qr—April, 1902. No. 48840 D.

Exposition.

Mining Appliances at the Düsseldorf Exposition (Der Bergbau auf der Düsseldorfer Ausstellung 1902). H. Hecker. Illustrating and describing especially the improved forms of mine hoisting machinery exhibited. 8000 w. 12 plates. Glückauf—May 24, 1902. No. 48958 B.

Explosions.

Safety Lamps and Colliery Explosions. Reviews reports of recent explosions given in the Blue-book recently issued, and discusses the safety lamps used in British mines. 4200 w. Engr, Lond—May 23, 1902. No. 48468 A.

Explosives.

The Evolution of Mining Explosives. Gives particulars pointing to the conclusion that the departure from gunpowder to high explosives is a failure as regards safety and a loss in the economical working of coal mines. 2600 w. Col Guard—May 23, 1902. No. 48458 A.

Haulage.

Intermediate Side Track for Tail-Rope Haulage. L. L. Logan. Illustrates and describes a plan as operated at the Slope mine at Robertsdale, Pa. 800 w. Mines & Min—June, 1902. No. 48669 C.

See Electrical Engineering Power Applications.

Hoisting.

Hoisting and Haulage in Mining Operations—A Description of the Plant on the Le Roi Mine, Rossland, B. C. Bernard MacDonald. A description of this plant and the economies affected by its operation. Ill. 11300 w. Can Hin Rev—May 31, 1902. No. 48545 B.

Hoisting Apparatus at the Erdwachs Mine at Boryslaw (Förderschachtanlage auf den Erdwachsgruben in Boryslaw). A. Lukaszewski. Describing the electric hoisting plant used at the mines at Boryslaw in Galicia, in connection with the deepening of the shaft. 2500 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—June 7, 1902. No. 48956 B.

See Electrical Engineering, Power Applications.

Steam v. Electrically Driven Winding Engines. An interesting comparison made by F. Buschmann. 500 w. Ir & Coal Trds Rev—May 23, 1902. No. 48473 A.

Winding Engine at Sherwood Colliery. Illustrated description of a direct-acting Corliss winding engine. 1000 w. Ir & Coal Trds Rev—June 6, 1902. No. 48782 A.

Winding Plants for Great Depths. Hans C. Behr. Read before the Inst. of Min. & Met., London. Full paper with illustrations. An investigation of the various systems proposed. Vertical winding only is considered. 26000 w. Col Guard—May 23, 1902. No. 48456 A.

Mexico.

The Geographic and Geologic Features, and Their Relation to the Mineral Products of Mexico. Robert T. Hill. Describes the four physiographic provinces; (1) the Gulf coastal plain; (2) the Cordilleran plateau; (3) the Sonoran; (4) the Tehuantepecan province. 5400 w. Trans Am Inst of Min Engrs—June, 1902. No. 48827 C.

Mining.

Boring, Shaft Sinking and Underground Work (Tiefbohrung, Schachtabteufen, Abbau, und Grubenbetrieb). H. Herbst. Illustrating and describing the improved mining methods and apparatus exhibited at Düsseldorf. 3500 w. 5 plates. Glückauf—June 7, 1902. No. 48960 B.

Mining Machinery.

Mining Machinery of the South Sea Islands. Brief illustrated descriptions of odd types of mining devices used by natives. 1300 w. Min Rept—June 12, 1902. No. 48799.

Steam Driven Mining Machinery (Berg und Hüttenwerksmaschinen mit Dampfbetrieb). H. Dubbel. A review of the motive power machinerv for mining and metallurgical uses, shown at the Düsseldorf exposition. Serial. Part 1. 2500 w. Zeitschr d Ver Deutscher Ing—June 7, 1902. No. 48920 D.

Ontario.

Eastern Ontario: A Region of Varied Mining Industries. Willet G. Miller. Calling attention to the great variety of mineral deposits which are being worked in the eastern part of the Province. Nickel and copper, gold, iron, arsenic, pyrite, corundum, mica, talc, graphite, feldspar, cement, etc.. 7300 w. Can Min Rev—May 31, 1902. No. 48544 B.

Ore-Crests.

The Mineral Crest, or the Hydraulic Level Attained by the Ore-Depositing Solutions, in Certain Mining Districts of the Great Salt Lake Basin. Walter P. Jenney. Describes observed phenomena. considering conditions attending their formation. 1600 w. Trans Am Soc of Min Engrs—Feb. and May, 1902. No. 48823 C.

Ore-Deposits.

Problems in the Geology of Ore Deposits. Prof. J. H. L. Vogt. Discussion by Walter Harvey Weed, criticizing views in this paper which was presented at the Richmond meeting. 1200 w. Trans Am Inst of Min Engrs—Feb., 1901. No. 48821.

Pumping.

Centrifugal Pumps for Mine Work. W. R. Crane. Discusses the service for which they are adapted, and methods and principles of construction. Ill. 3800 w. Mines & Min—June, 1902. No. 48671 C.

The Pumping Machinery at the Düsseldorf Exposition (Die Wasserhaltungsmaschinen auf der Düsseldorfer Ausstellung). Dr. H. Hoffmann. Describing especially the exhibits of mining pumps and draining machinery. 3000 w. 8 plates. Glückauf—May 31, 1902. No. 48959 B.

See Electrical Engineering, Power Applications.

Rock Drill.

The Francois Rotary Rock Drill. N. Orban, in *Revue Universelle des Mines, de la Métallurgie, etc.* Describes and illustrates the three types employed at the Werister Colliery in Belgium. 1100 w. Coal Guord—June 13, 1902. No. 48872 A.

Safety Devices.

Safety Devices for Mine Hoists (Sicherung des Förderbetriebes durch Besondere Apparate). A. Schlüter. Describing improved forms of safety brakes and position indicators for deep mine hoists. 3000 w. 3 plates. Glückauf—May 17, 1902. No. 48957 B.

Safety Lamp.

Hübner's Benzine Safety Lamp (Hübner's Benzin-Sicherheitslampe). H. Rössner. The lamp is provided with a special device, enabling it to be lighted after closing. 1200 w. Oesterr Zeitschr f Berg u Hüttenwesen—May 17, 1902. No. 48955 B.

Shaft-Sinking.

Recent Shaft Sinking in Europe by the Freezing Method. Description of three shafts, 447, 456 and 787 feet deep, respectively, sunk by means of the Poetsch method. 1700 w. Eng Rec—June 14, 1902. No. 48794.

United Kingdom.

Mining Employment, Output and Accidents in 1901. A summary of the general results of the year as given in the General Report just issued. 1000 w. Col Guard—May 30, 1902. No. 48654 A.

Vancouver.

Notes on the Economic Minerals of Vancouver Island, B. C. W. F. Best. The most important economic minerals are copper, coal and iron, but gold, silver and other minerals are found. The interior has not yet been explored. 1600 w. Can Min Rev—May 31, 1902. No. 48543 B.

Veins.

Notes on the Structure of Ore-Bearing Veins in Mexico. Edward Halse. Illustrates and describes some of the characteristics of these veins. 2800 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 48815 D.

MISCELLANY.

Corundum.

Occurrence and Distribution of Corundum in North Carolina and Georgia. Joseph Hyde Pratt. Abstract from Bulletin 180 of the U. S. Geol. Survey. Illustrated description of the deposits and information concerning them. 2500 w. Sci Am Sup—June 14, 1902. No. 48756.

Education.

The Education of Mining Engineers, Surveyors, Metallurgists and Iron Metallurgists in Germany. J. J. Monaghan. A review of the mining schools and their courses. 3500 w. Mines & Min—June, 1902. No. 48675 C.

Nickel.

The Mond Process for the Extraction of Nickel (Le Procédé Mond pour l'Extraction du Nickel). Léon Guillet. A general account of the process with details of the apparatus. 2000 w. Génie Civil—May 31, 1902. No. 48905 D.

Petroleum.

A Brief Account of the Petroleum Industry (Korte Aanteekeningen betreffende Petroleum en de Petroleum-Industrie). C. L. M. Lambrechtsen Van Ritthem. Discussing especially the oil wells and petroleum industry of the Dutch East Indies. 6000 w. De Ingenieur—March 22, 1902. No. 48966 D.

Petroleum and Petroleum Vapor. J. H. Heck. A lecture before the Marine Engrs. Inst., England. Information concerning the crude oil and the various products derived from it, and their uses. 3500 w. Engrs Gaz—June, 1902. No. 48732 A.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in April. Classified list of principal accidents. 2500 w. R R Gaz—May 30, 1902. No. 48532.

Dispatching.

Car Dispatching. An illustrated article

giving an outline of the Methods employed on the Washington, Alexandria, & Mt. Vernon Ry. Dispatching is done entirely by telegraph. 2800 w. St Ry Rev—June 20, 1902. No. 49024 C.

Express Trains.

Between London and Paris. A comparison of routes, service, gradients, speed, etc., of the English and French lines. Ill. 2100 w. Transport—June 6, 1902. No. 48765 A.

Railway Accelerations—English and French. Charles Rous-Marten. Gives details of improved service on both English and French lines. 2500 w. Engr, Lond—June 6, 1902. No. 48777 A.

Management.

Railway Management and the Civil Engineer. Theodore Voorhees. Lecture before the College of Civil Engineering. Suggestions on the relation between the civil engineer and the railway management, giving notes on the general organization of a railway company. 6000 w. Trans Assn of Civ Engrs of Cornell Univ—1902. No. 48592 F.

Operation.

Progress Toward Safer Railway Operation. Editorial discussion of the record of casualty in the United States for the last 13 years as given in the annual report of the Interstate Commerce Commission. 1600 w. Eng News—June 19, 1902. No. 49029.

Resistance.

Train-Resistance. J. A. F. Aspinall. Extracts from a paper presented before the (British) Inst. of Civ, Engrs., setting forth details and results of some very elaborate experiments to ascertain the resistance of trains. Plate. 5000 w. R R Gaz—June 20, 1902. No. 49037.

Special Trains.

Express Trains at Four-Minute Intervals on an English Railway. Extract from an English paper concerning the arrangements for the extra traffic at the celebration over the coronation of the King. 900 w. Eng News—June 12, 1902. No. 48717.

Statistics.

Ton-Mile Basis for Engine Service Statistics. Gives a form of locomotive and car performance sheet devised by Jno. M. Taylor of the Illinois Central R. R., with remarks on the completeness in detail, etc. 000 w. Ry & Engng Rev—June 14, 1902. No. 48847.

Train Service.

The London and Northwestern Company's Accelerated Train Services. Information concerning improved service between London, Manchester and Liverpool, and between Wolverhampton, Birmingham and London. 2500 w. Transport—May 30, 1902. No. 48637 A.

Train Speed.

Concerning the Cost of Train Speed. Editorial discussion of the importance of the speed of freight trains, and the chance for economy. 1400 w. R R Gaz—June 13, 1902. No. 48749.

Tyrol.

The Railway Question in the Northern Tyrol (Die Nordtirolische Eisenbahnfrage). Victor Witasek. A review of present and projected railways in the northern Tyrol, showing the necessity for improvement. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—May 16, 1902. No. 48931 B.

MOTIVE POWER AND EQUIPMENT.

Boilers.

See Mechanical Engineering, Steam Engineering.

Brakes.

Report of Committee on High Speed Brakes. Report, with illusrated description of automatic reducing valve and general dimension. 13500 w. Cent Ry Club—May, 1902. No. 48731 C.

Car Design.

The Course in Car Design at Purdue University. William Forsyth. A description of the course as conducted during the fall term of 1901. 2400 w. R R Gaz—June 13, 1902. No. 48747.

Cars.

Advantages and Disadvantages of Standard Box Cars. H. H. Perkins discusses what is regarded as the standard car, and their loads and handling. General discussion follows. 4000 w. Cent Ry Club—May, 1902. No. 48730 C.

Combined Tank and Gondola Car. Illustrates and describes a car designed with the object of providing a tank car which will hold and carry the maximum weight of liquid, and which when empty may be utilized as a flat or box car for transporting freight. 800 w. Ry & Eng Rev—June 25, 1902. No. 49018.

50-Ton Steel Coal Car (Vanderbilt Type): West Virginia Central & Pittsburg Ry. Illustrates and describes the design and construction of hopper-bottom coal cars. 800 w. Eng News—June 19, 1902. No. 49031.

Four-Wheeled Cabin Car. Southwest System Pennsylvania Lines. Detailed drawings and description of a recently designed car for freight train crews, making their quarters more comfortable and commodious. 1100 w. Ry & Engng Rev—June 14, 1902. No. 48846.

Modern Car Design. C. A. Seley. Considers the general principles of importance in this line of engineering. 2000 w. Am Engr & R R Jour—June, 1902. No. 48574 C.

100,000 Lbs. Capacity Steel Ore Cars for the Great Northern Ry. Illustrated detailed description of design from which 300 cars have been ordered. 1800 w. Ry & Engng Rev—June 14, 1902. No. 48850.

Self-Dumping Cars in Railroad Construction. Day Allen Willey. An illustrated article on the remarkable work done by these cars in the building of railroads. 900 w. Sci Am—June 7, 1902. No. 48618.

60,000 Lbs. Capacity Logging Car, A. T. & S. F. Ry. System. Illustrated description of cars built for service in the lumber districts of Northern Texas. 900 w. Ry & Engng Rev—June 21, 1902. No. 49019.

Continental Practice.

Features of Continental Locomotive Building. Chas. R. King. Mr. King's second paper illustrates and discusses very fully the locomotives of Italy and Austria-Hungary. 4500 w. Engineering Magazine—July, 1902. No. 48985 B.

Couplers.

A Diagnosis of M. C. B. Coupler Defects, Based on Results Obtained in Service. R. D. Smith. Gives statistics concerning couplers and their performance, showing the comparative strength of the different parts of the mechanism. General discussion follows. 6800 w. W Ry Club—May 20, 1902. No. 49002 C.

Draft Gears.

Some Modern Draft Gears. Brief illustrated descriptions of various types. 1200 w. R R Gaz—June 13, 1902. No. 48745.

Report of Committee on Draft-Rigging in Relation to the Whole Cars. Report and general discussion. 4700 w. W Ry Club—May 20, 1902. No. 49003 C.

Road Tests of Spring and Friction Draft Gears. Remarks on the tests on the Lake Shore & Michigan Southern, and the Bessemer and Lake Erie, made with a view to determine the amount of shocks in ordinary service, the amount in rough and extreme service, and the behavior of the two types of gears. Conclusions from the results. 2200 w. R R Gaz—June 13,1902. No. 48741.

Firing.

Locomotive Firing. T. J. Hoskins. The present article discuss s theoretical and practical points, and the science of light and heat. 1500 w. Loc Engng—June, 1902. Serial. 1st part. No. 48567 C.

Locomotives.

Atlantic Type Fast Passenger Locomotive. Illustrated detailed description of Class E2 fast passenger locomotive. 1200 w. Am Engr & R R Jour—June, 1902. No. 48580 C.

Balancing Locomotives. W. E. Dalby. A formal proof that the only force acting to constrain the motion of a balance-weight in its trochoidal path, passes through the center of the axle, and therefore the balance-weights have no effect on the crank-axle. 900 w. Engng—June 13, 1902. No. 48873 A.

Baldwin Decapod for the Santa Fe. Illustrated detailed description of a powerflu engine for freight service on the mountain division of this road. 1700 w. Ry Age—May 30, 1902. No. 48510.

Building of American Locomotives. The present article deals with the Baldwin Locomotive Works. Ill. 2400 w. Sci Am—June 7, 1902. Serial. 1st part. No. 48617.

Competitive Locomotive Types for the Illinois Central. Illustrates and describes two designs by Mr. William Renshaw, of the wide firebox type for passenger service. Their performance is to be carefully watched to determine which of the two to adopt for general use. 1500 w. R R Gaz—June 20, 1902. No. 49033.

Decapod Tandem Freight Locomotive. Illustrated description of this locomotive for the A. T. & S. F. R. R. which is supposed to be the most powerful in the world. 600 w. Am Engr & R R Jour—June, 1902. No. 48581 C.

Duplex Tank Locomotive. Illustration and brief description of a trial locomotive on the Mallet system for use on French railways. 500 w. Engr, Lond—May 23, 1902. No. 48470 A.

Good Work of a Tandem Compound. Report of engine No. 1705 on the Baltimore & Ohio R. R. 600 w. Loc Engng—June, 1902. No. 48565 C.

Large Modern Locomotives—Repairs and Loading. William McIntosh. Discusses these points in their relation to the greatest economy and the best results. 900 w. Am Engr & R R Jour—June, 1902. No. 48577 C.

Locomotive Traction Increasers. Edward Grofstrom. Discussion of the types recently put into service on the Atchison, Topeka & Santa Fe. 1000 w. Am Engr. & R R Jour—June, 1902. No. 48576 C.

New Locomotive Equipment for the St. Louis & San Francisco R. R. Illustrated detailed description of the three types of engines most recently constructed. 1600 w. Ry & Engng Rev—June 21, 1902. No. 49016.

New Power for the Frisco System. Illustrates and describes two types of engines recently built. A consolidation and a 10-wheel passenger, in which as many castings and forgings as possible are made interchangeable. 1000 w. Ry Age—June 13. 1902. No. 48796.

New Suburban Engines of the Central Railroad of New Jersey. Illustrated description of engines of the Prairie type having features of interest. 1200 w. R R Gaz—June 20, 1902. No. 49034.

Notes on Some Twentieth Century Locomotives. Charles Rous-Marten. Paper read before the Soc. of Engrs. Indicates the writer's opinion of what appear to be some of the most prominent, interesting and important features in the locomotive practice of this century so far as it has yet gone. 4500 w. Mech Engr—June 7, 1902. Serial. 1st part. No. 48764 A.

Repairing Locomotives by Schedule. A detailed description of the scheme in use at the Chicago shops of the Chicago & Northwestern with one of the schedules. 1600 w. R R Gaz—June 13, 1902. No. 48744.

Roumanian Locomotives. Illustrated description of the standard type of goods engine for the Roumanian State Railways. 600 w. Engng—June 6, 1902. No. 48774 A.

Should Railroads Design Their Own Locomotives? F. F. Gaines. Answers the question in the affirmative (conditionally), and discusses details frequently overlooked by builders. 1600 w. Am Engr & R R Jour—June, 1902. No. 48575 C.

Six-Wheeled Coupled Bar-Frame Passenger Locomotive for the Cape Government Railways. Illustrated description, with two-page plate. 800 w. Engng—May 23, 1902. No. 48463 A.

The Advantages of an Oil Burning Locomotive. G. B. Von Boden. Concerning the arrangements for burning the oil and methods for successful operating, with statement of the advantages. 1200 w. Loc Engng—June, 1902. No. 48569 C.

The Largest Geared Locomotive Yet Built—El Paso & Rock Island Route. General view, with description and general dimensions. 1500 w. Ry & Engng Rev—June 14, 1902. No. 48848.

The N. Y. C. Traction Increaser. Illustrated description of the mechanism as given by George S. Hodgins. 2000 w. Loc Engng—June, 1902. No. 48566 C.

Two-Cylinder Compound Consolidation for the Wheeling and Lake Erie R. R. Illustrates and describes an engine designed to burn bituminous coal and for a working boiler pressure of 200 lbs. 1000 w. Ry & Engng Rev—June 7, 1902. No. 48707.

Oil Fuel.

Oil Fuel for Locomotives. Concerning the application of oil fuel to the Hoosic Tunnel helping locomotives by the Boston & Maine Railroad, with the object of keeping the tunnel clear of smoke from the coal-burning engines. 1200 w. Am Engr & R R Jour—June, 1902. No. 48579 C.

Rolling Stock.

Standards for Locomotives and Cars. Concerning the standardizing of equipment on the "Harriman Lines." Ill. 800 w. Am Engr & R R Jour—June, 1902. No. 48572 C.

Staybolts.

Staybolt-Breakage. A report kept during the year 1901, by a southwestern railroad of the breakage of staybolts in order to determine the influence of the water on this breakage. Illustrations showing the location of the broken staybolts. 2000 w. R R Gaz—June 13, 1902. No. 48739.

Superheating.

The Application of Superheated Steam to Locomotives (Applications de la Vapeur Surchauffée aux Locomotives). T. Barbier. Discussing especially the experiments made with the Schmidt System on locomotives built by Borsig for the Prussian State Railways. 2000 w. 1 plate. Génie Civil—May 31, 1902. No. 48904 D.

Superintendence.

The Superintendent of Motive Power and What Is Expected of Him. A general discussion of his responsibilities and requirements and how best to fit him for his work. 3400 w. R R Gaz—June 13, 1902. No. 48742.

Wheels.

Cast Iron Wheels Under Heavy Cars. Information obtained by recent investigations, confirming the opinion that with proper materials and design and correct methods of manufacture the cast-iron wheel may be made adequate for any service now required. Ill. 3000 w. R R Gaz—June 13, 1902. No. 48743.

Some Experience with Special Wheels in Heavy Service. P. H. Griffin. States experience of a company having a reputation for special wheels for exacting service, and shows the effect of manganese in promoting the class of fractures which have given alarm. 1500 w. R R Gaz—June 13, 1902. No. 48748.

NEW PROJECTS.

Asia.

Railroad Development in Asia. Compiled by C. T. Mason. Information of what has already been done, and what it is proposed to accomplish in India, Asiatic Russia, Asia Minor, China, and Indo-China. 1700 w. Sci Am Sup—June 21, 1902. No. 49012.

Borneo.

Railway Enterprise in British North Borneo. Map with illustrated description of a recently opened line and account of the scheme for a trans-Borneo line to terminate at Cowie Harbor. 1000 w. Engr, Lond—May 30, 1902, No. 48662 A.

Cuba.

Railroads in Cuba. Waldon Fawcett. An illustrated account of the existing and prospective lines. 1500 w. Sci Am—May 31, 1902. No. 48535.

The New Cuban Railroad. Waldon Fawcett. An illustrated account of the project now being carried out, for the construction of a complete railroad system throughout the length of the island. 1200 w. Loc Engng—June, 1902. No. 48570 C.

Indiana.

A New Railway Between Chicago and Cincinnati. Illustrated description of a nearly completed line about 30 miles shorter than existing routes. 1600 w. Eng News—June 19, 1902. No. 49028.

Ottoman Empire.

The Persian Gulf Railway. A brief account of the alternative routes which have been from time to time put forward, and their engineering merits and demerits. Map. 2400 w. Engng—June 6, 1902. Serial. 1st part. No. 48773 A.

Russia.

The Connection of the Central Railway of Asia with the European Russian System (Die Verbindung der Mittel-Asiatischen Eisenbahn mit dem Russisch-Europäischen Eisenbahnnetz). An account of the new line to connect Tashkent and Orenburg and unite the Trans-Caspian system with Europe. 1000 w. Glasers Annalen—June 1, 1902. No. 48900 D.

PERMANENT WAY AND FIXTURES.

Curves.

A Problem in Railroad Curves. Malverd A. Howe. Mathematical demonstration. 700 w. R R Gaz—June 20, 1902. No. 49038.

Suggestions for a Uniform Practice in Fixing the Lengths of Spiral Curves. W. D. Taylor. Gives tables connecting the degree of curve, amount of superelevation, the maximum velocity and lengths of spiral, with suggestions for making an economical adjustment. 2000 w. Wis Engr—May, 1902. No. 48589 D.

Engine House.

New Engine House on the Boston & Maine at East Cambridge. Illustrated description. 900 w. R R Gaz—June 13, 1902. No. 48740.

Improvements.

Jacques Cartier Cut-off. John David Black. Illustrates and describes details of an improvement made on the Quebec, Lake St. John railway. 1400 w. Can Engr—June, 1902. No. 48634.

Shops.

Chicago & Northwestern Shop Enlargements at Chicago, Ill. An illustrated account of the extensive improvements being made. 1800 w. Ry Age—May 30, 1902. No. 48511.

Mexican Central Shops at Aguascalientes, Mex. An account of improvements at this place with description of the new shops and their equipment. Ill. 1000 w. Ry Age—June 6, 1902. No. 48693.

Michigan Central Shops at Jackson, Mich. Illustrated description of extensive improvements being made. 1200 w. Ry Age—June 20, 1902. No. 49014.

Pennsylvania Division Shops of the N. Y. C. & H. R. R. R. Gives list of new installations, and illustrated description of shops at Oak Grove, Penn., for locomotives and freight car repairs. 2500 w. Ry & Engng Rev—May 31, 1902. No. 48507.

Progress in Locomotive and Car Shop Plans. Editorial comments on the great improvement shown in recently built shops, calling attention to points of interest. 2600 w. R R Gaz—June 20, 1902. No. 49039.

Suggestions Concerning Locomotive Erecting Shops. C. H. Quereau. Remarks presented with the view of stimulating study and investigation. 1200 w. Am Engr & R R Jour—June, 1902. No. 48578 C.

The Baring Cross Shops of the St. Louis, Iron Mountain & Southern Railway. Illustrates and describes this new plant, calling attention to the symmetry and convenience of the track and building arrangements. 3000 w. Ry Age—June 13, 1902. No. 48797.

The Cedar Lake Shops of the Minneapolis & St. Louis R. R. Illustrated description of shops of interest because of their location, and local conditions, and for their labor-saving devices. 4000 w. Ry & Engng Rev—June 21, 1902. No. 49017.

The Hannibal Shops of the Chicago, Burlington & Quincy Railroad. Illustrated detailed description of the recently completed shops and their equipment. 4300 w. St. Louis Ry Club—May 16, 1902. No. 48498.

The Roanoke Shops of the Norfolk & Western. Brief description of extensive improvements, involving a complete change in the power plant. 1300 w. R R Gaz—June 20, 1902. No. 49035.

Signals.

Mechanical Fog Signal Appliance. Illustrates and describes Pindar's apparatus which places detonators on the rails by mechanical means. If necessary the detonator may be withdrawn when the engine is within a foot of it. 1000 w. Engr, London—June 6, 1902. No. 48780 A.

Station.

Passenger Transfer Station at Philadelphia, Pennsylvania R. R. Plan and brief description of improvement of terminal facilities. 500 w. Eng News—June 12, 1902. No. 48713.

Steel Ties.

Steel Ties Coming. Remarks on the growing scarcity of wood, and its displacement by steel, with brief notice of works being erected for the manufacture of steel ties on a large scale. 900 w. Loc Engng—June, 1902. No. 48571 C.

Switch Renewals.

Crossing and Slip Switch Renewals on the Chicago and Western Indiana R. R. Illustrates and describes improvements in certain features of slip switch design, and the interesting methods pursued in the work of renewal. 1400 w. Ry & Engng Rev—May 31, 1902. No. 48506.

Versailles.

The New Line from Paris to Versailles (Nouvelle Ligne de Paris à Versailles). A. Dumas. A description of this new section of the Western Railway of France, with especial reference to the construction of the Meudon tunnel. 4000 w. 1 plate. Génie Civil—June 7, 1902. No. 48906 D.

TRAFFIC.

Freight.

Freight Transfer Houses and Consolidation of Picked-Up Freight. Edwin H. Lea. Gives suggestions which the writer feels would materially improve the present service. 2000 w. R R Gaz—June 20, 1902. No. 49040.

Handling Merchandise Freight on British Railroads. Outlines the conditions of freight service in Great Britain, and gives an account of recent changes made at Crewe by the London & Northwestern Ry. 1500 w. R R Gaz—June 6, 1902. No. 48612.

Railroad Freight Handling in New York City. Illustrated description of the system of lightering in New York harbor, method of handling the cars, etc. 1000 w. Sci Am—June 14, 1902. No. 48754.

Interstate Commission on the Right to Route Freight. The conclusions of the majority opinion, and the dissenting opinion of Chairman Knapp, are given practically in full, in the cases regarding the right of carriers to control the routing of shipments of fruit. 5000 w. Ry Age—June 6, 1902. No. 48692.

Per Diem.

"Per Diem" Runs Against the First Snag. Discussing the action of the Boston & Maine, and New York, New Haven and Hartford roads concerning the transportation of cotton. 2000 w. Ry Age—June 20, 1902. No. 49013.

Rates.

The Nebraska Maximum Rate Decision. S. M. Hudson. A study of this decision concerning the justness of certain rates. 2600 w. Ry Age—June 6, 1902. No. 48694.

MISCELLANY.

Historical Review.

Early History of the Delaware, Lackawanna & Western Railroad and Its Locomotives. Herbert T. Walker. This road is a consolidation of a number of short railroads, and it is proposed to take up each separately, showing the growth of the system from the smallest beginnings, and also the development of the locomotives. Ill. 5200 w. R R Gaz—May 30, 1902. Serial. 1st part. No. 48530.

Testing Laboratory.

The Relation of a Testing Laboratory to a Large Railway System. J. C. Thorpe. An account of the work of a railway laboratory, showing its relation to the railway system, and hence its value. 1600 w. Technograph—No. 16—1901-2. No. 48447D.

Timber Preserving.

The Timber Preserving Plant of the Great Northern. Illustrations and information concerning one of the largest preserving plants in the country, having a capacity of 4,000 ties a day. Located on Flat Head Lake, Montana. 1600 w. R R Gaz—May 30, 1902. No. 48531.

STREET AND ELECTRIC RAILWAYS

STREET RAILWAYS AND TRAMWAYS.

Acceleration Tests.

Comparative Acceleration Tests with Steam Locomotive and Electric Motor Cars. B. J. Arnold and W. B. Potter. A report of tests for determining the comparison on short-haul suburban passenger service, in connection with the preparation of a report on the use of electricity for their propulsion in the tunnel entrances and terminal in New York City. Ill. 2000 w. Trans Am Inst of Elec Engrs—June 19, 1902. No. 49042 D.

Air Resistance.

Results of Tests for Air Resistance on the Berlin-Zossen Experimental High Speed Line. Gives curves showing the relation between air pressure and speed, with account of tests. 1300 w. St Ry Jour—June 7, 1902. No. 48551 D.

Berlin.

The Berlin Metropolitan Railway (Métropolitain Electrique de Berlin). H. Martin. Illustrating and describing especially the power station and the rolling stock of the Berlin electric railway. 2500 w. 1 plate. Génie Civil—May 17, 1902. No. 48928 D.

Brake.

Electric Brakes for Street Railway Cars (Die Elektrische Bremsung der Strassenbahnwagen). M. Müller. Giving a number of diagrams showing the action and advantages of electric brakes on tramways. 6000 w. Elektrotech Zeitschr—June 12, 1902. No. 48950 B.

Bridge Connections.

East River Bridges Connecting Line. Julius Meyer. Extracts from an address delivered before the Board of Rapid Transit Commissioners discussing the requirements of this line. 900 w. R R Gaz—June 6, 1902. No. 48611.

Connecticut.

Steam, Trolley and Third Rail in Connecticut. Clarence Deming. Discusses problems of electric transportation as affected by the peculiar conditions of this state, especially the developments of the past year. 2100 w. R R Gaz—June 6, 1002. No. 48608.

Electric Traction.

Electric Traction on Roads and Mineral Railways. W. R. Cooper. Discusses whether the cost will make it advantageous to use as a means of transporting from mines to railroads. 1800 w. Ir & Coal Trds Rev—June 6, 1902. No. 48785 A.

Mechanical Engineering of an Electric Railway. H. P. Quick. A general review of the administrative and maintenance departments of an electric traction system, based upon the operation of the transport systems of Boston, Mass. 4000 w. Engineering Magazine—July, 1902. No. 48983 B.

The Cost of Electric Traction. Editorial review of a recent paper by Prof. C. A. Carus-Wilson under the title of "Electrical Traction on Steam Railways in Italy." 2500 w. Engng—May 30, 1902. No. 48659 A.

Elevated Railroad.

The Elevated Structure of the Atlantic Avenue Improvement, Brooklyn. Illustrated description of the steel-work designed for the improvements made to remove the Long Island Railway tracks from the surface. 3000 w. Eng Rec—June 17, 1902. No. 48682.

The Elevated Structure of the Atlantic Avenue Improvements. Discusses some of the peculiar features in the design of elevated railways in Brooklyn. 1200 w. Eng Rec—June 14, 1902. No. 48786.

Europe.

Electric Railway Practice on the Continent of Europe. Heinrich Vellguth. An illustrated article giving important information relating to the electric railway practice of Germany, France, Switzerland, and Holland. 2200 w. St Ry Jour—June 7, 1902. No. 48547 D.

Express Service.

Electric Freight and Express Service for Eastern Ohio. An illustrated account of the methods which have proved successful on the Cleveland and Eastern Ry. 2500 w. St Ry Jour—May 31, 1902. No. 48489 D.

Freight Business.

Freight Business on the Chicago, Harvard & Geneva Lake Railway. An illustrated article indicating the volume and kind of business in a farming community and related matters of interest. 2000 w. St Ry Jour—June 7, 1902. No. 48550 D.

Handling Crowds.

Handling Traffic at the Inter-State and West Indian Exposition, Charleston, S. C., Jan. 1 to May 31, 1902. Describes the arrangement made to accommodate the public and meet the conditions, and gives a comparative statement of earnings and expenses. Ill. 3500 w. St Ry Rev—June 20, 1902. No. 49020 C.

High Speed.

The Speed Tests on the Military Railway between Marienfelde and Zossen (Die Versuchsrfahrten auf der Militäreisenbahn zwischen Marienfelde und Zossen). H. Lochner. Data and results of the trials of September to November, 1901. Speeds of 130 Kilometres per hour were attained. Two articles, two plates. 7500 w. Glasers Annalen—May 15, June 1, 1902. No. 48929 each D.

Italy.

Electric Traction on Steam Railways in Italy. Prof. C. A. Carus-Wilson. Read before the Inst. of Elec. Engrs. An account written from an economic rather than from a technical standpoint, of what is being done toward providing, by means of electricity, a service of short trains, running frequently at high speeds, with some comparisons between the conditions of railway working in Italy and in England. Ill. Discussion. 8000 w. Elec. Engr, Lond—May 30, 1902. Supplement. No. 48648 A.

Monthly Reports.

The Street Railway Monthly Report. C. Nesbit Duffy. Suggestions from the writer's experience and practice as to the preparation, scope and arrangement of the monthly report. 3500 w. St Ry Jour—June 7, 1902. No. 48548 D.

Mountain Railways.

Light Mountain Railways. George B. Francis. A compilation of references and facts covering the location of the information, together with a statement regarding the gauge, grade, curvature, and weight of rail on quite a number of existing railroads. 2500 w. Jour Assn of Engng Socs—May, 1902. No. 48894 C.

The Electric Road of Berthoud-Thoune, Switzerland. Describes a mountain line using the three-phase low-tension electric current, with illustrated descriptions of the rolling-stock. 2000 w. Sci Am—June 14, 1902. No. 48751.

Oldham.

Oldham Corporation Electrical Tramways. History and illustrated description of these recently opened lines. 2500 w. Elec Engr, Lond—May 30, 1902. No. 48649 A.

Polyphase.

Some Notes on European Practice in Electric Traction with Three-Phase Alternating Currents. Carl L. De Muralt. Abstract of a paper before the Am. Inst. of Elec. Engrs. Gives facts showing the present standing of polyphase electric traction, with illustrated description of motors and car equipments. Also editorial comment. 7200 w. St Ry Jour—May 31, 1902. No. 48490 D.

Power Facilities.

Increased Power Facilities for the United Railways & Electric Co., of Baltimore, Md. Illustrates and describes extensive improvements being made which will considerably increase the generating and distributing capacity. 3300 w. St Ry Rev—June, 20, 1902. No. 49023 C.

Power Investigations.

Method of Ascertaining by Means of a Dynamometer Car the Power Required to Operate the Trains of the New York Central & Hudson River Railroad Between Mott Haven Junction and Grand Central Station, and the Relative Cost of Operation by Steam. and Electricity. Bion J. Arnold. Report of the investigation made. Ills. & records. 6500 w. Trans Am Inst of Elec Engrs—June 19, 1902. No. 49041 D.

Railway Motors.

A Study of the Heating of Railway Motors. A. H. Armstrong. A study of some of the variables met with and their influence upon the motive power and station output for the higher as well as the lower speed schedules. 6000 w. Trans Am Inst of Elec Engrs—June 20, 1902. No. 49051 D.

Rapid Transit.

Interborough Rapid Transit in New York City. Editorial discussion of questions in relation to a complete interborough system of underground passenger railways, and the powers of the Rapid Transit Commission. 2000 w. Eng News—June 5, 1902. No. 48705.

Signals.

Automatic Block Signals for Electric Railways. Editorial discussion of the need of such systems, considering proposed schemes. 1500 w. St Ry Jour—June 7, 1902. No. 48549 D.

Standard Railways.

Electric Traction and Standard Railways. E. Huber. Gives details regarding the experiments made by the Oerlikon Company, briefly describing the system and showing its advantages over existing systems. 3500 w. St Ry Jour—June 7, 1902. No. 48552 D.

Stray Currents.

Electrolysis of Underground Metals. J. M. Humiston. Explains the action, cause and means of protection. Ill. 4000 w. Pro Age—June 16, 1902. No. 48798.

Street Cars.

The Sanitary Condition of Street Cars in New York. George A. Soper, in *Medical News*. The effects of poor ventilation, bacterial condition of the air in cars, and the condition in tunnels and subways are discussed, and the need of laws to prevent overcrowding, spitting, and proper ventilating and warming. 4000 w. Sanitarian—June, 1902. No. 48666 D.

Surface Contact.

A New Surface Contact Tramway System. From *Le Genie Civil*. Brief illustrated description of the novel features of the invention of M. Cruvellier. 1300 w. Engr, Lond—June 13, 1902. No. 48877 A.

Surface-Contact Electric Traction System (Traction Electrique par Contact Superficiel). A description of the Cruvellier system in which two insulated conductors are used. 1200 w. Génie Civil—May 24, 1902. No. 48903 D.

Tramways.

Doncaster Electric Tramways. History of the undertaking, with illustrated description of the equipment, generating works, etc. 2500 w. Elec Engr, Lond—June 6, 1902. No. 48769 A.

Undergrounds.

The Whitechapel and Bow Railway. Illustrated description of the last of the London "undergrounds," and an account of the opening ceremonies. 4000 w. Transport—June 6, 1902. No. 48766 A.

Electric Underground Railways in London. A descriptive summary of the scope of the new lines, with list dealt with in the Parliamentary Session of 1902. Map and report of the Committee proceedings. 4700 w. Elect'n, Lond—June 6, 1902. No. 48760 A.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Am. Manuf. and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
American Telephone Journal. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Armee und Marine. *w.* Berlin.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin Scientifique. *m.* Liege.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemist & Metallurgist. *m.* London.

Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *w.* New York.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Indian and Eastern Engineer. *m.* Calcutta.
Ingenería. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Científico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallographist. *qr.* Boston.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. m. Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Wurtt. Ver. f Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Power Quarterly. New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Digest. *w.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. ed Agr. *b-m.* Catania.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Steam Engineering. *m.* New York.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Telephony. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a. S.

Current Record of New Books

NOTE—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post-Office Orders, home and foreign, should be made payable to* THE ENGINEERING MAGAZINE.

Alternating-Current Apparatus.

Alternating Current Machines: Being the Second Volume of Dynamo Electric Machinery; Its Construction, Design and Operation. By Samuel Sheldon, A. M., Ph. D., and Hobart Mason, B. S., E. E. Size, 5 in. by 7½ in.; pp. IV, 259; figures, 184. Price, $2.50. New York: D. Van Nostrand Company. London: Crosby, Lockwood & Son.

This book, like its companion volume on direct-current machines, is primarily intended as a text-book for use in technical educational institutions. It will also be of use, however, to engineers who are not perfectly familiar with the subject of alternating currents, but whose work leads them into this field, and it is furthermore intended for those who are studying by themselves and who have acquired some proficiency in mathematics. The first four chapters contain a clear treatment of the theory of alternating currents. The next four are devoted to the construction, principle of operation and behavior of the various types of alternating current apparatus. Another chapter treats of power transmission, and the last gives directions for making a variety of tests on alternating current circuits and apparatus. The book is well illustrated and has an index, and is altogether a very good work, combining, in a happy degree, conciseness with comprehensiveness.

Balancing of Engines.

The Balancing of Engines. By W. E. Dalby, M. A., B. Sc. Size, 5½ in. by 8½ in.; pp. XI, 283; figures, 173. Price, 10s. 6d. New York: Longmans, Green and Co. London: Edward Arnold.

The main object of this book is to develop a semi-graphical method which may be consistently used to attack problems connected with the balancing of the inertia forces arising from the relative motion of the parts of an engine or machine. But the author, who has made other important contributions to the subject of engine balancing, does much more than this, and after a general treatment of the theory of balancing, discusses its special applications to locomotives and marine engines, and also takes up the question of the vibrations of the supports and, particularly, of the hulls of ships. Only very slight reference is made to D. W. Taylor, of the Construction Corps, U. S. Navy, who has done so much original work in this field, and the system which he was probably the first to describe is here called the "Yarrow-Schlick-Tweedy." Considered on the whole, however, the present work is a most timely and notable one on a subject which is assuming greater and greater importance, and it will undoubtedly prove very useful to the designer and engineer.

Cost-Keeping.

The Cost of Production. By Charles J. Watts. Size, 5 in. by 7¾ in.; pp. 64; figures, 21. Price, $1.00. Muskegon, Mich., and Chicago: The Shaw-Walker Company.

This is a neat, well-made, paper-covered book describing and illustrating a card cost system, which, while free from all the intricate problems of a balance-ledger system, furnishes information sufficiently accurate for all practical purposes. It will enable the progressive manufacturer to determine his own costs absolutely as well as to point out to his superintendent any weakness existing in the operation of the factory, and so provide for a speedy reduction of excessive expense in the cost of manufacture.

Heating and Ventilation.

Steam Heating and Ventilation. By William S. Monroe, M. E. Size. 5¾ in. by 9¼ in.; pp. 150; figures, 89. Price, $2.00. New York: The Engineering Record.

The chapters comprising this book were originally written as a series of articles for *The Engineering Record* and have been somewhat revised for their present form. It has been the aim of the author to present briefly the theoretical considerations involved in the design of heating and ventilating plants, and to compile the best of the large array of empirical formulæ and data in a way that will be of value to those interested in the current practice of the art. In this design he has succeeded remarkably well, and his work will be most useful to heating and ventilating engineers, as well as instructive to the general public which has such a vital concern in the matter.

Iron Industry.

Jahrbuch für das Eisenhüttenwesen. (Ergänzung zu "Stahl und Eisen.") Edited by Otto Vogel, for the "Verein deutscher Eisenhüttenleute." Size, 6 in. by 9½ in.; pp. XVI, 460; figures, 77. Price, 10 marks ($2.50). Düsseldorf: August Bagel.

This first volume of an "Annual for the Iron Industry," covering the year 1900, is issued to supplement the semi-monthly journal "Stahl und Eisen" and "Gemeinfassliche Darstellung des Eisenhüttenwesens," the publications of the "Verein deutscher Eisenhüttenleute," the leading German metallurgical society. This annual gives a systematic account of the progress in all branches of the iron and steel industry for the year, there being about 1,800 abstracts and references gathered from 110 journals printed in eight different languages. The divisions of the book conclude an historical introduction, fuels, ores, processes of manufacture, descriptions of works, properties of iron and steel, alloys, testing of materials, etc., and an index to authors, as well as a comprehensive general index add greatly to the convenience of a very serviceable and valuable work.

Mathematics.

On the Study and Difficulties of Mathematics. By Augustus De Morgan. Edited by Thomas J. McCormack. Size, 5 in. by 7½ in.; pp. 288; figures, 13. Price, $1.25 (4s. 6 l.) Chicago: The Open Court Publishing Compa y. London: Kegan Paul, Trench, Trübner & Co., Ltd.

This is the second reprint edition of the famous work in which the author illumines the mazes of mathematics with the light of common sense. The original treatise, published by the Society for the Diffusion of Useful Knowledge, in 1831, is now practically inaccessible, and is marred by many errata which have been corrected in the present edition.

Mechanics.

The Science of Mechanics: A Critical and Historical Account of its Development. Translated from the German of Prof. Ernst Mach by Thomas J. McCormack. Size, 5¼ in, by 7½ in.; pp. XIX, 587; cuts and illustrations, 259. Price, $2.00 (9s. 6d.) Chicago: The Open Court Publishing Company. London: Kegan Paul, Trench, Trübner & Co., Ltd.

This is the second edition of the translation, prepared from the fourth German edition of Prof. Mach's highly interesting and thought-compelling examination of the foundation of our scientific beliefs. The author's additions to his first edition, which are considerable, have been relegated to the appendix of the present translation. These additions are generally either supplementary in character or in answer to criticisms, but some are of special importance, as, for instance, the discussion of Hertz's *Mechanics* and the history of the development of Prof. Mach's own philosophical and scientific views. There is also a chronological table of a few of the most eminent scientific inquirers and their more important mechanical works.

Pavement.

City Roads and Pavements Suited to Cities of Moderate Size. By William Pierson Judson. Size, 5¾ in. by 8½ in.; pp. 195; illustrations. Price, $2.00. New York: Engineering News Publishing Company. London: E. & F. Spon; and Sampson Law, Marston & Co., Ltd.

This is an enlarged and revised edition of a work first published in 1894. In fact, there has been such an advance in methods of paving and roadmaking in the last eight years that the present book is practically a new one. It contains well-illustrated and up-to-date descriptions of the various kinds of pavement in practical use, with costs of laying and maintenance, and many statistics for cities and localities all over the United States, with occasional references to European experience. There are chapters on concrete base for pavement, block-stone pavement, wood pavement, vitrified brick pavement, asphalt pavement, bituminous-macadam pavement and broken-stone roads. One valuable feature is a description of simple and practical cement tests, which can be made by the city engineer himself, with an outfit costing not over four dollars and which can be stored in a desk pigeon-hole. The book is supplied with an index, and altogether, it can be heartily recommended to all who are interested in city pavements.

Water-Supply.

Water-Supply. (Considered Principally from a Sanitary Standpoint). By William P. Mason, Professor of Chemistry, Rensselaer Polytechnic Institute. Size, 5½ in. by 9 in.; pp. VII, 448; figures, 40, plates, 22. Price, $4.00. New York: John Wiley & Sons. London: Chapman & Hall, Limited.

This is the third edition of Professor Mason's standard work on water-supply, brought up to date and practically rewritten. The author is a doctor of medicine as well as a chemist, and is thus peculiarly qualified to treat his subject in the manner indicated in the sub-title. Special attention is given to the relations between drinking-water and disease, water pollution and water purification, but the whole subject of water supply is ably discussed and well illustrated. There are many tables of statistics, records of analyses and references to authorities, and the work is completed by a comprehensive index.

THE WORLD IS ITS FIELD.

THE ENGINEERING MAGAZINE

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THE NAVAL ENGINEER OF THE FUTURE.

By Walter M. McFarland.

THE succeeding article in this issue by Inspector Johnson, to which Mr. McFarland's serves as preface and commentary, deals with the British navy. Mr. Johnson's extremely pessimistic view of the outlook for naval engineering therein naturally suggested that a discussion of naval engineering in the United States navy would be opportune as a companion article, and Mr. McFarland was asked to prepare such an article, which would at the same time give the opinion of an American engineer on the views advanced by Mr. Johnson. In view of his long service as an engineer in the American navy, which he left only a few years since, and of his active connection with the Personnel Board, he seemed to the editors the most suitable person to undertake this task; and he does it as he says the more willingly because his interest in the navy, and particularly its engineering, is as great as ever, and if he can aid in disseminating right ideas as to what is necessary for the highest engineering efficiency, he will feel that it is a duty faithfully performed. Both articles, extremely important in themselves, are doubled in interest by this companionship in presentation.—THE EDITORS.

MR. JOHNSON'S views of the future of the British naval engineer are distinctly pessimistic, and are recognized by him as being so. Indeed, the British engineer can hardly be blamed for losing heart when he sees how apparently futile have been all the efforts to give engineering in the British navy its rightful standing. The most discouraging feature is the pretense to investigate the subject and to do justice. It would be less discouraging to have a brutally frank refusal, because it would be realized at once that this could be due only to utter ignorance of the subject, while the continual postponement is an indication that the justice of the demands is recognized but that there is an unwillingness to comply with them.

While sympathizing very heartily with Mr. Johnson in his disappointment at the turn affairs have taken, and, to some extent, with his feeling that, while the engineers are getting no greater authority, they are being deprived of important duties, I feel that he is not looking far enough ahead and is making a decided mistake in considering the Admiralty regulation which puts certain duties formerly performed by the engineers under executive officers a great misfortune. As a matter of fact, in my judgment, this is simply the beginning of a movement which is bound to lead to the same results as have been reached in the American navy. Just here it may be well to comment on that part of Mr. Johnson's article, in his criticism of the Admiralty, where he excuses the First Lord on the ground that he is a civilian and entirely at the mercy of his naval colleagues. In my judgment this is an utterly mistaken view, and the First Lord is the one most to blame, for the very reason that, being a civilian, he ought not to have any personal prejudice in the matter and ought to be open to hear both sides of the case (although, in fact, there is really only one side in the judgment of all engineers), and thus be able to render substantial justice. The result of my observation for many years has been that this plea that a civilian head of a military or naval organization is not able to pass on technical matters, is simply a convenient excuse for not making decisions where it requires some strength of character to do so. A really strong civilian has no difficulty at all in getting at the facts of these technical matters, as was shown by the splendid grasp of naval matters possessed by President Roosevelt when he was Assistant Secretary of the Navy.

I have taken pains for many years to keep in close touch with the question of the position of engineers and their aspirations in both the American and the British navies, and, speaking broadly, these aspirations have been the same. Beginning as the representatives of a department which was small and of secondary importance, they have seen their work grow until in the minds of unprejudiced persons it has become the most important in the navy, meaning, of course, that the growth of the modern war-ship has been along such lines as to make it what it has been so often and so aptly designated, "a floating machine shop." With this growth in the importance of machinery there has been the accompanying growth in the number of men necessary to take care of it, thereby greatly increasing the executive side of the engineers' duties; and the necessity of having the legal right to exercise this executive authority has been the motive impelling engineers to demand full recognition for their position as military officers in a military organization.

This whole matter has been discussed thoroughly by many able men, and so recently that what they have written is readily accessible;

but it may be remarked that Secretary Gideon Welles, of the American navy, as far back as 1864 and 1865, recognized that the thoroughly competent naval officer should be an engineer as well as a sailor. Since that time various others have advanced similar views.

That the American navy was the first to give engineers their rightful position is due very largely to the good fortune that President Roosevelt was for a time Assistant Secretary of the Navy. With his tireless energy and constant aim to make everything with which he is connected highly efficient, it was necessary only that his attention should be called to the merits of the case to have him take it actively in hand. Before closing this aspect of the case, it may be well to say, as I had an opportunity of doing before the House naval committee, that engineers in other navies besides the British and American are dissatisfied with the lack of proper recognition of their position, the difference being that in these two countries they had a chance to make themselves heard, while in the others red tape and naval regulations prevent their saying anything publicly, and one knows of their feeling only from hearing about it in private conversation. It is a fact, however, that engineers of other countries are as dissatisfied with their treatment and have exactly the same aspirations as those of Britain and America, and when those of Britain shall have been as fortunate as those of America, the engineers of other countries may expect their turn to come.

In the discussions of the claims of the engineers in the American navy, a point which was frequently made by executive officers was that it would not be right to give engineers military titles because engineering was not military work. In the American navy it did not seem to be apprehended that if this were true the converse was equally true, namely, that it would be wrong for men with military titles to perform engineering duty. As a matter of fact, ordnance and electricity have always been in the hands of the executive in the American navy, so that so far as this feature of the recent Admiralty regulation is concerned, the British navy is now simply doing what the American navy had been doing for many years. Of course when such machinery was damaged so as to need special engineering skill, the engineers were called in to take charge of the work. It was this very fact, that the executive officers in the American navy were already doing engineering work, that made it easy, when Mr. Roosevelt took hold of the matter, to bring about the amalgamation. In other words, the executive was to take on more engineering and the engineer was to have more executive training, when the two would become the same.

It seems to me that Mr. Johnson has missed the point that the Admiralty regulation transferring certain strictly engineering work to executive officers is really an admission that military titles are not inconsistent with engineering duty, and that consequently this move should be looked upon as an admission, although a half-hearted one and very unsatisfactory one, that the claims of the engineers are just. In view of the outcome in the navy of the United States, which is well-known to all students of the subject, it seems to me that this recent Admiralty regulation should really be a source of some satisfaction to British engineers, but it should not cause them to relax their efforts to secure their proper standing. Of course it can be satisfactory in a negative way only, for they personally have not as yet gained anything; but the action of the Admiralty brings out forcibly the truth of President Roosevelt's remark in his report to the Secretary of the Navy, where he says:

> "Every officer on a modern war vessel in reality has to be an engineer whether he wants to or not. Everything on such a vessel goes by machinery, and every officer, whether dealing with the turrets or the engine room, has to do engineer's work. There is no longer any reason for having a separate body of engineers, responsible for only a part of the machinery. What we need is one homogeneous body, all of whose members are trained for the efficient performance of the duties of the modern line officer. The midshipman will be grounded in all these duties at Annapolis, and will be perfected likewise in all of them by actual work after graduation. We are not making a revolution; we are merely recognizing and giving shape to an evolution which has come slowly but surely and naturally, and we propose to reorganize the navy along the lines indicated by the course of the evolution itself."

It may be well in this connection to consider some of the objections which have been advanced against the idea so well expressed in the quotation from President Roosevelt. Mr. Johnson has put forward one, where he speaks of the long period given to the training of the men who at present do only engineering work, his idea being, evidently, that it would be practically impossible for men already trained for a different profession to acquire engineering in addition. There are also those who object to this idea of the one homogeneous body of officers, on the ground that this is an age of specialization and that such a course is contrary to the spirit of the age. The simple fact is that the logical basis for this idea of one homogeneous body whose members will be what Congressman Foss, chairman of the naval committee of the House of Representatives, calls "fighting engineers," is a thorough training in engineering. It is probable that the average layman, not familiar with the curriculum of the United States Naval School at Annapolis, has little idea that even before the amalgamation it was essentially an engineering school; and yet line officers had exactly the same mathematical training, including applied mechanics, as the engineers, as well as the same courses in physics and chemistry, and they studied ordnance from an engineering side while the engineers took up strength of materials and steam engineering. The present superintendent of the Naval Academy, Captain Wainwright, who was a member of the Personnel Board, recently published an article in one of the leading American periodicals about the Naval Academy, in which occurs the following statement:—

"At the close of the Civil War, the study of steam was introduced, but unfortunately, the advice of Isherwood was neglected and the students were separated, some remaining sailors with little training in engineering, while others became engineers with little training in executive duties. But the necessities of the service required the seamen to be trained in ordnance and electrical engineering with some knowledge of the steam engine, so that when the amalgamation came and the mistake made thirty odd years ago was rectified, there was no great change in training necessary. The seaman was taught a little more engineering and the engineer a little more seamanship, and now true marine engineering includes steam, electricity, and ordnance."

This shows that this accomplished officer, who occupies the extremely responsible position of training young naval officers, understands thoroughly what is to be done to carry out the idea of making the modern line officer a fighting engineer, and in the same article he makes another statement as follows:—

"The course at the Naval Academy places in his hands the means to become an ideal seaman and marine engineer, lacking only experience at sea to make him a thorough American naval officer."

Everyone who has had experience on a modern war vessel realizes that skill as a seaman is not obtained by reading books, but by actual experience in handling vessels in all sorts of weather, and this can be acquired only at sea. Very much the same is true of the executive duties in the handling of men. This can come only from contact with them, and it is notorious that high scholastic attainments are not necessarily an idex of success in this work. It comes to this, that the preliminary work which can be given in the schools to the best advantage is the preliminary engineering training, with the principles of sailorizing and military duties, which are also learned by drills; but the final efficiency must come, as Captain Wainwright says, through experience at sea.

With regard to the matter of specialization, we must not be misled by general terms nor forget that the war vessel is itself a very marked specialty. Each war vessel has to be complete in itself, and it would be absurd to attempt to provide a specialist of the highest type for each of the many things which may be necessary. The real fact is that the modern naval officer, the fighting engineer, will be a specialist in the most exact sense of the term. A certain set of conditions has to be fulfilled by him, and the midshipmen at the Naval School are being trained to fill these very conditions. It may, of course, occur to some, as it did to members of the Personnel Board when the matter was under discussion, that care must be taken to have competent designing and constructing engineers. In this matter we had the experience of the navy in ordnance to guide us, for without any separate corps of ordnance specialists in the navy, there had always been a sufficiently numerous body of officers who paid special attention to ordnance and furnished the necessary designers. With a body of more than a thousand officers to choose from, all of whom in time will have been trained as engineers, it would be absurd to think that the necessary men for designers and constructing engineers could not be obtained. Another matter which ought to be frankly recognized and admitted, is that none of the duties performed by naval officers, in whatever branch of engineering, are occult or such that only men of the highest genius can perform them. For designers men of remarkable talent are needed, but, as shown above, there will be no difficulty to get them. Every-day routine work requires men who have had suitable preliminary training and adequate experience, and with an honest effort to give the young officers the necessary experience it will be obtained.

In this connection the obvious inquiry will occur to every reader :— How has the Personnel Law in the American navy worked out in the three years that have elapsed since it was passed? The answer to this is that thus far the result is very disappointing, but the reason is very simple. For a long time not the slightest effort was made to carry out the essential idea of the amalgamation, namely, that of regular alternation between the deck and the engine room for all the young officers. When the scheme was mooted it was believed that Mr. Roosevelt would be in power to see that his ideas were carried out; but, as is well-known, he had left the Navy Department even before the bill was passed and, although always retaining his interest, had no opportunity until recently to bring any personal effort to bear on its enforcement. The friends of the measure did all they could to have it carried out, but its actual administration fell into the hands of an officer who, having been a member of the Personnel Board, was openly opposed to the principle from the very start and always stated that he was opposed to it. It is a fact that, owing to Congress not having made the provision which had been contemplated for additional officers, there were difficulties in the way of providing for the alternation of duty, and it would not be warrantable to say that this officer did not want the measure to be a success and therefore made no effort. Before vacating the position which put the administration of these matters in his hands, he had initiated an effort looking towards at least a partial carrying out of the idea, and this is now going on. Admiral Sampson, who had been a member of the Personnel Board, was Commander-in-Chief of the North Atlantic squadron when the bill passed; and as soon as he had received official notice of it he issued a squadron order showing that he thoroughly appreciated what was necessary. This order reads as follows:—

> "April 12th, 1899.
>
> "In view of the fact that hereafter the junior officers of the service will be called upon to perform the duties of both line and engineer officers, it is essential that they should be taught both of these duties.
>
> You will therefore make such arrangements for this purpose as the number of officers under your immediate command will allow.
>
> To all officers below the grade of junior lieutenant you will assign the duties of engineer officer, and to all assistant engineers, you will assign the duties of line officers as far as the number of officers serving on board the vessel under your command will permit.
>
> This interchange of duties for the line and engineering officers will take place for the space of one month."

Admiral Sampson, with his usual clearness of vision, realized that efficiency in both parts of the duties of the modern officer could be secured only by continual performance of each of them. It will be noticed that the interchange of duties was to take place for a month, and this is a feature which the writer has always insisted upon from the first suggestion of the idea of amalgamation. To make one cruise as an engineer and another as a deck officer, would never give that thorough familiarity with both duties which is absolutely essential.

Although in the quotation from President Roosevelt's report given above, the statement is made, and correctly, that the amalgamation is not a revolution but an evolution, nevertheless, considering the intense conservatism of naval officers and the prejudices which are the growth of many decades, the change is of a very radical nature. This ought always to be borne in mind when considering the question of how rapidly the new state of affairs contemplated is being brought about. In this age of so many marvels of high speed there is a danger that we may expect these economic changes to occur as rapidly as the transformation of a cable railway into an electric. I personally have spent many sad hours in thinking how slowly the change in the American navy is being made, when with hearty effort on the part of all concerned it might have been pushed with enthusiasm and we might already be congratulating ourselves on the splendid results attained. However, we must not give up in despair and talk about the doom of engineering, simply because what we believe to be the best method of securing the highest engineering efficiency does not receive complete acceptance on all sides at once. It was an enormous step in advance to have the fact recognized that engineering is the basis of the training of the naval officer, and to have this recognition set forth so strongly by a man who is now President of the United States and to have it enacted into law. Engineers had been working and waiting for more than fifty years hoping to accomplish much less than this. The ground has been cleared, the right principle is recognized, and an effort is being made to carry out the principle. Congress at its last session provided for a large increase in the number of cadets at the Naval Academy, and in a few years when they become available and there are officers enough to give the scheme a fair trial, there can be little doubt that it will be tried in earnest.

As has already been stated, the idea of amalgamation in what might be called a practical form, or, as may be otherwise expressed, its presentation at the opportune moment, was due to Admiral Evans; but he, of course, does not claim to be the originator of the idea. As I have stated above, Secretary Welles had this idea nearly forty years ago and, to my certain knowledge, many thoughtful American naval officers, both of the line and of the engineers, had realized that one homogeneous body of officers was the ultimate solution. While we may regret that progress toward the ideal is much slower than we would like, we must not, therefore, give up the ideal; and hence I believe that, although Inspector Johnson has good cause for feeling that the Admiralty have not given the British engineers proper treatment, he and his friends should not sit down in despair; but they and the friends of engineering all the world over should hope on, fight on, and use their influence to hasten the day when it will be generally acknowledged that the modern naval officer is in fact what so many earnest students of the case have asserted he must be—a fighting engineer.

THE DOOM OF THE NAVAL ENGINEER.

By Charles M. Johnson.

IN this, the second year of the twentieth century, it sounds somewhat pessimistic to head an article "The Doom of the Naval Engineer"; but the Admiralty order of 9 January last to the commander-in-chief at Portsmouth, directing that in future certain machinery is to pass from the charge and control of the engineer officer to that of the gunnery or torpedo lieutenants, respectively, seems to me fully to justify the title.

At a time when the engineer is supreme in every avenue of life—when the aid of machinery and of mechanical science is every day more widely sought to shorten distances, to accelerate motion, to abolish manual labour, and to transfer from the uncertainty of the human agent to the infallible mechanical process all that may be done by the ingenuity and the adaptations of the engineer's science—at such a time, to take a step which is evidently but the precursor of others having as their ultimate end and consummation, the abolition of the naval engineer—is surely to court the destruction of the navy and the utter extinction of British naval supremacy. If the Admiralty are right in thus presaging the abolition of the engineer, the whole commercial and manufacturing world must be acting on erroneous principles, and will shortly have to reconsider its policy with the view of reconciling it with the astute decision of the British naval board.

Every reading man knows that for many years the engineering department of the navy has been in a more than unsatisfactory condition; it has been in a state of partial collapse. It is not from one public paper alone that the trumpet sound of danger has come. Every correspondent who has been permitted to accompany the ships on the summer cruise or in the autumn manœuvres, has to a greater or less extent played on the same note. Some, like Mr. Rudyard Kipling, have not hesitated to "call a spade a spade." They have manfully and impartially endeavoured to bring home to the "man in the street" the deplorable weakness and inefficiency of this branch of the navy. Public men of all classes have joined in protest against this paralysing state of affairs in Great Britain's first and only line of defence. The naval engineers themselves have—as far as the "Regulations" permit—represented to the Admiralty, through the proper channels, the absolute necessity of redressing, not their personal or collective grievances, but the grievances of the British taxpayer, inflicted on him through the utter neglect and starvation of the engineering department. The great engineering institutions throughout the country have talked over the matter, have investigated it as a question worthy of their deepest interest and study. Prominent men in the profession, like Mr. D. B. Morison of Hartlepool and others, have given prodigally of their valuable time to study and master the subject to its minutest detail. Members of Parliament, of every shade of party and of every grade of life, have spoken of it in the House and on political platforms. Together with an influential deputation of prominent engineers and ship-builders, about twenty members of the House of Commons, on the 16th July last, waited upon the First Lord of the Admiralty and laid their views before him. Last, but not least, officers of the military (commonly called the executive) branch of the navy have added their testimony to the imperative need which exists of placing the engineering department on a sounder and more satisfactory basis.

And what has been the result, as far as the Admiralty is concerned, of all of this great consensus of thought and opinion? Has it succeeded in removing one single disability from, or of adding even one per cent. of either officers or men to, this dangerously undermanned branch of the service? Has it strengthened the hands of the chief engineer by giving him a staff of better trained units, although no added numbers? Has it in any way met the need of the engineer for greater authority and more control over his staff? In fine, has the board done anything to meet this widespread and public demand for reformation in the engineering department of the navy?

If these questions were put to the Lords of the Admiralty, they would doubtless be answered in the affirmative; but as a member of this over-worked, under-manned, slighted, barely tolerated class, I not only answer it in the negative, but I must go further and charge the Admiralty* with deliberately sacrificing the national interests and

* In speaking of the Admiralty, one is compelled, in justice to the First Lord, to state distinctly that he cannot be held responsible for the shortcomings of the Board on such an exceptionally technical subject as this. It must be obvious to every thinker that on such questions, the First Lord must be entirely at the mercy of his naval colleagues; and that is why I think the board of Admiralty should consist chiefly of civilians, assisted by representatives of the executive, the engineering, and other branches of the service. There would then be some hope that justice would be meted out to all alike; impartially. But so long as the whole control and administration is absorbed by one branch only of the navy, so long may we expect to find privileges, rank, honours, emoluments, place, and power confined to that branch alone.

the Empire's safety to the professional interests and prejudices of their own class—the sailor element. To make good this charge, I here reproduce an order recently issued to the commander-in-chief at Portsmouth.

Admiralty. S. W.
9 Jan. 1902.

SIR:

I am commanded by the Lords Commissioners of the Admiralty to acquaint you that they have had under consideration the division of responsibility for the care and maintenance generally of gun mountings and torpedo appliances in His Majesty's ships, and are pleased to direct that in future the duties of the gunnery, torpedo, and engineer officers in connection therewith are to be as follows:

Gunnery Lieutenants:—To have charge of, and to be responsible for, the care and maintenance of all gun mountings, as well as for the hydraulic fittings in connection with the guns and hydraulically worked machines, outside the pumping engines at present used for serving them.

Torpedo Lieutenants:—To have charge of, and to be responsible for, the care and maintenance of all dynamos, electric motors, electric lighting, Whitehead torpedoes and discharges.

Engineer Officers:—To be in charge of all steam-driven machinery, and for the supply of water, electricity, or air, at the required pressure; and where dynamos are coupled to steam engines, they are to be responsible for running them, and supplying electricity at the proper voltage at the machine terminals.

2. My Lords desire that you will direct the captains of the Excellent and Vernon, and the chief inspector of machinery at Portsmouth, to consider and report upon the methods best calculated to facilitate the adoption of the change in systems, including the revision of the courses of instruction for both officers of the military and engineer branches, and the general regulations necessary to provide for the efficient performance of the duties which will in future appertain to the former, instead of the engineer officers, thereby freeing the latter for work from which they can ill be spared.

As it is desirable that this arrangement may take place as soon as possible, I am to add that proposals should be submitted for the establishment of a course of practical mechanical training for the officers of the military branch concerned, by means of which, and by the introduction of a staff of hydraulic and electrical artificers to work directly under their orders, the change in responsibility may be effected.

I am etc., etc.,
Signed, EVAN MACGREGOR.

To the Commander-in-Chief.
Portsmouth.

It will be seen that this order takes away certain machinery and certain scientific weapons from the engineer and places them in the hands of officers who are not only not engineers, but who have had no practical mechanical education, and the reason assigned is one of expediency, not of efficiency. This policy of sacrificing efficiency to expediency has been the policy of the Admiralty board for the past forty years—how much farther back it goes it is unnecessary now to enquire. It is more to the purpose to enquire into the reason for the proposed change in the care and management of certain machinery and weapons, and the probable results of that change should it take place.

We will take the Admiralty reason first:—"Thereby freeing the latter (the engineers) for work from which they can ill be spared. The Jesuitical casuistry of this statement it would be difficult to surpass. Ground down to absolute, unadulterated truth, it means that the chief-engineer's staff is insufficient for the work it has to do; but the Admiralty dare not say so, in face of their long-continued assertions to the contrary. The chief engineer is not a working mechanic —he is the head of the most important and comprehensive department on board ship, and therefore it is not to "free" him that this change is to be made. Neither is the senior engineer supposed to be a working mechanic, although—God help him!—he is too often obliged to put his shoulder to the wheel because the staff under him is not numerous enough for all there is to do. Neither is it to free the other engineer officers, because their duties are performed under the supervision of the chief engineer, and if there were only more of them the duties of the chief would be less exacting, and he would be able to carry on the work throughout his department with greater profit to the service, with greater satisfaction to himself, and to all those placed in authority over him, and would also be enabled to maintain a higher standard of efficiency everywhere. The reason given, then, can only be considered a subterfuge. It is put forward to mask and hide the real reason.

Let us then endeavour to ascertain what the real reason is, and for this purpose let us analyse the constitution of the present Board of Admiralty, and the staff of executive officers employed there. The First Lord of the Admiralty, Lord Selborne, is a peer and a civilian, and is therefore a negligible quantity in the consideration of this question. He stands, or should stand, an impartial, inflexibly just unit of the board, holding the scales without bias, and weighing all questions with a single eye to the efficiency of the navy, and the safety of the Empire. We may all desire to believe that as far as his surroundings will permit, this is Lord Selborne's attitude. Let us next, then, look at his colleagues. There are four Sea Lords to complete the Board of Admiralty, and the following table shows to which section of the executive or military branch of the navy each belongs, or did belong:—

First Sea Lord, Gunnery.
Second Sea Lord, Gunnery.
Third Sea Lord and Controller, Torpedo.
Fourth Sea Lord, Torpedo.*

So we see that all Lord Selborne's naval colleagues belong to either one or other of the sections of executive officers, to whom, by the new order, is to be committed the care and maintenance of the machinery and weapons taken away from the engineer, who from their first introduction into the service has had them in charge. The reason of the new order, therefore, is at once apparent to any naval man. It has for years been the ambition of the officers of the gunnery and torpedo sections to get rid of the expert supervision of the engineer as far as guns and torpedoes and their accessories were concerned, and to confine the chief engineer to the four walls—if I may so term them,—of the engine-room.† For years, the engineer has had to hold his office simply at the bias of the captain of the ship. Where that bias fell to the gunnery or torpedo side of the fence, everything which could be filched from him, without a too flagrant disregard of the regulations, was filched. And, of course, where the captain, like a sensible man, preferred that his ship should be run by experts rather than amateurs, the chief was left in undisputed possession of those machines and weapons which he is certainly the proper man to have the care and management of. In some cases where the engineer was ousted the results were disastrous; but what other result could be expected? On shore we do not, as a rule, as business men, put delicate and expensive machinery into the hands of amateur engineers (and that is just what our gunnery and torpedo lieutenants are) but we endeavour to get hold of good practical engineers, who combine theoretical knowledge with practice and experience. We then have some grounds for believing that our machines will be well looked after, that they will be run with judgment and discretion, and that we may expect to get full or nearly full value out of them. Our anxiety, under such circumstances, is reduced to a minimum. And what we as business men on shore would do, may be taken as a very safe guide for the administrators of a great spending department like the Admiralty. The country

* I have enumerated here only the officers actually occupying seats on the board; besides these there are many others employed at the Admiralty, belonging to these sections of the executive branch of the navy, whose active influence would be a great force in strengthening the hands of the board in such a matter.

† As far back as the year 1877 these officers intimated to the Admiralty their readiness to take charge of all machinery outside of the engine-room. They were "just a little too previous" at that time, but now that they fill all the leading positions at the Admiralty, what more reasonable than that they should seek to give effect to their little note of that early year?

wants no experiments of so reckless a character as the one here foreshadowed, played with its first line of defence. The risks are too momentous; the stakes are too large. There is no good reason why this change should be made, but there are many why it should not be made.

I have thus endeavoured to show that this new departure is presumably initiated in the interests of the gunners and torpedoists. But while looking after the interests of these sections to which they belong, the Lords of the Admiralty have also had an eye to the inexorable demand which has surrounded the Admiralty as with an atmosphere for so many years and which they have hitherto been able to ignore, or at least to pass by on the other side, but which they now intuitively perceive they will be unable to disregard much longer—the demand that the engineer staff in all ships shall be increased to adequate proportions, and that the engineer shall be given definite rank and authority. The Admiralty have for years set their faces resolutely against increasing the engineer staff. Why? Because if they permitted the engineer department to grow to its legitimate proportions—proportions corresponding to the multifarious duties which naturally and properly belong to it—it would quickly equal in numbers, if it did not surpass, the sailor element. When we remember that in the present day everything is done as far as may be by mechanical means—that is, by the engineer, and that all the sailor is left to do is to fight the guns and keep the ship clean—are we not naturally surprised to find that the ratio between the sailor and the engineer branches respectively is as 4 to 1? Again I ask, why? Because command of men means power, and needs authority to wield that power. The engineer has no executive or military authority—he is a civilian! He can do nothing to reward or punish any member of his staff. It is by the mere accident of being what he is that he is able to have any control over the officers and men of his department. Not many years ago we had this strange anomaly, existing in the navy, that the engineer and his assistants belonged to the civil branch (as they still do), but their men belonged to the military branch. The appeal to this anomalous condition of affairs by those who even then advocated executive rank for the engineer was so frequent, and as numbers increased, so flagrant, that the Admiralty were forced to make most extensive changes in the military and civil branches, so that officers and men—who for years untold had been on the military list—found themselves, apparently without reason, suddenly relegated to the "shades and cold abstraction" of the civil list. Among these were the engine-room artificers and the stokers. And thus the Admiralty saved their face, and rid themselves of the bugbear of being continually asked how they reconciled the anomaly of having executive men under the orders and control of civilian officers. Not that these men were thenceforth to carry shovels only, and no arms. Oh, no! The Admiralty did not intend to lose the services of these fine fellows who numbered among their ranks some of the best shots in the service; they deprived them of the name, but kept them as combatants all the same. Let South Africa and China bear witness to their value, both as combatants and handy men. Again I ask, why? Because the Admiralty would not give the engineer officers military command even in their own department. It was a case of doing either the one or the other, and the Admiralty chose the other. As shedding some light upon the spirit in which this demand is met by the Lords Commissioners of the Admiralty, it may not be out of place here to quote some sentences from the speech of Mr. Arnold-Forster in a discussion on the navy estimates on 26 February last. Mr. Arnold-Forster, like his chief, Lord Selborne, can speak of these matters only as he is instructed by his naval colleagues; therefore in reading his words we imbibe the spirit of the Lords Commissioners. With regard to this question of giving executive rank to the engineer officers, Mr. Arnold-Forster said:—

> "With regard to the question of punishment, what was claimed for the engineer officers *was something which was conceded to no other officer on board ship. The lieutenant* with the same seniority as the engineer *had absolutely no power of punishment.* There was, however, a difference of opinion among naval officers as to whether the claim should be conceded; but *it was necessary to go forward, if at all, very carefully,* because it was very easy to make mistakes. . . . . *The Naval Lords were very jealous of the privileges and rights of all branches of the navy,* and though they were ready to be impressed by every reasonable appeal for change, they would not accept such appeals without due consideration."

The italics are mine, and I wish here to pause awhile to notice one or two points I have thus emphasised. The first point I will deal with is the statement, that what was claimed for the engineer officers "was something which was conceded to no other officer on board ship." I am at a loss to understand how Mr. Arnold-Forster could have come to make such a grave mis-statement. He must for the moment, at any rate, have forgotten the marine officer, who has the very concession which it is sought to obtain for the engineer officer. The next point which I will deal with is:—"The lieutenant with the same seniority as the engineer had absolutely no power of punishment." This statement is even less understandable than the former. Is Mr. Arnold-Forster unaware, after nearly two years' experience at the Admiralty, that in ships under the command of either a captain or a commander in which the next executive officer is called the "first lieutenant," all minor punishments are awarded by the first lieutenant? And that in vessels on detached service, having a lieutenant-commander in command, all punishments are awarded by him, when not actually in the presence of a senior officer? Few people will be disposed to quarrel with Mr. Arnold-Forster's dictum that "it was necessary to go forward, if at all, very carefully." The sting is in the parenthesis, "if at all." It seems to us that the Admiralty have no intention of going forward in this case; for they have had the recommendation of their own committee of 1875 under their consideration for twenty-seven years, and Mr. Arnold-Forster's words quoted above are their answer to that appeal when re-presented twenty-seven years after. One must confess that Mr. Arnold-Forster holds out the possibility that all is not lost, although in the year of grace one thousand nine hundred and two, he still thinks it advisable that the Admiralty should go slow on this momentous question. I come now to my last quotation from Mr. Arnold-Forster's speech, in which he states "the Naval Lords were very jealous of the privileges and rights of all branches of the navy." I am quite prepared to endorse Mr. Arnold-Forster's statement as far as the privileges and rights of the sailor branch of the navy are concerned, but doubts will assail me when I look back and think how one privilege after another has been taken away from the engineer. As an illustration let me cite one of the latest proofs of the "jealousy of the Naval Lords" for the privileges of the engineer. They were asked to put the fleet engineer on an equality as regards pay with other officers of the civil branch, whose duties are far less onerous, irksome, and dangerous; and what did the "jealousy" of the Naval Lords for the engineer's privileges achieve? They not only did not give what was asked for, but they actually took away, approximately, one-half of an old-established privilege—"charge pay"—which in many cases more than counterbalanced the small increase of pay which they gave. That is an instance of the Admiralty's "jealousy" for our privileges, of which I make Mr. Arnold-Forster a present, so that he may be able to produce it on the next occasion on which he desires to illustrate this peculiar virtue of the Admiralty, of which he is the sole discoverer.

How can one hope that justice will be done to the engineer when we find the mouthpiece of the Admiralty speaking such grave inaccuracies as these in the House of Commons? Had that august assembly numbered among its members but one naval engineer, Mr. Arnold-

Forster might have wished that his case had been a little more carefully got up.

It may be of interest to the readers of this magazine to note the names of a few of the members of late Admiralty boards, who, when out of office, advocated this bestowal of executive rank upon the engineer, but who on entering office, found it necessary and advisable, to go slow on the matter. The late Admiral Sir Astley Cooper Key was president of the committee of 1875, which recommended it; yet that officer was first Sea Lord for five years, but did not think it incumbent on him, as a man of principle, to give effect to the recommendation which he had himself presented to the Admiralty. Mr. (now Viscount) Goschen, when in opposition in 1877, was very sarcastic with the then First Lord, the late Mr. Ward Hunt, because it did not find a place in the naval programme for that year; yet he himself occupied the post of First Lord of the Admiralty for more than four years without finding means to introduce this reform which he thought so desirable in 1877. The late Mr. Otto Trevelyan is another instance of a man holding opinions when out of office, to which, in office, he fails to give effect.* And so I might go on adding to the list, but I think I have written enough to show that there is a very determined opposition on the part of the executive officers of the navy to sanction anything which shall confer on the engineer a rank and an authority "commensurate with the greatness of their present trust, and to the weight of their enlarged responsibilities;†" and that the parliamentary officials of the Admiralty, however favourable they may be, or may have been before attaining to office, to the conferment of executive rank upon the engineer, have always contrived to evade the question when in office, or else have been influenced by the naval atmosphere surrounding them to discover good and sufficient reasons why the engineer should remain a member of the civil branch of the navy.

Before proceeding to consider the remaining portions of this paper, viz., the probable results of the new order and the system of training necessary for the gunnery and torpedo lieutenants to enable them to carry out their new duties efficiently, let me sum up briefly the causes which have led the Admiralty to issue the new order.

I. The preponderance of gunnery and torpedo officers at the Admiralty.

* I am not aware that Mr. Arnold-Forster ever committed himself to an advocacy of this reform, but in the years anterior to his elevation to office he expressed himself as being in active sympathy with those engineer officers with whom he was brought in contact. He, also, has apparently succumbed to the baleful atmosphere of office.

† *Vide* Sir E. J. Reed's "Letters to the *Times*," 1877.

II. The growing necessity of reinforcing the engineer staff, in all ships; or as an alternative, of relieving the engineer of some portion of his multifarious duties and responsibilities.

III. The reluctance of the sailor element at the Admiralty to increase the engineer staff, because in doing so the importance of the engineer would also be increased.

IV. The insuperable objections entertained by the great majority of the executive officers to investing the engineer with executive rank and authority.

I pass now to the results which the proposed change is likely to have upon the standard of efficiency of the machinery and weapons included in the new order, and I think it unnecessary to do more than ask one single question, in answering which my readers will solve for themselves the point at issue:—"Is machinery of any sort, likely to be as efficiently handled, to give as good results, or to last as long, in the hands of amateurs as in those of experts?"

The third and last point in this question, viz., the training necessary for the executive officers who are to supplant the engineer officers may I think be dealt with as briefly as the second was. If they are to undertake the duties and responsibilities of the engineer, they must have an engineer's training to fit them for the work. Now what comprises the training of a naval engineer, before he is considered competent to undertake the independent charge of machinery? First, he serves five or six years in the workshops at Keyham, acquiring a practical acquaintance with the various branches of the mechanical side of an engineer's profession, a facility in the use and handling of all machines and tools comprised in a well-ordered engineering establishment, and a thorough knowledge of, and acquaintance with, the varieties of engines, machines, and mechanical appliances in use in the British navy. Having completed this pupilage, the student evolves into the assistant engineer, and is sent to sea under the orders of a superior engineer. He remains generally in this subordinate position for a further period of about ten years, when he is considered eligible for an appointment in charge of the machinery of a gun- or torpedo-boat. Is this the kind of training contemplated in the new order? I think not; because if it were the new order of things could not come into workable existence for many years, and the order states "that it is desirable that this arrangement may take place as soon as possible." No; the fact is the Admiralty entertains a sort of idea that the officers of the executive branch have a special "call" for the duties and work of any other branch. It remains to be seen whether the taxpayer will be equally impressed with their claim to oust the engineer.

Omineca Mountains from Peace River.

MINING INDUSTRY AND MINERAL RESOURCES OF BRITISH COLUMBIA.

By Wm. M. Brewer.

There are strong signs that the Pacific region of North America will exhibit within the next few decades one of the most wonderful industrial expansions the world has ever seen. The energy is there; the markets are but newly opened in the Far East; the machinery of commerce and traffic is being liberally supplied; that the fourth element—rich natural resources—exists in full proportion is indicated by Mr. Brewer's article, supplementing the important papers in this Magazine by Mr. Lamb, July and December, 1900, and Mr. Bogle, March, 1901. —The Editors.

THE Province of British Columbia is an enormous territory of varied resources, including mineral, timber, fish, agriculture and stock raising. It is hardly surprising, considering its extent (which is, roughly speaking, 1,500 miles north and south by 500 miles east and west) that large areas within its boundaries are *terra incognita* so far as the white man is concerned. Its island possessions are very numerous and embrace all of the islands in the Pacific north from San Juan Island, latitude 48° 20′ north, near the southern extremity of Vancouver Island, to Mary Island, latitude 55° north, near the entrance to Portland Canal, up which the provisional boundary line between British Columbia and the United States is located. A glance at the map of the province hardly enables one to form a clear conception of its extent, and especially does this statement apply to the length of coast lines. Extensive travel alone will impress on the mind the vastness and magnitude of this mountainous domain.

Nature has not only been very beneficent in scattering with lavish hand her resources, but has also been most generous in providing highways by which the explorer can travel during his work of research. The coast lines along the mainland and around the outlying islands are indented with sounds, bays, inlets, and canals, very similar

PORT ESSINGTON, AT THE MOUTH OF THE SKEENA RIVER.

to the fiords along the coast of Norway, while in the interior are many navigable rivers as well as lakes. The prospector is obliged in very many sections, and especially on the islands, to pack his blankets and supplies on his back; indeed. he considers himself particularly fortunate if he finds stage roads or pack trails over which he can use pack animals and saddle horses. The row-boat, canoe, and sloop are universally used along the coast lines and on the lakes, even though steamers ply on the waters, because it is of course impossible for the steam-boat companies to afford a service by which a prospector can thoroughly prosecute his work, and exploit the shore lines for indications of mineralisation. Glaciation and volcanic action are undoubtedly the responsible agencies for the formation of the fiords. Observation demonstrates that the general direction of the action of erosion from glaciation has been from northeast to southwest, the eastern shores of the islands being very much less cut up by bays and inlets than the western. The general trend of the mountain ranges is to the northwest, as is also the direction of the coast lines. The islands are for the most part made up of one or more ranges of mountains, extending almost or altogether the entire length of each like a backbone, with series of deep cañons reaching from near the mountain summits to the shore lines like ribs. The mainland coast has a very similar appearance, for the Coast or Cascade Range of mountains extends along the entire coast line, from and south of the international boundary thence to the northwest through Alaska.

The mineralised zones follow the mountain ranges and to a certain extent parallel each other. Travelling from east to west there are first the Rocky Mountains, next the Selkirks, then the Gold Range, and last the Coast or Cascade range occupying the coast line and extending for about 100 miles inland.

The various mineral-bearing zones maintain throughout the province the some northwesterly lines of strike which characterise the mountain ranges, but the leads (if such a general term may be allowed) do not usually have their lines of strike conformably with those of the country rock. For instance, the coal seams in the Rockies through the Crow's Nest Pass territory strike to the north; many of the copper-gold ores in the Boundary district in southwestern British Columbia strike north also, but through the silver-lead district in the Slocan, many of the veins have a northeast and some an easterly strike. The same variation in lines of strike is also found on the coast and through the islands. The term lead, as applied to British Columbia ore bodies, is to a certain extent misleading, because some readers may interpret that term to mean continuous ledges of great length similar to the Colorado fissure veins, whereas so far as my observations have gone there are but very few ore bodies of this character in the province, and I have used the term in a general sense as being applicable to occurrences of ore of every character.

After a close study of the mineral resources of British Columbia extending over a period of four years, I have observed that the Gold range, which occupies a position between the Selkirk and Coast mountains, contains a mineralised zone remarkable for its length and production of placer gold. The southern portion is comparatively quite narrow, but the northern is very much wider. The free-milling gold-bearing quartz camps at Camp McKinney and Fairview, with the placer mining camp at Granite Creek, are located at the southern extremity of this zone, so far as it applies to British Columbia, while the northern portion is represented by the Atlin and Porcupine placer and free-milling gold-ore camps. The country lying between these points,

so far as it has been explored from south to north, embraces the old placer-mining camps on Granite Creek, Tulamene, Similkameen, and Fraser Rivers, as well as those in Cariboo, Omineca and Cassiar. North from Lytton, where the main line of the Canadian Pacific Railway crosses the Fraser River, the productive auriferous gravel extends over a much wider extent of country than either at the extreme south or extreme north in British Columbia. For instance, the Cariboo diggings extend towards the east in the Selkirk Range, and the Cariboo Range of mountains of that district belong to the northwestern portion of the Selkirk Range, as also do some of the mountains in the Omineca and Cassiar, while the mountains of the Atlin and Porcupine districts are northeastern continuations of the Coast Range. The same conditions as to increased width of this auriferous formation also applies on the western side, for it includes the free-milling ore zone through Revillagigedo and Douglas islands in southeastern Alaska.

But the extent of explored territory in British Columbia north from the main line of the Canadian Pacific Railway is very limited as compared with the unexplored portions. Practically, exploration has begun and ended along the streams which really form the only highways through this enormous territory, and it is a remarkable fact that every important stream from Granite Creek north which flows through that portion of British Columbia lying between the Selkirk and Coast mountain ranges has contributed its quota of placer gold. Another fact, too, is worthy of record, which is that throughout that vast area but very few occurrences of free-milling auriferous quartz veins or deposits have yet been discovered. In the Lillooet district some have been worked on Cadwallader Creek, a tributary of Bridge River, as well as on McGilvray Creek, which flows into Anderson Lake, and on Cayoosh Creek, a tributary of the Fraser River. Those on this last-named creek, though, proved notable failures when the attempts to work them on a commercial scale were made. The reason for this was, that although the outcrops were rich and yielded quantities of fine specimens, yet deeper work resulted in exposing low-grade ore stringers only. The veins generally in that portion of the zone are of the

GOLD DREDGE ON THE FRASER RIVER AT YALE.

"gash" variety, lying conformably with the country rock as to dip and line of strike and pinching out into a series of narrow stringers of very low grade as depth is attained. But on Cadwallader and McGilvray Creeks the structure of the ore bodies is that of fissure veins which promise permanency with depth as well as along the line of strike, and besides it has been determined by milling operations that the ore maintains a sufficiently high average grade to warrant mining operations whenever the camps are more easy of access than at the present time, when the cost for transporting machinery and supplies is from 5 cents to 7 cents per pound for packing from Lillooet to Cadwallader Creek, a distance of about 70 miles.

McGilvray Creek mines are more accessible because freight can be transported by water up Seton and Anderson Lakes to within a short distance from the camps. Inaccessibility and cost for freighting are the main causes for the unexplored condition of this vast territory designated as the Gold range, north from the Canadian Pacific Railway. Near the coast line the Coast range has been explored as far as could be easily done from the rivers and their tributaries. This work has resulted in the discovery of a mineralised zone containing magnetite, pyrrhotite, chalcopyrite, with occasionally bornite and some copper carbonates. In addition to these, occurrences of copper-gold ore bodies, usually at the contact between the igneous rocks and the limestones but sometimes filling fissures in the igneous rocks, have been discovered at several points. The most notable of these are on Seymour Creek, about ten miles northerly from Vancouver City, near the western shores of Howe Sound on Frederick Arm, on Bella Coola River, on the Skeena River, and on Observatory Inlet, as well

VIEW OF PINE CREEK, ATLIN, AT THE UPPER END OF THE FAIRVIEW LEASE, OPPOSITE THE STEPHEN DYKE GROUP.

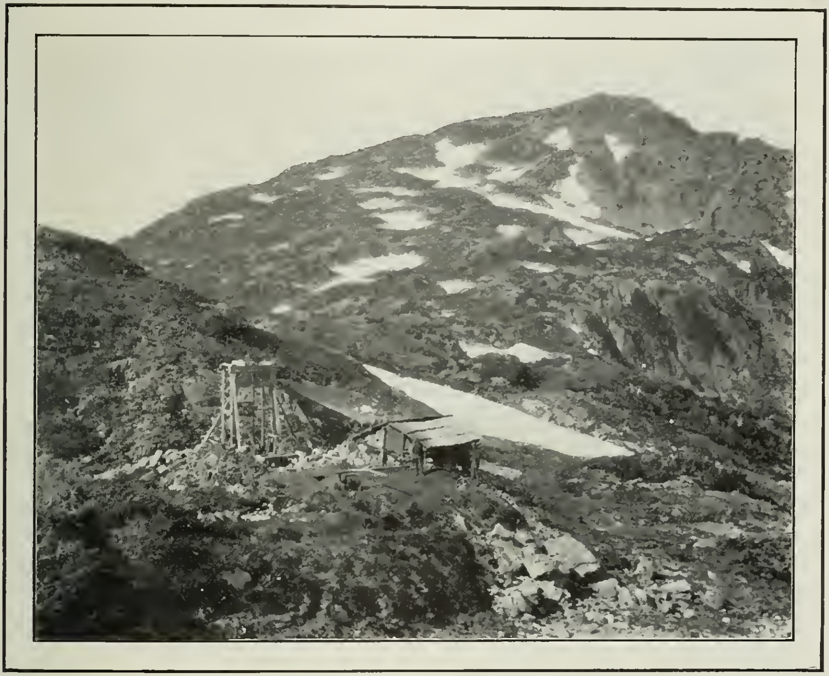
CASCADE RANGE FROM SKEENA RIVER.

as on both the east and west sides of Prince of Wales Island. But the coast has been prospected only to a very limited extent, the main reasons being the unfavourable conditions prevailing as to thick timber, high mountains, impenetrable undergrowth, thickness of moss, lack of trails and necessity for packing supplies, etc., on men's backs. Consequently comparatively very little is known as to the mineral resources of the Coast range, and in fact the earliest discoveries of ore bodies, so far as British Columbia is concerned, date back only to about 1897. The outcroppings on the discoveries so far made have been generally unique, because of their vast extent. As an example of the most extensive outcroppings so far known there is that on the Britannia group of claims on Howe Sound, where occurs a mountain of ore about 6,000 feet long at the base, nearly 300 feet high, and in which a tunnel driven 125 feet long shows a solid mass of ore from the mouth to the face, with the face still in ore. This tunnel is not exactly a cross cut at right angles to the line of strike, but has been run slightly diagonal across the ore body. The altitude at the mouth of this tunnel near the base of the mountain is 4,250 feet above sea level, and only about three miles from the shore "as the crow flies."

CROSSING FRASER RIVER NEAR LILLOOET, B. C.

The same mineralised zone extends through the islands of the North Pacific. On Vancouver, Texada, Queen Charlotte, Princess Royal, and Banks, in British Columbia, as well as on Prince of Wales Island in Alaska, conditions exist very similar to those attaching to the mainland coast. There are, though, on Queen Charlotte and Vancouver Islands, in addition to the metalliferous bearing zones, extensive areas of cretaceous rocks containing seams of coal—bituminous on Vancouver Island, but anthracite on Queen Charlotte Islands.

Because of the discovery of coal on Vancouver Island about 1835 by Dr. Selwyn, who was then director of the Dominion Geological Survey, the Hudson's Bay Company about 1849 commenced the work of exploiting the coal measures, which resulted in opening collieries that have been producers on a commercial scale ever since, and for several years furnished the only local supply of coal on the Pacific Coast, having yielded 6,085,687 long tons to December 31st, 1901.



BORNITE MOUNTAIN, SKEENA RIVER.

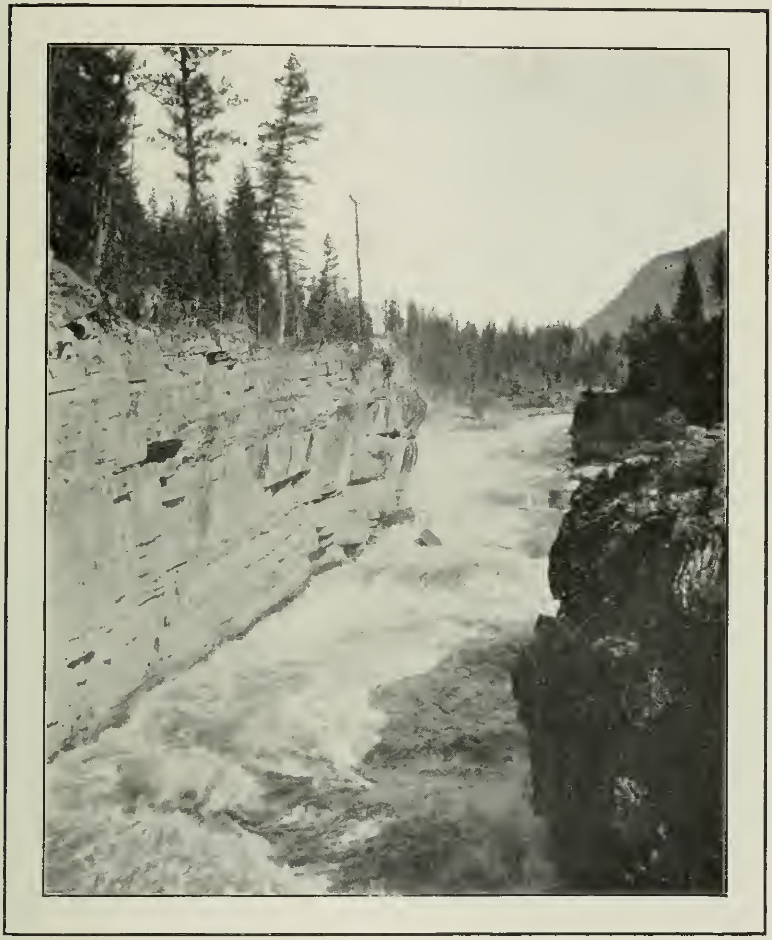
The coal measures on Queen Charlotte Islands have never been thoroughly explored; indeed, although large areas of land containing these coal measures were acquired under Crown grants several years ago, it has only been within the past two years that any attention whatever has been directed towards this group of islands by prospectors. Few parties have as yet visited it. In fact, except on Vancouver, Texada, and a few smaller islands, so little systematic exploring has been carried on that beyond the fact that a few discoveries of copper-gold bearing ores on Princess Royal and Banks Islands have been reported, the resources of the British Pacific Islands are unknown quantities. The Klondike excitement since 1897 has been responsible for the exploration and prospecting which have been carried on through the islands northward from Queen Charlotte Sound.

On Vancouver Island, placer gold was mined on Leach and Bear Rivers, and also on China and Granite Creeks, about 1862. These streams were worked out and for several years but little interest was taken in prospecting the mineral resources of the island, except the coal on the eastern side. In fact, 1897 is about the earliest date for the discovery of any of the deposits of the copper-gold ores which promise in the future to increase very materially the output of metals from the province.

Although the discoveries of the ores in the Rossland, Camp McKinney, and Boundary districts, south of the Canadian Pacific Railway on the mainland, antedate those on Vancouver Island, and have in the past been the main factors in bringing British Columbia into prominence as a mining centre, yet in this review I will confine detailed description of the mining industry to the island sections, beginning with Vancouver and proceeding eastward.

STEAMER HAZLETON ABOVE KITSILAS CAÑON, SKEENA RIVER.

On Vancouver Island prospecting for lodes was commenced about 1896 in the neighbourhood of Alberni village at the head of Alberni Canal. Gold-bearing quartz float was found by placer miners in China and Granite creeks, which resulted in the discoveries of bodies of auriferous quartz on Mineral Hill at the head of China creek as well as on the mountains near the head of Granite creek. The geologi-



ELK RIVER CAÑON, NEAR ELKO, EAST KOOTENAY.

cal formations are metamorphic schistose rocks and granites. Later prospecting demonstrated that the zone made up of these rocks was of comparatively limited width, and its length has never been determined. The trend of these rocks is northwesterly; the ore bodies fill fissures lenticular in structure with pay ore in shoots. The gangue is quartz, which at and near the surface is free-milling and carries gold values, but with depth the ore becomes refractory. Most of these mineral claims are situated from 10 to 15 miles from the eastern shore of the canal. The lack of transportation facilities has been sufficient reason for the closing down of active developement. But these discoveries proved an incentive to prospectors to exploit the shores of Alberni canal, as well as those of the numerous bays or fiords which indent the west coast of Vancouver Island.

As a result from this work, there are today a very large number of mineral locations, many of which are very promising prospects containing usually chalcopyrite and sometimes bornite, situated in a zone trending northwesterly, which in some localities attains a width of twelve to fourteen miles and reaches from near the southern end of

PRINCETON, SIMILKAMEEN MINING DISTRICT.

the island at Sooke Harbor to almost the extreme northwesterly end at Quatsino Sound. The full extent of this zone, so far as width is concerned, has been determined at only a few points.

Southeasterly from the head of Alberni canal, but with its position northeasterly from the zone of auriferous free-milling ores referred to earlier in this article, occurs a zone of schistose rock on Mts. Brenton, Sicker, Richards, Malahat, and Skirt, which flanks on the southeastern side the cretaceous coal measures of the eastern portion of Vancouver Island, and contains the productive copper-gold mines. For while a great deal of attention has been devoted by prospectors and engineers to the prospects on the west coast of the island, only in a few cases has the developement been carried sufficiently far to place the mineral claims in the ranks of the shipping mines. But the district locally known as the Mt. Sicker has been more fortunate, because, although occupying a far less extensive area, yet several mineral claims were acquired by enterprising companies whose management has carried on the development work so persistently since 1899 as not only to ship about 30,000 tons of high-grade copper-gold ore of an average value of $5.00 in gold and 6 per cent. copper per ton, but to show sufficient ore in sight to demonstrate that profitable smelting operations can be carried on by local smelters. Consequently two smelting plants are being erected on the east coast of the island, one at Osborne Bay about eleven miles distant from Mt. Sicker by rail, and the other at Ladysmith, about nineteen miles distant. The zone of schistose rocks in which occur the mines referred to is of undetermined extent longitudinally, but known to maintain continuity from the southeasterly coast of Vancouver Island from the vicinity of Saanich Inlet and Maple Bay across Mts. Malahat, Richards, Sicker, Brenton, and be-

SUNSET CAMP, BOUNDARY MINING DISTRICT.

yond these towards Alberni Canal. The distance it has been explored is some fifteen miles as the crow flies. The trend of the ore bodies is more westerly than northwesterly, and so far as at present known, there is no extension of this particular mineral-bearing zone beyond the Alberni Canal.

The width of the productive zone—so far as at present known—is about 1,200 feet, but discoveries have been reported of other parallel zones lying to the southwest, or rather southerly from the main one.

Northerly and northwesterly from the Mt. Sicker mines occur the areas of cretaceous rocks in which are found the coal seams of the eastern portion of Vancouver Island. These have been productive since about 1852 and have furnished the bulk of the coal used for domestic and steam purposes in California since that time. The coast from Ladysmith to Comox, a distance of nearly 100 miles, except a short break at Nanoose Harbor, is composed of these coal measures. The width is variable; probably the maximum is reached near Comox, where the measures extend for nearly twenty miles inland. Near Nanaimo the width is nearly as great, but at other points this is much less. Extensive collieries have been established and are in active operation at Extension, near Ladysmith, at Alexandria, Nanaimo, and Union, about twelve miles inland from Comox Harbor.

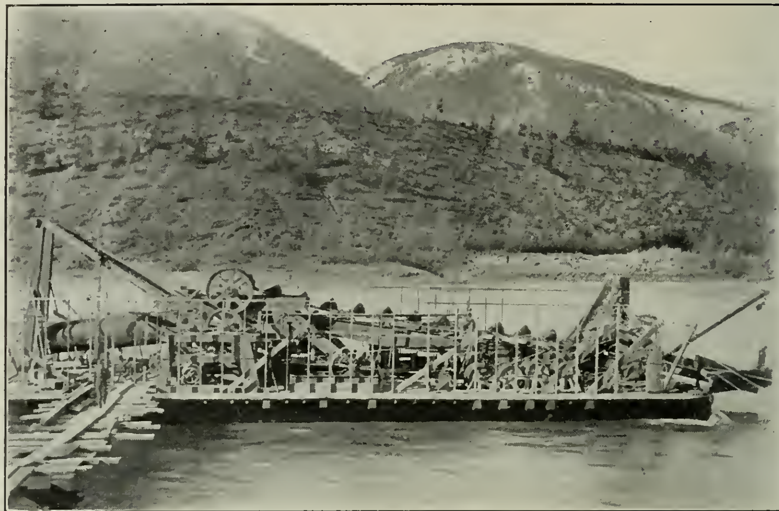
The islands in the Gulf of Georgia between Vancouver Island and the mainland, are as a rule, quite limited in area, and except Texada have not yet produced any metalliferous ores in commercial quantity, although mineral claims have been located on many of them, notably on Salt Spring, Thurlow, Valdez, and Redonda. The surface indica-

BREAST OF STOPE, 100-FOOT LEVEL, SUNSET MINE; BOUNDARY MINING DISTRICT.

tions which led prospectors to locate claims on these were very promising, but on none has sufficiently extensive developement work been done to determine the value of the prospects except on Texada Island, which is the largest in area and has produced nearly half-a-million dollars as the result of working the gold-copper ores found there. The island, considered geologically, is composed of crystalline lime-

FORTY THIRD COMPANY'S DITCH, KILDARE GULCH, OMINECA.

stone and igneous rocks. Mining operations have been confined to the northern end. Near the east coast deposits of bornite and chalcopyrite, the former carrying gold values sometimes as high as an ounce to the ton of ore in the three producing mines, and averaging about $8.00 to the ton in addition to the copper values, while the latter carries lower gold values but averaged 5 per cent. copper, from smelter returns from about 25,000 tons produced since 1899. The greatest depth attained on any metalliferous mine, either on Vancouver Island or the coast of the mainland, has been reached on the Copper Queen on Texada, where the working shaft is 515 feet deep. Bornite ore was found to predominate even at that depth, where the ore body was about 130 feet in length with a thickness of 4 feet on the foot wall, and a maximum of 12 feet on the hanging wall, with 13 feet of barren felsite, or possibly altered limestone, lying between the two bodies of ore. The ore bodies in the productive mines occur either in the limestone or felsite (as it is locally termed), or at the contact between these rocks: or else, but much more rarely, at the contact between limestone and diabase. The rock termed felsite, if subjected to an expert examination will possibly be found to be an altered impure limestone; it contains calcite, garnets, alumina, and silica, but may be a felsite of igneous origin and occur as intrusions in the limestone which has been thoroughly metamorphosed.



GOLD DREDGE UNDER CONSTRUCTION NEAR LYTTON ON THE FRASER RIVER.

The centre of this island is made up almost entirely of igneous rocks, many of which have a porphyritic structure, and these are often fissured. The veins so formed are filled with auriferous quartz, free-milling at and near the surface, but refractory and apparently in many cases losing their values at shallow depths. Consequently none of this class of ore bodies on Texada Island has as yet developed into permanent paying mines.

Near the northwestern coast of the island the crystalline limestone again occurs in vast bodies, and in contact with basic igneous rocks. The mineral resources of this portion are magnetite and limestone, the latter being burned and the product shipped chiefly to Hawaii as well as local markets, while the former is mined and at present shipped to the iron furnace at Irondale in the State of Washington, where it is manufactured into pig iron of a superior quality. The iron ore carries an average of about 70 per cent. metallic iron, and its content of phosphorus is well within the Bessemer limit.

The southern portion of Texada Island has not been explored, chiefly because of the landing places even for small boats being very few and far between, while in the interior the heavy growth of timber, the density of the brush, and the precipitous mountains render exploration very difficult, even for professional prospectors.

Note:—The illustrations accompanying this article are from photographs, many of which were kindly loaned to the writer by the Department of Mines for British Columbia, and the remainder photographed by himself.

THE PARIS-VIENNA MOTOR-CAR RACES.

By C. R. D'Esterre.

The most striking effect of the noted Continental motor-car races is noted by Mr. D'Esterre in the article below. It is the perfecting of the cars mechanically through the necessity of meeting conditions of extreme severity in what might be called "intensified service." Such a result goes far to offset any charge of undue attention to "sport." It is akin to the more slowly worked out processes of evolution in other branches of mechanical industry.—The Editors.

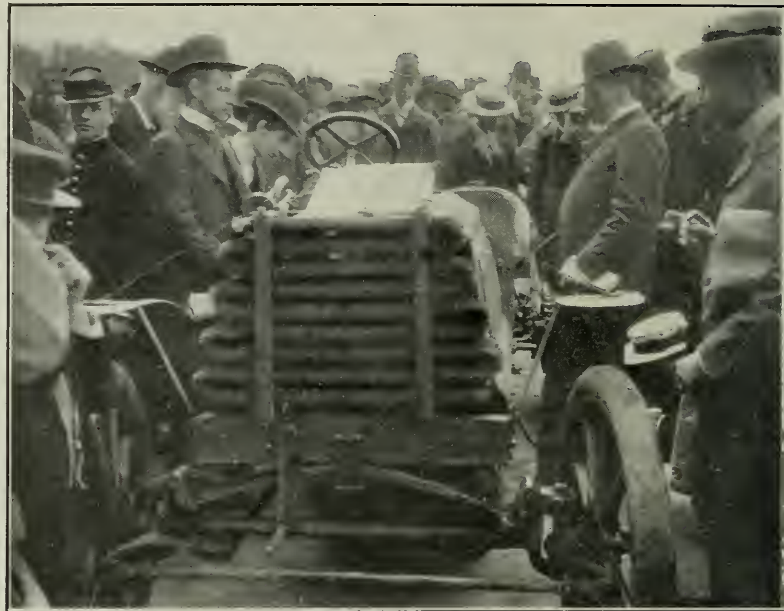
THE long-distance road races which during the past eight years have formed the central feature of automobilism in France, are undoubtedly largely responsible for the extraordinary developement which has taken place in the motor-vehicle industry in that country. To carry through one of these competitions successfully over even a few hundred miles of average macadam road demands that the vehicles shall have been brought to a state of at least tolerable practicability for everyday use; hence it was not until the internal-combustion engine of Daimler had been taken up by practical engineers and incorporated in a road vehicle, that these competitions were originated. It was in the early 90's, about 1892-94, that the reliability of the petrol cars constructed by the firms of Panhard & Levassor and Peugeot and fitted with engines of the Daimler type, led to the suggestion of running motor vehicles on the road under competitive conditions, and from the date of the first race from Paris to Rouen, 1894, those firms which have most energetically devoted themselves to the developement of vehicles especially designed to withstand the strains of these long-distance high-speed races have invariably retained their reputation as constructors of reliable vehicles for everyday use.

It is universally recognised among engineers that there is no test for any sort of mechanism better calculated to expose its defects than an organised competitive trial fixed for a definite date and time; and there is no combination of mechanism more liable to the unexpected developement of mysterious troubles and derangements than the delicate internal organs of a motor vehicle. Hence it is that each year many a car entered by its contractors under the belief that it represents their highest efforts in the direction of perfection of mechanical parts, is taken back to the shops after a race, in a condition which teaches more valuable lessons than would have been gained by a year of ordinary use in the hands of a customer employing the vehicle for pleasure purposes. It reflects great credit on the automobile manufacturers of France, that each year they have accepted the responsibilities and difficulties involved by races made more and more difficult and destructive to their vehicles. Eight years ago they were invited to send their vehicles for a run of one or two hundred miles over the best roads that could be chosen in France; they might effect all necessary repairs on the road, and if fortunate in escaping mechanical trouble the cars might run through from start to finish without a stop and almost without slowing down. Nowadays, however, the successful competitors in a race are called upon to pass through an ordeal such as probably no other mechanical contrivance is ever subjected to. The race is not now over some road in France chosen for its straightness and the perfection of its surface, but it takes the most difficult route through three countries. It extends from Paris to Vienna, crosses Switzerland and the Tyrolean Alps, rises above the snow line, and descends by a torrent-washed track over which the automobilist must pass in danger of utter destruction at every turn before he can reach his destination. This route of 1,400 kilometres must be traversed in four days, at an average speed considerably greater than that maintained on the railways which pass through the same districts. The automobilist must slow down at almost every village, and must stop and re-start twice at the controls of almost every town. When he arrives at his destination for the night he must drive his car to a definite spot and there leave it without spending a moment for repairs or adjustment, which must all be done on the road on the following day and in time which counts against his running time. To crown all these difficulties, the constructor must put his car on the road in running order, to weigh not more than 1,000 kilogrammes (about 19½ hundredweight) in the heaviest class, and to enable it to compete with its rivals in point of speed it must carry an engine developing 50 to 70 brake horse power.

Carrying these conditions in mind, the success of the Paris-Vienna race can only be characterised as marvellous. In the first place it must be remembered that it is less than a year ago that the

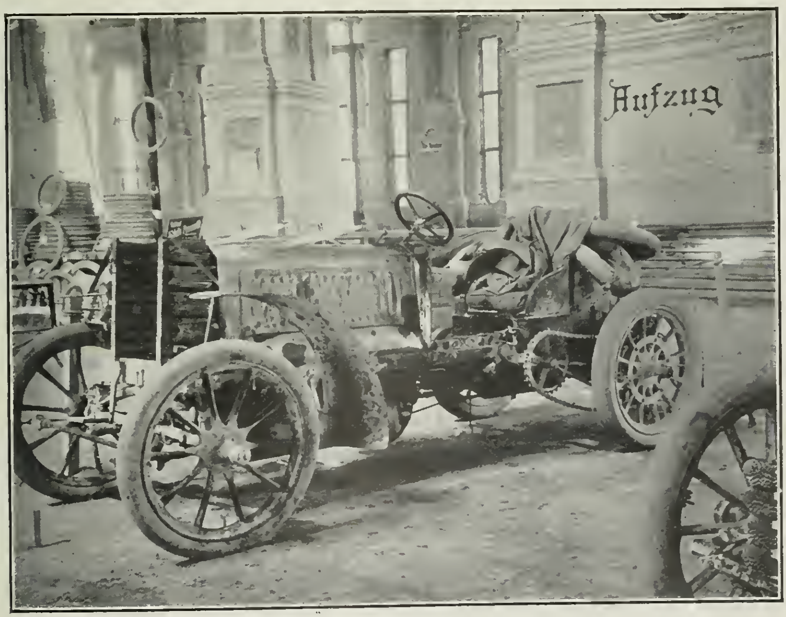
SCENE ON THE ARRIVAL OF ONE OF THE CARS ON THE RACE COURSE, VIENNA.

Automobile Club de France decided to fix the 1,000 kilogrammes as the limit of weight of a racing vehicle. All the constructors of heavy cars have thus been called upon to remodel their vehicles entirely. The factor of safety has been cut down to the finest in every part, every item not absolutely essential has been rigorously excluded: and notwithstanding this the engine power per pound of total weight has been greatly increased. The constructors of vehicles in the classes limited to weights of 650 and 450 kilogrammes respectively have correspondingly been called upon to increase their engine power to a point which a year or two ago would have been considered high for a heavy car, in order to maintain a speed approaching that of the heavy vehicles; whilst the motor tricycle with its 11-brake-horse-power engine has been developed into a machine which can be likened to nothing but an enormous grasshopper as it leaps over the road at 100 kilometres per hour. The skill and intelligence with which the manufacturers have met the manifold difficulties of constructing cars suitable for the Paris-Vienna race is of the very highest order. Examining the vehicles of a few of the leading constructors our attention is



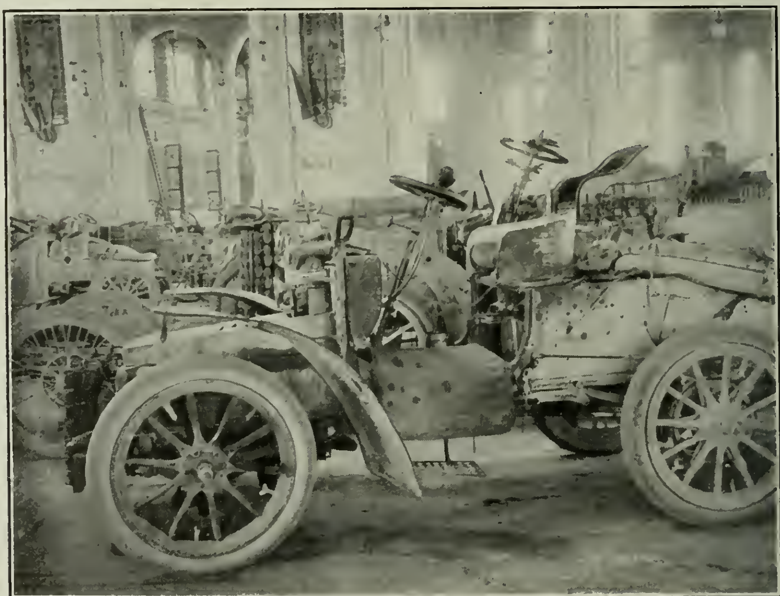
A 70-HORSE-POWER PANHARD WAITING THE START AT CHAMPIGNY, JUNE 26.

naturally in the first place attracted by the work of the Panhard & Levassor firm. In their latest type of cars, weighing only 960 kilogrammes, we find an engine which is stated on reliable authority to develope 70 to 75 brake horse power. The car is modelled generally on the well-known Panhard lines with four-cylinder vertical engine mounted toward the front of the underframe and transmission by spur, bevel and chain gearing to the rear road wheels; but in detail we find many modifications. The underframe, which carries all the essential items of the mechanism, is constructed of wood strengthened by suitably designed steel-plate girders, and is supported from the axles by three plate springs, two at the back parallel with the length of the frame, and one transverse spring attached centrally to the front cross member of the frame and pivotted at its ends from the front axle. The position of the front axle is preserved by light rods pivotted on the axle and on the longitudinal members of the frame. This front spring is extraordinarily light considering that it has to carry a full half of the total load, but its position is such as relieves it of one of the chief strains to which side front springs parallel to the frame would be subjected, namely, the continual rock of the engine in a plane at right angles to the length of the crank shaft due to forces entirely unbalanced. Weight has been saved in another direction by making the axles tubular, and the ends of the front axle are now forked to receive the steering-wheel pivots. The engine, although still of the four-cylinder vertical type, bears no more resemblance to the original Phœnix Daimler engine than does a modern locomotive, to early productions of Stephenson. It has been subjected to a rigorous process of lightening. The four cylinders are now entirely independent, the castings which in each case constitute cylinder body and head being bolted independently to the upper half of the aluminum crank chamber. The water jacket for the body of each cylinder is formed of sheet copper. The valves and pipes, both for inlet and exhaust, bear a much more just proportion to the cylinder volume and piston speed than in earlier engines. In order to obtain sufficient opening for the admission of the gas to the cylinders, the admission valve is in each case triple, as in the English Napier engines of two years ago, the three small valves giving a much more efficient opening than one large one. The governing of the engine is effected by closing the admission to all cylinders alike. The carburettor is, as formerly, of the spraying type originally adapted to these high-speed explosion engines by Maybach. In the matter of relation of bore and stroke we find that, although the engine is still high and the stroke long for the speed aimed at, the Panhard, together with all the other



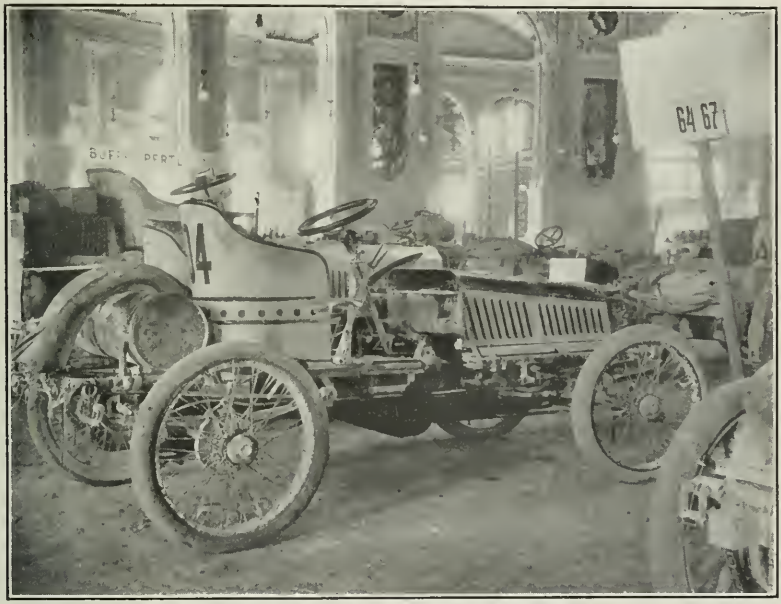
ONE OF THE 70-HORSE-POWER PANHARDS AFTER THE RACE.

firms, are being driven to shorten the stroke of their engines in proportion to the bore according to the dictates both of theory and practice, in spite of an obstinate clinging to the idea that power is best obtained by applying the force of the explosion to a crank of long leverage. The ignition in the engine is now only electric, the hot tube having evidently disappeared for good. The water circulation is maintained by a friction-driven centrifugal pump, and the cooling is effected by one of the latest "Loyal" coolers in which a battery of 22 small pipes coupled in parallel, bent to form 9 layers in series, is sheathed in aluminum radiating ribs and formed to fit the front of the bonnet covering the engine. The transmission of power from engine to road wheels is effected by a combined friction cone and bolt clutch, the female portion of which forms part of the flywheel, while



THE CROUAN LIGHT CAR; THE ONLY RACING CAR WITH HORIZONTAL ENGINE TO ARRIVE AT VIENNA.

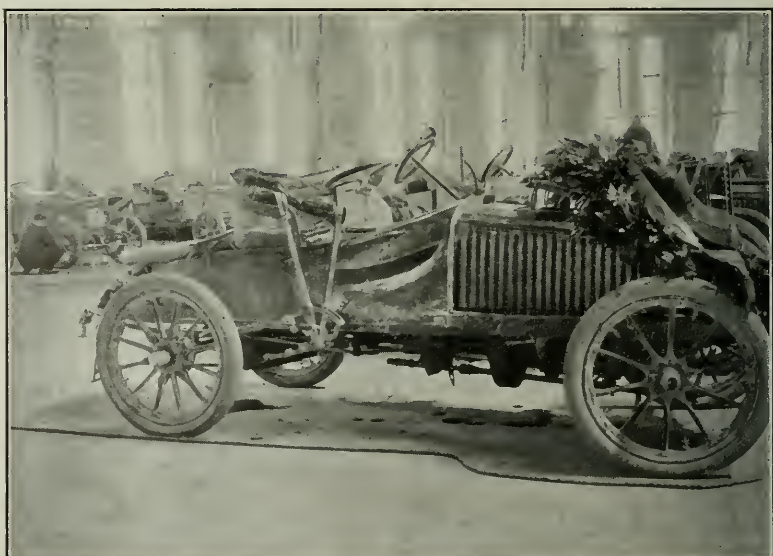
the male portion is mounted on an extension of the lower shaft of the change-speed gear. The main portion of the gear box is now mounted behind the differential cross shaft, but the general arrangement of sliding spur wheels on the lower longitudinal shaft driving fixed wheels on the upper shaft, which in turn drive the differential cross shaft of a single bevel gearing, is identical with last year's models. The cross shaft which carries the pinions of the final chain drive is now constructed in two parts as necessitated by the differential gear, and not as formerly in four parts to allow of play between the gear box and the frame. The gear box is now so hung that strains on the underframe are not transmitted to the shafting. The final driving chains are extraordinarily light considering the power to be transmitted; five years ago chains as heavy as these were fitted to cars of 6 brake horse power.



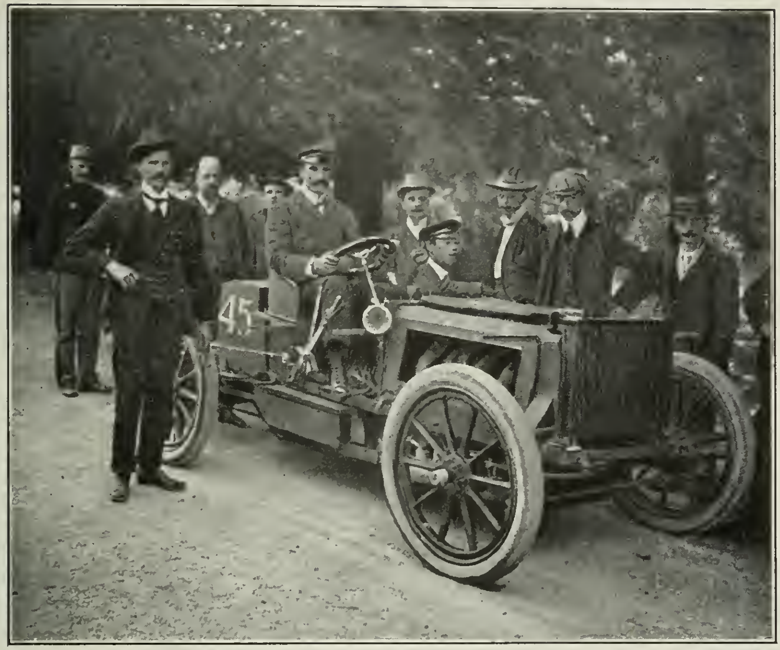
A DECAUVILLE LIGHT CAR AT VIENNA.

Many points of similarity are to be found between the vehicles of Mors and Panhard & Levassor, but the Mors firm, who carried off first honors in last year's Paris-Bordeaux and Paris-Berlin contests, had to face a much more difficult problem in remodelling their 1901 type, weighing about 1,400 kilogrammes, to reduce its weight to 1,000 kilogrammes, than had their rivals, whose type for last year weighed only about 1,150 kilogrammes. As the result of the Paris-Vienna race has shown, the problem proved too severe. Of the five Mors cars of 60 horse power which started from Champigny in the hands of the most expert drivers, two were wrecked by mischance, one by the severity of the road, and two arrived at Vienna but did not take very high places. An extenuating circumstance which must not be passed over unmentioned was that all these cars started practically untried. A point of great interest and ingenuity in the design of these Mors cars is the air dashpots employed to aid the springs supporting the underframe. The pots of the dashpots are attached to the underframe whilst the pistons are coupled to the axles, the action being to accelerate the return of the road wheels to the road when they have been raised by striking an inequality and so to keep the driving effort more regular.

Amongst the heavy vehicles the performance of the Mercedes cars constructed by the Cannstadt Daimler firm was highly successful. Of four cars entered, two only started and these both driven by amateurs. These two cars were amongst the leading vehicles throughout and actually arrived at Vienna second and third, but in the final classification one was reduced to the fifth place whilst the other was disqualified owing to the fact that it had to be towed over the last four-hundred yards of the course owing to a temporary mechanical derangement. These Mercedes cars were of the same type as so successfully competed at Nice in the spring of this year and although not of an excessively high power—40 horse power—they had been thoroughly tested on the road side by side with the petrol and alcohol cars. The steam vehicles of Serpollet fitted with furnaces burning alcohol ran with conspicuous regularity, all the starters, five in number, arriving at Vienna. This performance is unique in the history of steam-propelled carriages.



THE WINNING RENAULT CAR IN THE ROTUNDA AT VIENNA AFTER THE RACE.



MR. S. F. EDGE ON THE NAPIER CAR.

In the categories of light cars and voiturettes we find a diversity of design too complex to admit of a detailed description, but the construction of the most successful vehicles, the Renaults and the Darracqs, will naturally attract especial attention. The fact that it was a light Renault car, weight 650 kilogrammes, which took first place in the whole race, whilst Darracqs of similar weight hold the third and seventh, eighth, and ninth places, speaks very eloquently for the really light car of moderate power as a vehicle capable of high speeds and possessing great endurance. The engines in both the above types of car are four-cylinder vertical, of high speed and stroke very short in proportion to the bore. The underframes are in both cases constructed of steel tubing and spring by single plate springs from tubular axles. The road wheels of the Renault cars have wood spokes and the Darracqs are of the steel tangent-spoke type. The transmission is in each case by a spur change gear and flexible tail shaft to a bevel gearing driving the live rear axle through the differential gear.

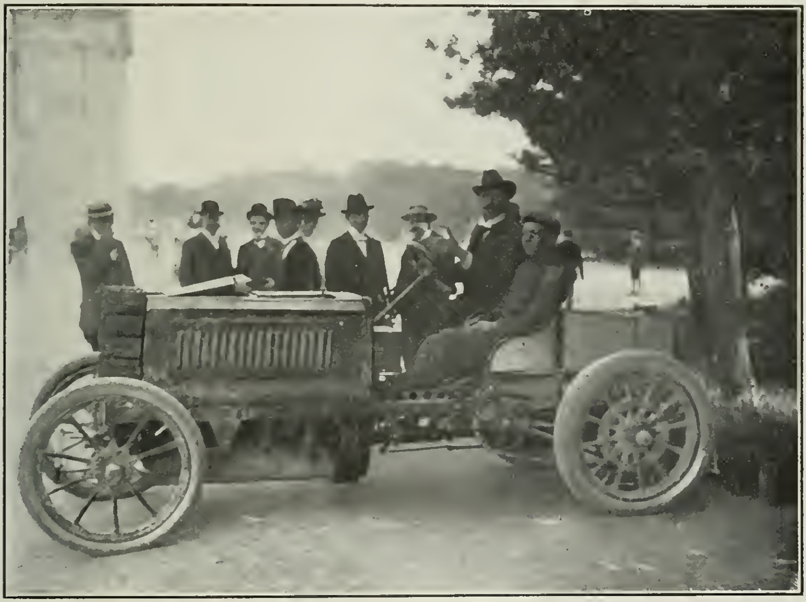
A car which is of especial interest to British automobilists is the Napier, which under the skillful guidance of Mr. S. F. Edge gained the Gordon Bennett cup, although in competition with the best cars and most skilled drivers that France could put upon the road. The race for the Gordon Bennett cup was run over the same course and at the same time as the Paris-Vienna race, but ended at Innsbruck in the Austrian Tyrol, about 900 kilometres from Paris. The four cars competing in this race started first amongst the Paris-Vienna cars and numbered, for France a Panhard-Levassor of 70 horse power driven by M. René de Knyff, a C. G. V. car of about 60 horse power driven by M. Girardot, and a Mors car of 60 horse power driven by M. Henri Fournier, whilst England was represented by the Napier light car driven by Mr. Edge. The result of this race, as of the Paris-Vienna, was a triumph for the light car. At about 70 kilometres from the start the C. G. V. car gave way under the strain of excessive speed; at about 250 kilometres a similar fate awaited Fournier on his

A GROUP OF MOTOR BICYCLES. THE FIRST TWO ARRIVALS WERE WERNERS.

Mors, whilst R. de Knyff, the engine of whose car, it may be mentioned, ran on alcohol, when within 50 kilometres of Innsbruck and virtually holding the assurance of success, was put *hors de combat* by a broken differential. The cup thus fell to Edge, whose car travelled consistently well throughout, maintaining a good average although not a very high speed. The Napier car, which is the first English vehicle to be victorious in a Continental race, is a totally different design from the vehicles of the same firm which since the 1,000 miles trial of 1899 have occupied a prominent position amongst British cars.

It is of the category of light cars, and carries an engine developing about 35 brake horse power of the four-cylinder vertical type, high-speed and short-stroke, with very large pipes and valves.

As is almost invariably the case in these important races, there was a great disparity between the numbers of cars entered and the number of actual starters. Of about 210 entries, 137 cars were sent off from Champigny on the morning of June 26; of this number 106 arrived at Belfort, 408 kilometres from Paris, the end of the first



HENRY FARMAN ON HIS 70-HORSE-POWER PANHARD.

day's run, and of these 85 cars arrived at Vienna on June 29. Considering the severity of the course and of the rules regulating the running of the cars, this result reflects the highest credit on all connected with the construction and running of the cars. The average speed of the winning car is not very high—about 58 kilometres per hour—but it must be remembered that the cars were constantly losing time by slowing down for villages and stopping at controls; that the whole of the route through Switzerland was neutralised, and that all repairs and replenishments were effected in the running time. On the first stage, where the roads were good and the route fairly well-known, R. de Knyff on his 70-horse-power Panhard using alcohol fuel maintained an average speed of almost exactly 100 kilometres—62 miles per hour. An achievement such as this speaks for itself.

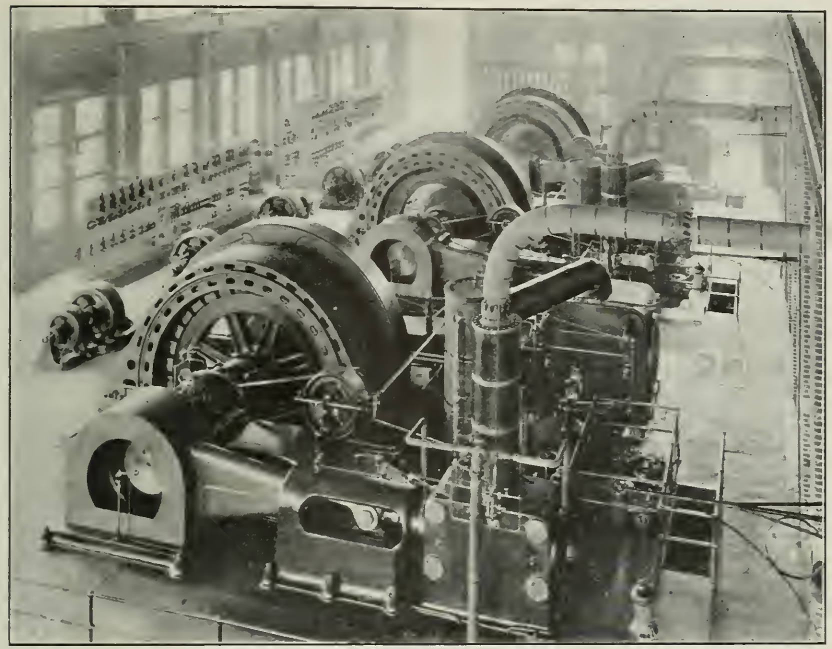
HIGH SPEED ELECTRIC INTERURBAN RAILWAYS.

By George H. Gibson.

The most significant suggestion from Mr. Gibson's article is that the electric railway, with all the wonderful extension it has had in the United States, is hardly more than beginning its work as an economic influence. How far that work may extend it would be almost rash to attempt to say. But this much appears certain:—the electric road is an additional—not a substitutional—transport agency. It will supplement and modify the steam railway—force it to specialize on the service for which it is most fitted—but not supersede it. The work of the world is increasing so fast it seems to demand all available tools, seizing the new, but adding them to the old. There may, however, be many changes in relative importance. Electric motive power will be enormously greater in the total application ten years hence. Mr. Gibson's account of its proved fitness and extended use even at present will carry great interest and almost a revelation to many readers.—THE EDITORS.

THE electric railway is to perform a service for mankind as notable and perhaps ultimately as great as that rendered by its steam-operated precursor. Already it handles the bulk of suburban and short-distance interurban passenger traffic; it carries freight, mail, express, and baggage; it operates at speeds reaching 60 miles per hour; its cars are operated on time schedules and dispatched by telephone; its roadbed is often as expensive and heavy of construction as that of the best steam lines; and, what is more interesting to the investor, it pays large dividends. At the present time $1,600,000,000 are nominally invested in electric roads in the United States and upon this sum $7,000,000 are paid in yearly dividends; 300,000 employees receive yearly in wages $250,000,000, and there are 20,000 miles of track on which 60,000 cars are run. In 1899, ten miles of electric road were built for every mile of steam road constructed.

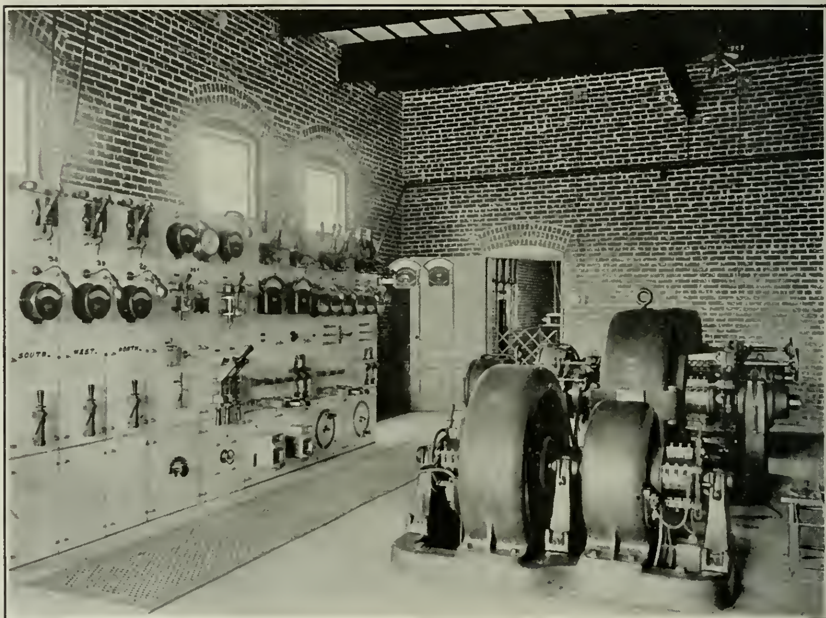
The greatest development of interurban roads has taken place in the great agricultural districts of the middle western States, where they have grown to a truly surprising extent. It is often said that electric railways have checked the concentration of population in great



THREE 1,000-KILOWATT ROTATING-FIELD WESTINGHOUSE GENERATORS, THREE-PHASE, 3,200 VOLTS. UNION TRACTION COMPANY OF INDIANA.

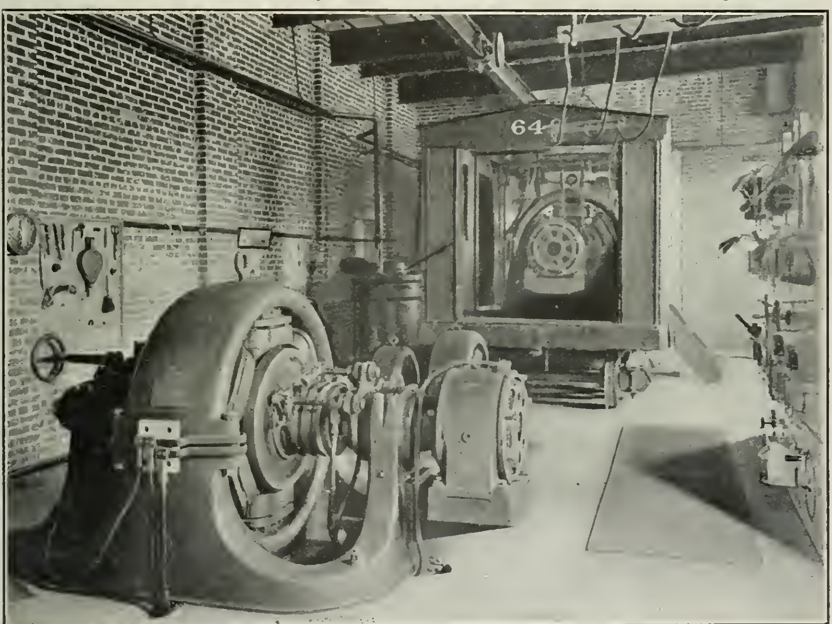
cities by creating suburban districts, but in the farming regions they have had a still greater effect in building up many small centers of population. The Union Traction Company of Indiana operates 109 miles of interurban track and 54 miles of city track in the gas belt of that State and serves a population of 350,000. It connects the cities of Anderson, Marion, Muncie, Indianapolis and about twenty smaller towns and traverses six of the most prosperous counties of the State. The interurban lines are located almost entirely on private right of way protected by fences and cattle guards. Tests have shown that a maximum speed of 58 miles an hour may be reached and an average speed of 45 miles an hour maintained. Cars are run in each direction every hour and special cars are furnished for theater parties, excursions, and picnics. The rates of fare are approximately one cent a mile. The daily receipts of the interurban lines are said to be $3,000 on an average, but this is frequently increased to $8,000 and on one occasion was $11,000 in a single day. Large additions are contemplated, about doubling the present mileage. Power is generated in a central station at Anderson, containing three 1,000-kilowatt Westinghouse alternators, and is transmitted by three-phase alternating current at 14,000 volts to eight sub-stations, which are supplemented by storage batteries.

One of the greatest possibilities of the interurban road lies in the development of freight traffic. It is well fitted for the transfer of farm produce and supplies for farmers and for carrying package merchandise, and it can often give great convenience of delivery and the possibility of handling freight economically, especially in small cities. The Chicago, Harvard & Lake Geneva Railway has not only a large freight traffic of its own but carries on an interchange of busi-



250-KILOWATT THREE-PHASE WESTINGHOUSE ROTARY CONVERTER AND ALTERNATING-CURRENT—DIRECT-CURRENT SWITCHBOARD, ALEXANDRIA SUB-STATION, UNION TRACTION CO. OF INDIANA.

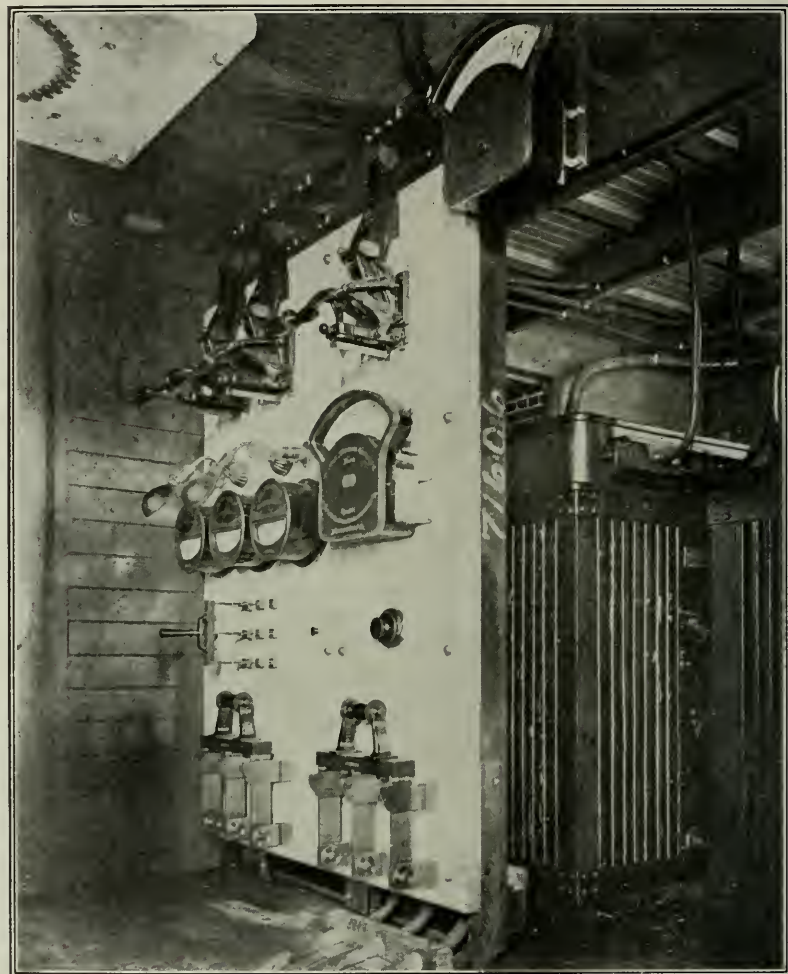
ness with steam roads, to a greater extent perhaps than any other electric road in the United States. Its southern terminus is at Harvard, on the Chicago & Northwestern Railroad, and at Walworth, 8½ miles north of this place, the road crosses the Chicago, Milwaukee & St. Paul Railway, thence running two miles northeast to Lake Geneva, one of Wisconsin's most popular summer resorts. One-third of the business of the road is in handling freight. Freight cars from the railroads are hauled to sidings on the electric road at a flat rate of $5 per car, and piece freight is transported on a one-rate plan between any two points on the road for five cents per hundred pounds, no package being handled for less than ten cents. A freight motor car with a crew of two men carries package freight and hauls from one to four steam-road freight cars. There are six freight sidings along the road, not including the company's yards. Live-stock shipments are an important part of the business. In summer refrigerator cars are run twice a week over the Chicago & Northwestern Railway for the benefit of creameries situated on the electric road, and last winter 3,000 tons of ice were hauled from Lake Geneva for local use along the line. The company receives $500 per year for hauling mail two trips daily each way. Passenger tickets are sold by the electric road to points on the steam roads and baggage is carried free. The power house is located at Murray and contains two generators of 500 kilo-



PORTABLE WESTINGHOUSE ROTARY CONVERTER, RUNNING IN MULTIPLE WITH STATIONARY ROTARY, 250-KILOWATT THREE-PHASE.
Union Traction Co. of Indiana.

watts each. The equipment consists of ten motor cars and six trail cars. The maximum speed is 45 miles per hour.

While many electric roads have been constructed cheaply and of light materials, the tendency is more and more towards a substantial type of construction similar to the best steam-railway practice. The Grand Rapids, Grand Haven & Muskegon Railway, recently completed, is equipped with standard 70-pound T-rails laid on a private



INTERIOR OF PORTABLE ROTARY-CONVERTER CAR SHOWING SWITCHBOARD AND TRANSFORMER.
Union Traction Co. of Indiana.

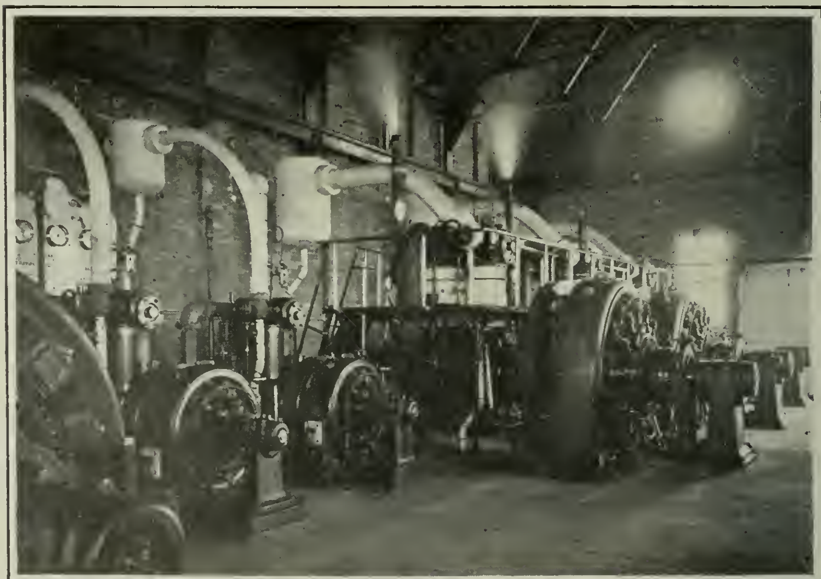
right of way. The road runs from Grand Rapids to Muskegon, Mich., a distance of 35 miles, with a branch 7 miles long to Grand Haven. It parallels steam roads to both cities, the running time of the electric and steam cars being about the same. The country is well developed industrially, containing tin-plate and paper mills, knitting factories, and machine shops. Grand Rapids has a population of 96,000, Muskegon 26,000 and Grand Haven 5,000. The country near Grand Haven is largely occupied as a summer resort by people from

PAVILION AT FRUITPORT ON SPRING LAKE, AND STEAMER OTTAWA, OPERATED BY GRAND RAPIDS, GRAND HAVEN & MUSKEGON RY.

Grand Rapids, Chicago, and Milwaukee. In passing through towns and cities, the road uses the overhead-trolley system, for which the cars are equipped with a trolley arm, while upon the enclosed right of way through the country the third-rail system is employed. The third rail is discontinued at crossings, the current being carried under the highways by conductors imbedded in pitch in underground conduits. The conductor rail is of 65-pound section and standard composition, and is supported upon reconstructed-granite insulators. The power house, located at Fruitport, contains five 250-kilowatt generators, three of which are double-current machines, generating both direct and alternating currents, while two are standard alternators. All are direct connected to Westinghouse vertical compound engines and are arranged for operation in multiple.

Another interesting road running out from Grand Rapids is the Grand Rapids, Holland & Lake Michigan Rapid Railway, extending from Grand Rapids to Holland and there connecting with two short lines to the lake shore. This road traverses a rich farming country, thickly settled by Dutch and Germans, and the two lines to the lake shore reach a favorite summer resort district. The aggregate length of track of the combined roads is 71 miles, the total distance covered being 45 miles, 19 miles of this comprising the two roads running from Holland to the lake. Cars are operated on a headway of one hour and require at the present time 90 minutes for the trip from Grand Rapids to Holland. This time is to be reduced as soon as the roadbed is improved and a maximum speed of 45 miles will be realized, with an average speed of 26 miles per hour, including stops. All railroads are crossed by bridges and subways, and the private right of way, which is four rods wide, is fenced in. The entire mechanical and engineering construction has been carried out very thoroughly.

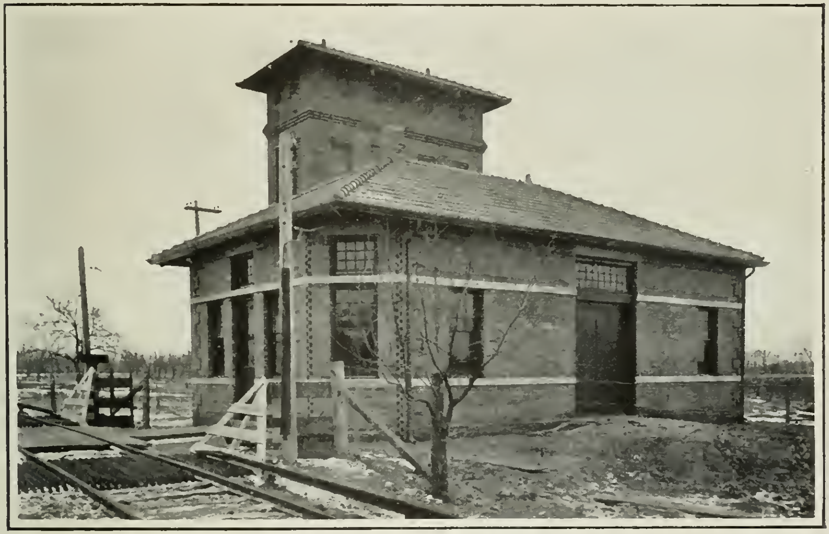
The track is standard gauge, laid with 70-pound T-rails, and is ballasted with coarse gravel and drained by vitrified tiling. The power



FRUITPORT POWER HOUSE, G. R., G. H. & M. RY. FIVE 250-KILOWATT WESTINGHOUSE GENERATORS.

The exterior view above shows arrangements for unloading coal.

plant embodies coal-handling apparatus, mechanical stokers, economizers, and forced draught. The two engines are of the vertical cross-compound condensing type and are direct connected to 500 kilowatt, three-phase, twenty-five-cycle alternators. The sub-stations at various points on the road are supplied with alternating current transmitted at 20,000 volts over aluminum conductors. The transmission lines are carried upon the poles supporting the trolley wire, the whole being protected from lightning discharges by a strand of barbed wire strung at the tops of the poles and grounded at each sixth pole to galvanized-iron pipes driven 12 feet into the ground. The cars are 47

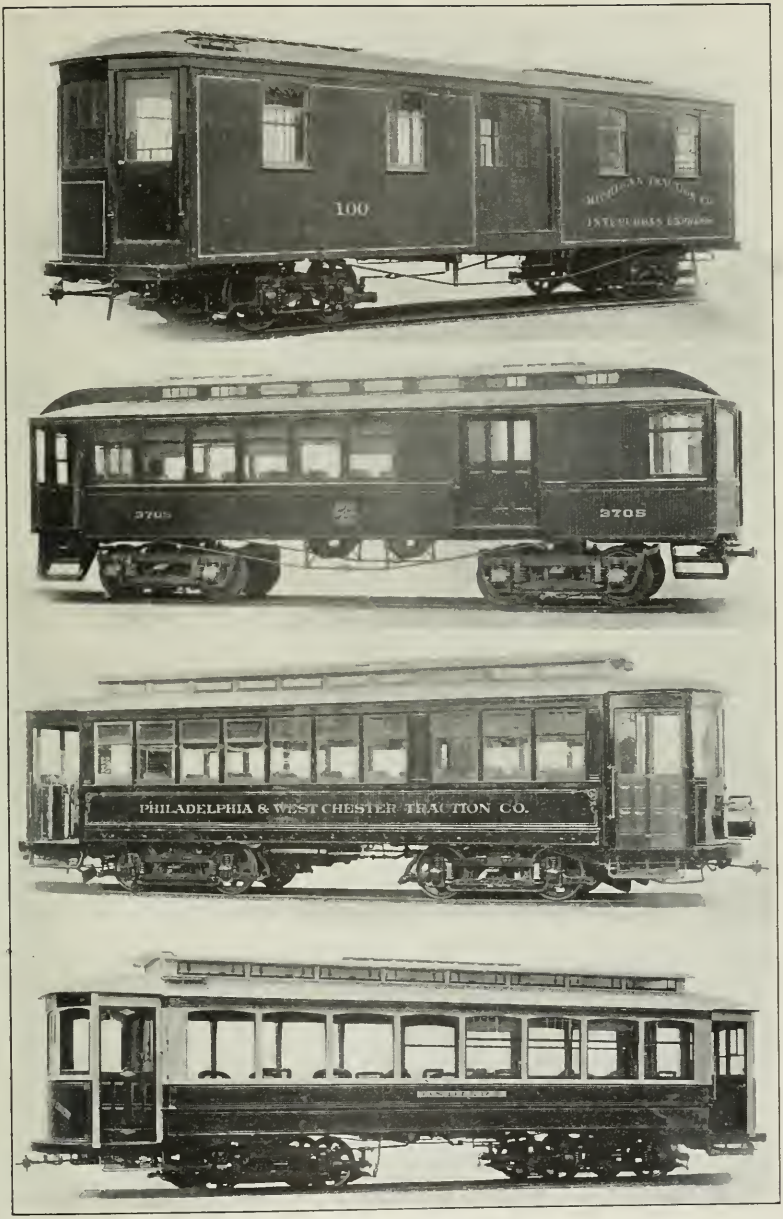


SUB-STATION, G. R., G. H. & M. RY., SHOWING THIRD-RAIL CONSTRUCTION.

feet long and weigh from 23 to 25 tons without load. They are completely equipped with heaters, air brakes, sand boxes, etc. The company has recently ordered a number of 50-foot cars and a number of 35-foot freight cars will be operated. The freight rates are low, ranging from 3½ to 23 cents per hundred pounds, depending upon a distance-rate basis and classification. The express rates vary from 20 cents for a package weighing not more than 10 pounds to 45 cents for packages weighing from 50 to 100 pounds, above which the rate is 45 cents per hundred. The franchise calls for rates not exceeding 1½ cents per mile for carrying passengers, but as the steam road paralleling the electric line has greatly reduced its fares since the building of the latter, the electric road has made special rates during certain hours of the day when the steam-road trains are in operation between the terminal points.

While electric roads are approaching steam lines in type of construction and methods of operation, many of the latter are finding it advantageous to adopt electric traction, especially for short-haul and suburban service. The Quebec, Montmorency & Charlevoix Railway has in this way within two years increased its total yearly capacity and receipts from $44,221 to $73,292. The overhead trolley is used and the cars are equipped with two 50-horse-power motors and air brakes and are capable of running 45 miles per hour. The total cost of the electrical installation for 30 miles of track, including six double-truck cars and a 600-kilowatt alternating-current generating station, was $169,375. On Sundays and holidays the road is used so extensively that its resources are fully taxed and it has been found necessary to increase the rolling stock, so that in addition to the regular cars specials may be run at 10 and 15-minute intervals. It will further be necessary to construct a double track between Quebec and Montmorency. In addition to the electric traffic, steam, freight, and special pilgrimage trains are constantly handled, and no collision or other accident has so far occurred.

Another road which has greatly improved its service by adopting electric traction is the Buffalo & Lockport Railway. The company operating this road was organized in April, 1898, and leased for 99 years the Lockport Branch of the Erie Railroad, running from Lockport to North Tonawanda, N. Y., and comprising 13½ miles of single track. It has since bought 5½ miles of road in the streets of Lockport, 7½ miles of single track between Buffalo and North Tonawanda, and a mile of track in Buffalo, making the total length of the line at present 29 miles and giving through service from Buffalo to Lockport and Niagara Falls. Power is obtained from the Niagara Falls Power Co., and is transmitted at 10,500 volts to a rotary converter sub-station located at Lockport, from which it is fed as direct current at 1,500 volts to the trolley wires. Both passenger and freight traffic are handled, trolley cars being used for the passenger service and two electric locomotives, built by the General Electric Co., for the freight service. These locomotives weigh 36 tons each. Since the road is a feeder of the Erie Railway system, the freight traffic is considerable and the locomotives are each equipped with four 160-horse-power motors, designed to give a draw-bar pull of 3,400 pounds when running at 15 miles per hour, which is considered sufficient to handle a 340-ton train. The locomotive trolleys are controlled from the cab by means of a



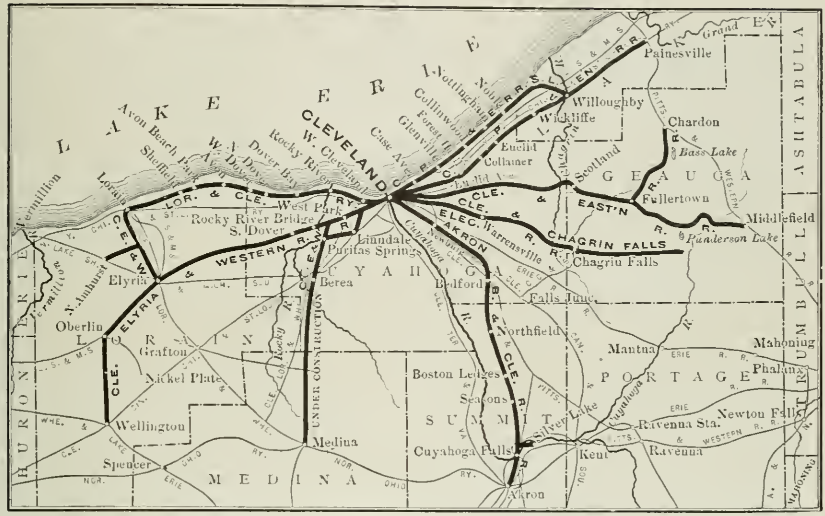
TYPES OF MODERN AMERICAN CARS FOR HEAVY ELECTRIC-RAILWAY SERVICE.

At the top is a 40-foot express car, weighing 25,000 pounds, open from end to end for load; diagonal doors to take in long pieces; speed 33 miles. Next comes a 40-foot trolley car with baggage compartment, Providence & Fall River branch of N. Y., N. H. & H. Ry.; weighs 45,000 pounds; seats 28 passengers. Below that is a 41-foot 25,000-pound car with 9-foot smoking compartment, intended for average speed of 20 miles. At the bottom is a semi-convertible parlor trolley car for the Buffalo railway, 41 feet 8 inches long, 31,000 pounds. All by the J. G. Brill Company.

LOCOMOTIVE FOR THE BUFFALO AND LOCKPORT RAILWAY. GENERAL ELECTRIC CO.

pneumatic arrangement. The most marked change on the road, however, has been accomplished by the trolley cars in connection with the passenger traffic. The equipment includes five cars which are operated on a half-hour headway. Each car is equipped with four 52-horse-power motors and a maximum speed of more than 60 miles per hour has been reached. The trip between Buffalo and Lockport, a distance of 25 miles, can be made in one hour, including stops. The cars are 31 feet long and have two passenger compartments, one of which is a smoker. In addition to the regular passenger car, one combined baggage and passenger car is operated, carrying mail and express.

A number of roads used chiefly for pleasure riding have been built in Southern California in the neighborhood of Los Angeles. The population is composed largely of wealthy people who have sought that part of the country on account of climatic conditions, and who patronize the roads liberally. One of the roads from Los Angeles extends to Pasadena and from there to Echo Mountain and Mt. Lowe. Another line runs from Los Angeles to Santa Monica on the Pacific Ocean. The Los Angeles-Pasadena line was so well patronized the first year that it was necessary to double-track the road. It competes with three steam lines, and one of the latter has been compelled to reduce its train service by half and would reduce it still further if that were not prevented by its franchise. The cars on the Pasadena line are each equipped with two 40-horse-power motors and Standard air brakes, and make a maximum speed of 25 miles per hour. The road to

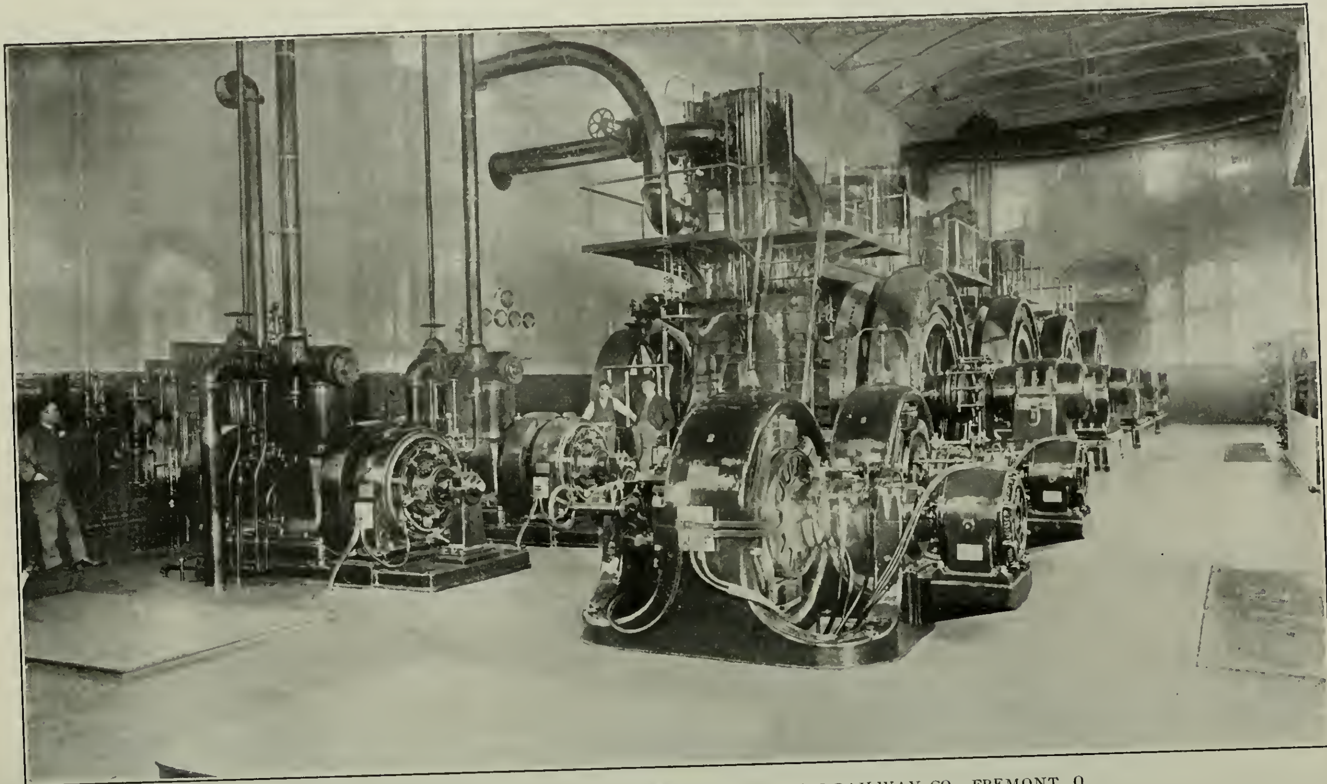


MAP SHOWING (BY HEAVY LINES) THE DEVELOPMENT OF ELECTRIC RAILWAYS ABOUT CLEVELAND, OHIO.

Santa Monica has quadruple equipments of 50-horse-power motors and can maintain a speed of 40 miles per hour. Another road which is being built from Los Angeles 20 miles to Long Beach will have as one of its features a broad boulevard, 184 feet wide, on each side of the track.

Perhaps the field of greatest activity in the United States for the construction of high-speed interurban lines has been in northern Ohio and southern Michigan, where there is now a network of highly equipped roads upon which through traffic is being established, offering even such accommodations as parlor and sleeping cars. It is said that a service of this character will shortly be established between Columbus and Cincinnati. The roads utilized will be the Southern Traction Company's lines from Cincinnati to Dayton; the Dayton-Springfield & Urbana to Springfield; and the Columbus, London & Springfield to Columbus, the service to be established as soon as the latter road is completed. The schedule time between Columbus and Cincinnati will be about six hours. It is also proposed to operate through cars between Cleveland and Cincinnati, the route from Cleveland being over the Cleveland, Elyria & Western, the Cleveland, Ashland & Mansfield, the Mansfield, Galion & Crestline, and the Columbus, Delaware & Marion, roads all either in operation or under construction.

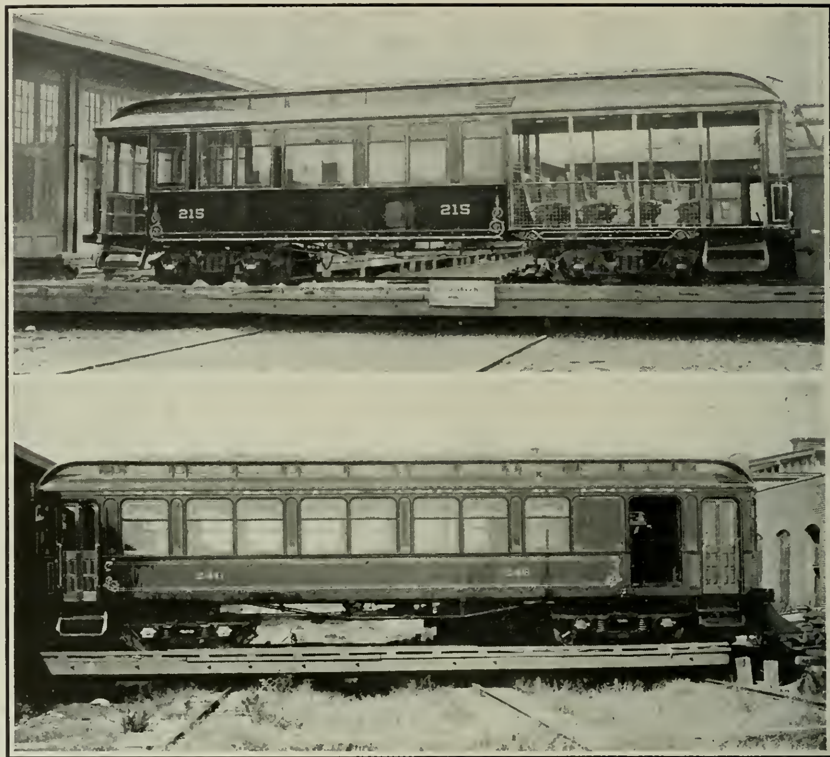
A few notes regarding the Cleveland, Elyria & Western may be of interest, since its power house will be the first railway power station



INTERIOR OF ENGINE ROOM, TOLEDO, FREMONT & NORWALK RAILWAY CO., FREMONT, O.
Four alternating-current generators direct-connected to 1,750-horse-power Westinghouse engines.

in the United States to be equipped with steam turbines. Two Westinghouse turbines running at 1,500 revolutions per minute are to be direct-connected to two 1,000-kilowatt, two-pole generators, delivering alternating current at 400 volts and 25 cycles per second. Steam will be supplied to the turbines at 150-pounds pressure and 200-degrees superheat, and the exhaust will be under a 28-inch vacuum. The steam consumption is guaranteed not to exceed 10.8 pounds of steam per horse-power-hour; and at one-half load the steam consumption per horse power is not to increase more than 15 per cent. These turbines are somewhat novel in construction in that the steam is expanded consecutively in two chambers—that is, the steam first passes through a high-pressure cylinder, then through a reheater, and finally through a low-pressure cylinder. The rotating parts of both the high- and low-pressure cylinders are upon one shaft, the bearing being placed between the two cylinders. Full load may be carried without superheat or vacuum. The adoption of steam turbines has increased the possible capacity with the space available in the existing power house from 2,000 to 5,000 kilowatts. Two 300-kilowatt rotary converters are being installed as connecting links between the present direct-current plant and the alternating-current apparatus. The power is transmitted to sub-stations along the road by alternating current at 20,000 volts.

Cleveland is the center of an extensive interurban electric railway system, extending in one direction nearly to Buffalo, N. Y., and in the other to Toledo, Ohio, which is also the terminus of a large number of roads. One of the roads connecting Cleveland and Toledo is the Toledo, Fremont & Norwalk, about 60 miles in length and controlled by the Lake Shore Electric Company. The power house at Fremont, about the middle of the line, contains four alternating-current generators, direct connected to 1,750-horse-power Westinghouse steam engines. Current is transmitted at 16,000 volts to six sub-stations, which are combined with passenger and freight stations in order to cut down the cost of attendance. The high-tension transmission wires are carried upon the poles supporting the trolley brackets. The roadbed, partly upon private right of way and partly upon public turnpike, is constructed for speeds exceeding 40 miles per hour. In preparing for a through service between Cleveland and Toledo, a series of experiments are being made by the Lake Shore Electric Company with a view of determining the most desirable motors for the traffic. A cross-country schedule of 35 to 40 miles per hour has been established and a speed of over 60 miles per hour has been maintained for short distances. Some of the cars are fitted with four 100-horse-power elec-



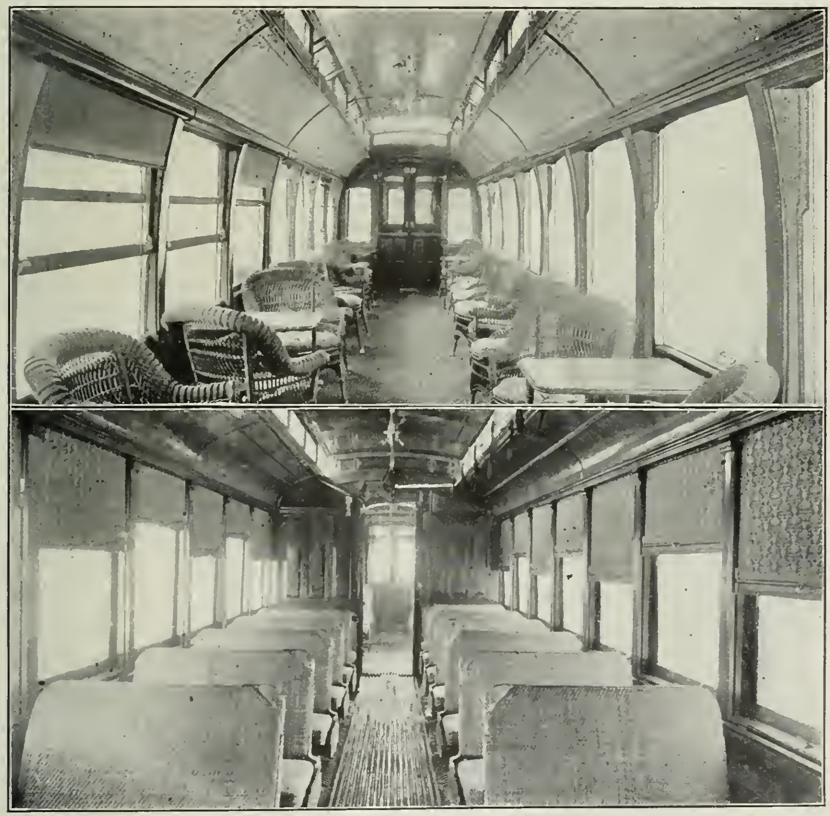
THE UPPER CAR IS FOR THE PACIFIC ELECTRIC RAILWAY, LOS ANGELES, CALIF.; THE LOWER ONE IS A MOTOR CAR FOR THE UNION TRACTION COMPANY OF INDIANA.
St. Louis Car Company, St. Louis, Mo.

tric motors. The cars now in service on the Toledo, Fremont & Norwalk are equipped with 75-horse-power Westinghouse motors. That part of the Lake Shore Electric Company's line between Cleveland and Norwalk is entirely on private right of way and is rock-ballasted and laid with 75-pound T-rails. This company is making an especial effort to develop freight traffic in fruit and dairy products. Passenger mileage books are sold for $12.50 per 1,000 miles, and local fares are about one-half of those charged by steam roads.

Toledo and Detroit are connected by a series of electric roads, one of the most completely equipped of which is the Toledo & Monroe Railway, having 18 miles of single track laid with 70-pound T-rails and ballasted with broken limestone. The equipment consists of ordinary passenger cars, chair cars, combined passenger and baggage cars, and freight cars. The passenger cars are 40 feet long and a regular schedule speed of 30 miles per hour, including stops, is maintained.

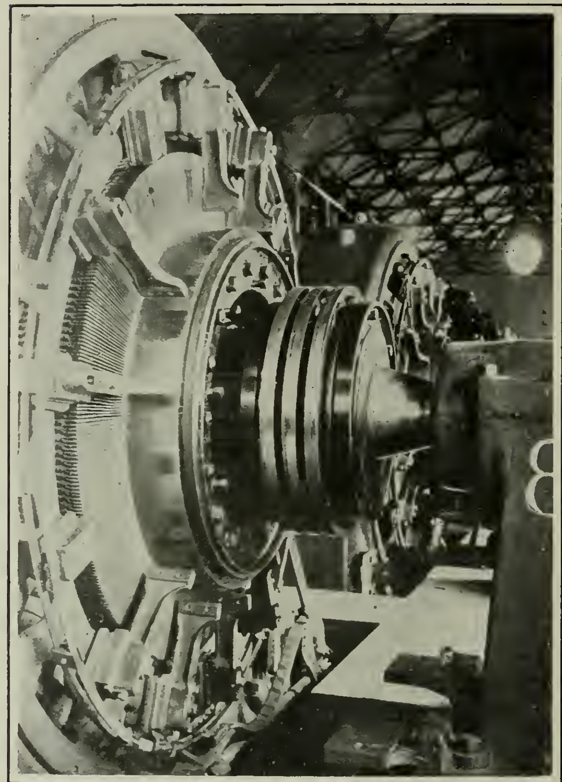
The power house contains two 400-kilowatt Westinghouse three-phase alternators and a sub-station contains a 200-kilowatt rotary converter. The long distance transmission is at 15,000 volts, the wires being carried on 45-foot pine poles set 6 feet in the ground and surrounded by concrete so that no guy wires are necessary. The same poles support the double trolley wire.

One of the oldest high-speed roads in America is the Detroit, Ypsilanti & Ann Arbor Railway. As originally constructed this road had a length of 50 miles, 40 miles between Detroit and Ann Arbor with a branch line of 10 miles to Saline. The line has recently been considerably extended, now reaching to Jackson, Mich., where it connects with other interurban roads. It is composed of single track throughout. The



INTERIORS OF ADVANCED TYPE TROLLEY CARS.

The car above is the "Ondiara," shown in exterior view at the bottom of page 867. Below is a 46-foot 35,000 pound car for the Chicago & Joliet Railway. It has a 14-foot smoking compartment and toilet room against the partition. Maximum speed 70 miles per hour.



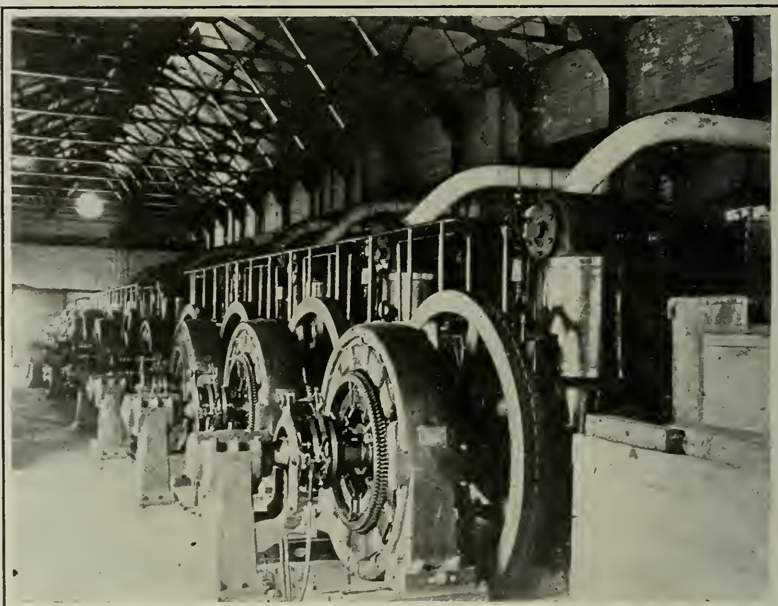
DOUBLE CURRENT WESTINGHOUSE GENERATORS, POWER HOUSE OF DETROIT, YPSILANTI & ANN ARBOR RAILWAY.

equipment consists of 20 cars, each provided with four 50-horse-power motors and quick-acting air-brakes. The motors can all be thrown in series for slow speed through cities. A regular half-hour service is maintained with an occasional 15-minute service, and all cars are dispatched by telephone, telephone stations being located at turnouts. The most remarkable effect of this road has been the development of an enormous passenger traffic. During the first year 4,000 passengers were carried per day, against 200 previously carried per day by the steam road passing through the same towns. The fare for 40 miles is 50 cents, while the fare charged by the steam roads for the same distance is $1.12. A 1,000-mile mileage book is sold for one cent per mile. The average fare per passenger is 15.9 cents. Many houses are being built in the small towns along the route and market gardening is rapidly developing in the country traversed. Freight service is given twice a day and express packages are carried in the baggage compartments of the passenger cars. When the line was first opened, more freight was offered than could be carried, although the rates were two-thirds more than those asked by the steam-railroad company.

Extending north from Detroit 73 miles to Port Huron, Mich., and comprising in all 110 miles of single track exclusive of sidings, are the lines of the Rapid Railway Company, another early pioneer in the electric interurban railway field. This road is an excellent illustration of the great advances in the building of electric roads made possible by high-tension power transmission. All power is generated at a main station at New Baltimore and transmitted in either direction by alternating currents at 16,500 volts. The power house is equipped with all the latest improvements in the way of coal and ash-handling machinery, mechanical draft, economizers, etc., and contains three 1,000-horse-power Westinghouse steam engines all direct connected to

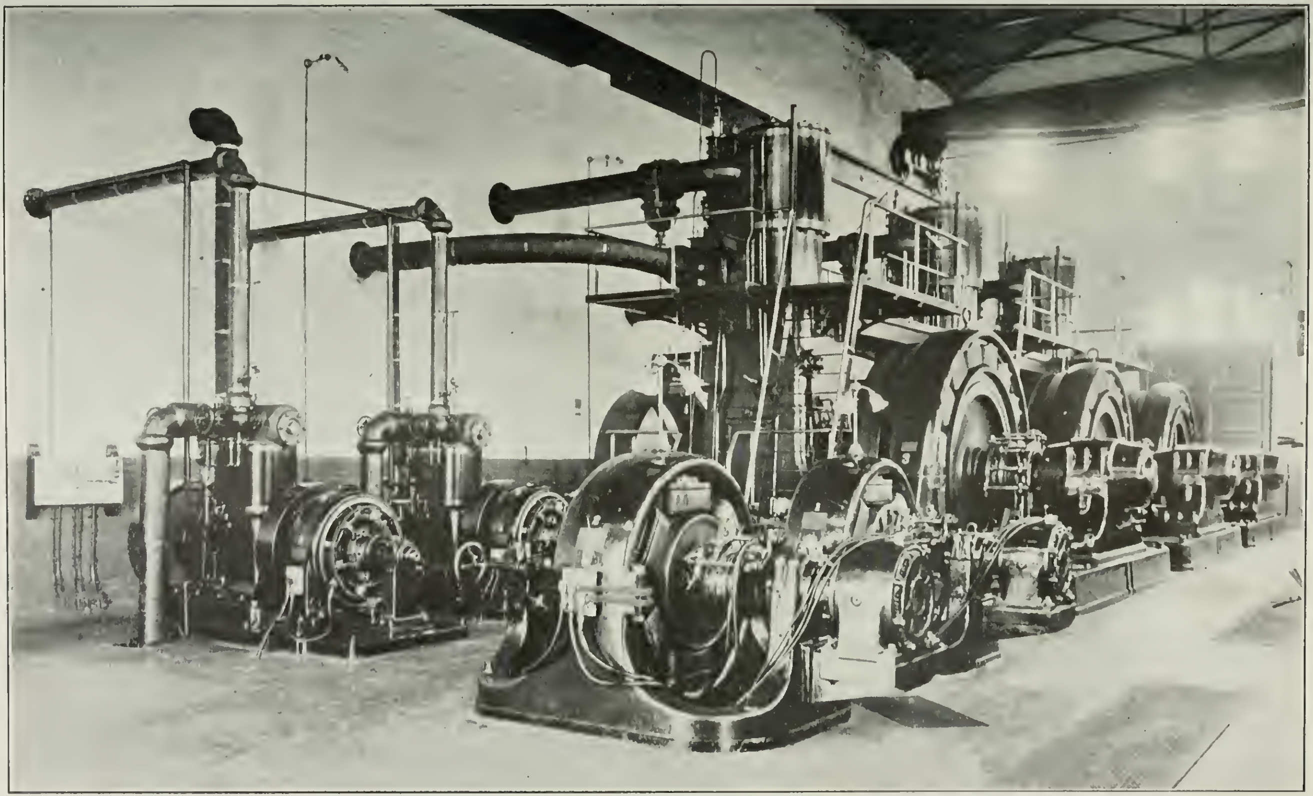
EXTERIOR OF POWER HOUSE, DETROIT, YPSILANTI & ANN ARBOR RAILWAY, YPSILANTI, MICH.

three-phase generators. There are five rotary-converter sub-stations, —two north of, two south of, and one at the power house. This railway passes through a rich agricultural country and at its middle part through a noted summer-resort district, which is rapidly being built up in consequence of the transportation facilities furnished by the electric line. About the same fares are charged as upon the Detroit, Ypsilanti & Ann Arbor Road, and arrangements have been made for an extensive freight traffic in fruit, fish, vegetables, groceries, and general merchandise. It is said that 50 per cent. of the lighter trade going to Detroit is now carried by the electric road. The cars are run on train dispatchers' orders, telephone stations being placed at all sidings. After leaving the city limits of Detroit there are no grade crossings and the track is thoroughly well-laid and ballasted. One of the branches of the road closely follows the shore of Lake St. Clair and the northern part of the road follows the St. Clair River, passing through many fishing, hunting, and boating resorts. Hourly service is given regularly over the whole line and cars are operated at shorter intervals between points where traffic is dense. The schedule time for the cars is 27 miles per hour, including stops, and between stations the speed reaches 45 miles per hour.



YPSILANTI POWER HOUSE, D., Y. & A. A. RAILWAY.

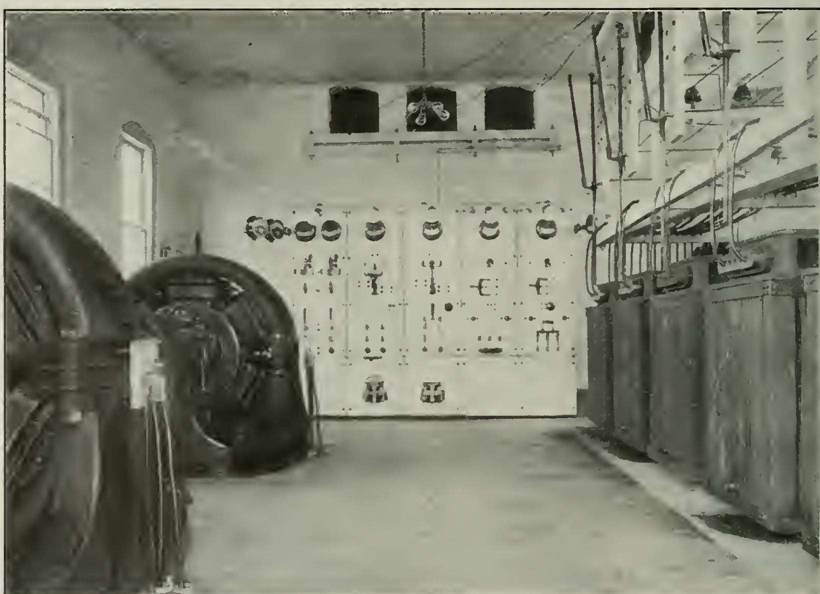
Another interesting Michigan road is the Houghton County Street Railway, located in the copper mining region of the Upper Peninsula. The line is 16½ miles in length and is constructed on a private right of way. It extends from Houghton to Calumet and Wolverine and serves a total population of 51,000. The interurban lines are single track with turnouts about two miles apart. Cuts are avoided, the ties being laid on an embankment which is in no place less than three feet above the level of the surrounding country, this precaution being necessary in order to avoid snow-drifts. As a further measure the equipment includes a rotary snow-plow, three Taunton heavy-nosed plows, and three snow-scrapers. Railway tracks are cleared by five wooden tres-



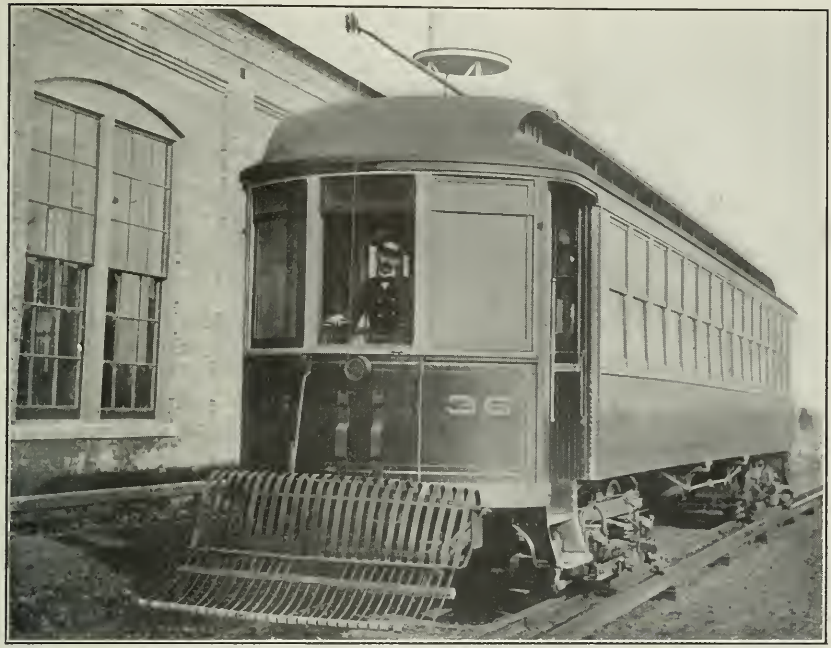
MAIN POWER STATION OF RAPID RAILWAY CO., NEW BALTIMORE, MICH.
Three 1,000-horse-power Westinghouse engines direct-connected to Westinghouse three-phase generators.

tles, the maximum grade being 7½ per cent. The roadway is laid throughout with 60-pound T-rails on cedar ties. The company operates sixteen closed cars having straight sides and vestibules with folding doors, and, because of their length equipped with trolley poles at each end. On account of the shortness of the summer season, no summer cars are used, but the windows of the closed cars are wide and low. The business of this road has been very large and in order to handle the summer travel it is probable that some of the rolling stock will be equipped with multiple train-control apparatus so that two-car trains may be operated. The power house is located at Hancock, where coal may be received at the company's dock. The power-house equipment consists of a Westinghouse 500 kilowatt, railway generator, a 500-kilowatt, 25-cycle alternator, and a 250-kilowatt rotary converter with two other converters of the same size at sub-stations.

In the state of Michigan there are twenty-four interurban lines actually in operation and franchises have been asked for forty-seven more. The great activity in building electric roads in this territory is due, perhaps more than to anything else, to the fact that it was here that a number of the earliest and most successful roads in the country



TWO 250-KILOWATT THREE-PHASE WESTINGHOUSE ROTARY CONVERTERS; SHOWING ALSO FOUR OF THE SIX OIL-COOLED RAISING TRANSFORMERS AND DIRECT-CURRENT SWITCHBOARD. HOUGHTON CO. STREET RY. CO., HANCOCK, MICH.



MOTOR CAR ON THE ALBANY & HUDSON RAILWAY, GENERAL ELECTRIC CO.

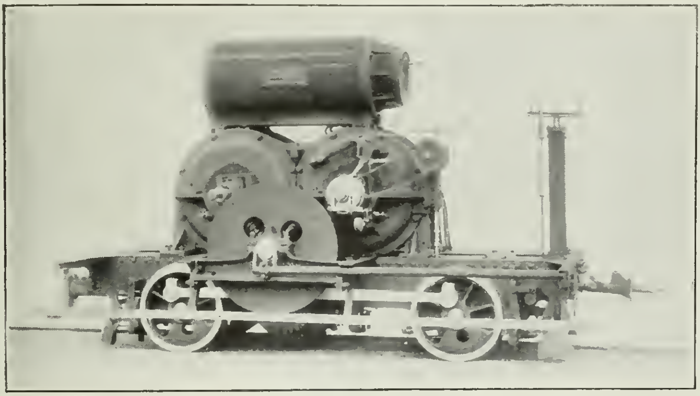
were constructed, thus bringing the possibilities of electric traction before the eyes of business men and capitalists.

While the middle west has been the scene of the most active electric railway building in the United States, considerable progress has been made in some of the more thickly populated eastern States. At Hudson, N. Y., begins a long electric railway system which extends a distance of 105 miles to Warrensburg, near Lake George, running for a great part of the way along the Hudson and through a semi-mountainous country and giving a view of the Catskills and the Berkshire Hills. The first 37 miles is covered by the Albany & Hudson Railway, a small part of which is operated by trolley and the remainder by the third rail system. Except through city streets the company owns its own right of way, which is fenced in and laid in a very substantial manner. Both running and conductor rails are of T section and weigh 80 pounds to the yard, the third rail being somewhat lower in carbon than the service rails in order to reduce the electrical resistance. The track has been heavily ballasted and the ties are laid two feet center to center, every fifth tie being extended to support the third-rail insulators. The latter are supported six inches above the tie and are made of wooden blocks topped by malleable cast-iron caps or chairs. At all highways and farm crossings the third rail is interrupted, but the continuity of the circuit is not broken. Power is supplied from a hydraulic plant at Stuyvesant Falls on Kinderhook Creek, about ten miles north of Hudson, and is transmitted by three-phase current at 12,000 volts to three sub-stations along the line, where it is transformed to direct current at 600 volts. The water-power station has a total capacity of 4,000 horse power and is relayed by a steam plant of 2,750 horse power, there being in all five generators, all built by the General Electric Company. The car equipment consists of five winter passenger cars, two combined passenger and baggage cars, two express cars, and a number of summer cars. The passenger cars are 53 feet long and seat sixty people. They are provided with two trolley poles at each end of the car and two pairs of contact shoes to operate on the third rail. A special switch placed on the platform allows the motormen to throw the controller upon either pair of contact shoes or upon the trolley, leaving the other devices "dead." This is necessary since the shoes are raised and lowered by hand at the junctions of the third-rail and the trolley sections. The summer cars are each equipped with four 50-horse-power motors and the winter cars with four 75-horse-power motors. The road is operated according to standard steam-line practice, the cars being controlled by telephone, or by telegraph in case of emergency. At Hudson this road meets the lines of the Hudson Valley Railway Co. operating over 100 miles of road and running north from Albany and Troy to Saratoga, Lake George, and the Adirondacks. At the present time, power for operating this road is derived from several independent power stations located at Stillwater, Saratoga, Middle Falls, Glens Falls, and Caldwell, but ultimately power for operating the entire system will be developed on the Hudson near Waterford.

In view of the high-speed experiments with three-phase motors that have recently been carried on in Germany, it is gratifying to note that similar experiments with direct-current motors are shortly to be made in America. The Aurora, Elgin & Chicago Railway has been designed for a continuous maximum speed of 70 miles per hour and the track is of such substantial character and easy alignment that higher speeds can be attained. The service rails are to weigh 80 pounds to the yard, the track is to be rock-ballasted, and all bridges will be of concrete and steel construction. The third rail is to weigh 100 pounds to the yard and is to be supplied with direct current from sub-stations, to which power will be transmitted at 26,000 volts by three-phase alternating current over aluminum feeders. The schedule speed will be 40 miles per hour, including stops at stations three miles apart.

Cars are to weigh 40 tons and are to run at a maximum speed of 65 miles per hour with a possible 70 miles per hour on a level track and with normal voltage on the third rail. The cars are to be operated either singly or in trains and are to be equipped by the General Electric Company.

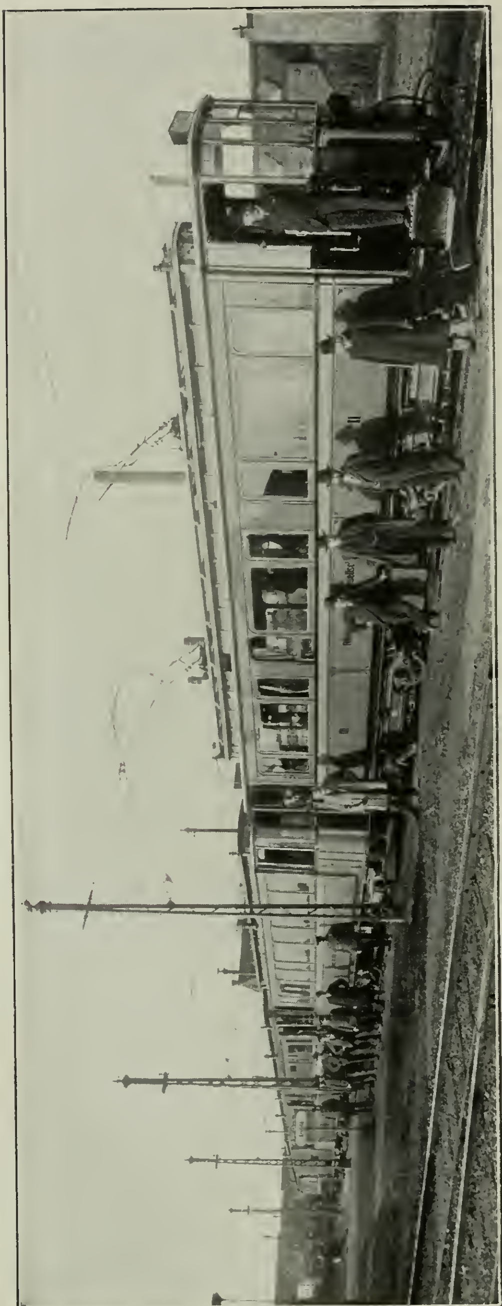
This paper might seem unduly partial if no mention were made of European roads. However, of high-speed interurban roads in Europe there are extremely few. In Great Britain it can truthfully be said there are no high-speed electric roads at all. The difference between America and Europe with respect to the development of electric traction is very strikingly shown by the following figures: The miles of electrically operated railways are, in the whole world outside of the



STANSSTAD-ENGELBERG ELECTRIC LOCOMOTIVE BEFORE HOUSING.

United States, 4.64 per million people; in Germany, the highest of Continental countries, 41.8 miles; and in the United States, 276.2 miles. It is said that the new plant of the Manhattan Elevated Railway Company, of New York City, which will have a total power of 40,000 kilowatts, equals in capacity the total electric power available for traction purposes in France. The United States has 76 per cent. of all the electricity available in the world for traction, 76½ per cent. of the electric-railway mileage, and 83½ per cent. of all the trolley cars.

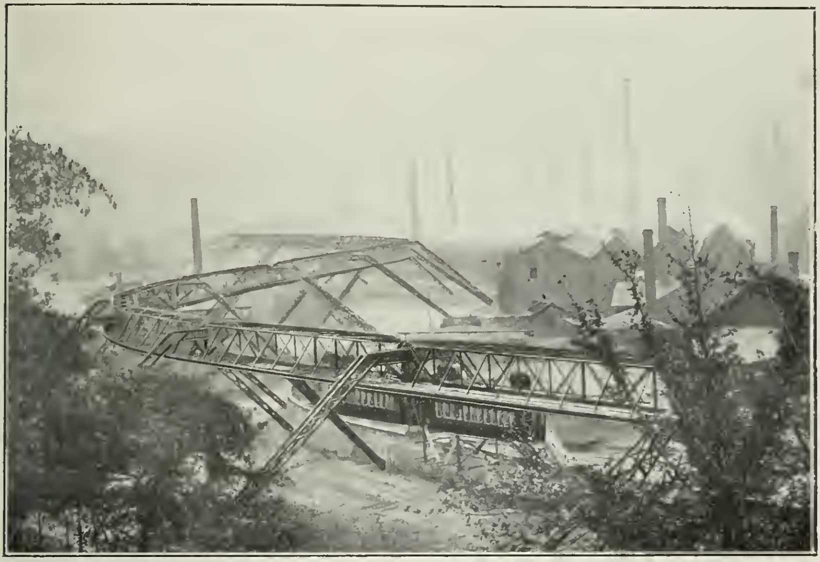
A German steam road upon which electric traction has been tried is the Wannsee line between Berlin and Zehlendorf. Since August, 1900, an electric train has been interspersed in the regular service, a speed of about 25 miles per hour being maintained. The train weighs 193 tons empty and 220 tons loaded, and is composed of ten coaches, the first and last having three motors each of an aggregate capacity of 975 horse power. It runs 225 miles per day, the maximum speed being



DÜSSELDORF-KREFELD ROAD WITH CARS WHICH RUN AT SIXTY KM PER HOUR.

31 miles per hour. Direct current is used at 750 volts. The efficiency of the power transmission between switchboard and axle was found to be from 70 per cent. to 85 per cent. The government railroad authorities have decided to discontinue the electric service, but the failure of the road has been due more to half-hearted measures than to any defect in the system.

The first installation of a high-speed electric road in Europe was between Düsseldorf and Krefeld, a total distance of 13.6 miles, the longest stretch between stopping places being 10.4 miles. Since the road parallels the steam railway for the greater part of its length, it is considered necessary to maintain a speed of 25 miles per hour on the open stretches. A speed of 37.2 miles per hour has been reached on trial trips. The road does not pass through the intervening towns but only touches the outskirts. It is double-tracked form Düsseldorf to Oberkassel, the terminus of the Düsseldorf local traffic. Direct current is used at 600 volts pressure and the cars are mounted upon double trucks, each truck carrying a 40-horse-power



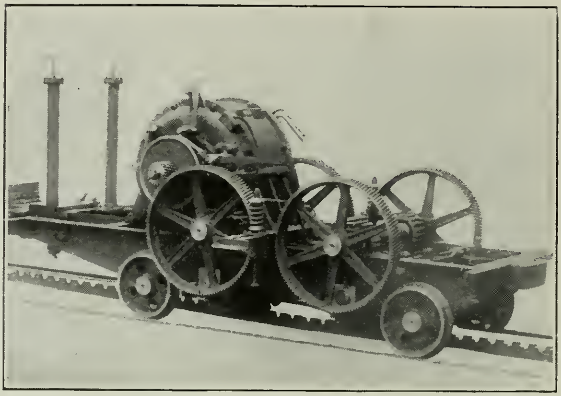
SUSPENDED RAILWAY AND TRAIN AT ELBERFIELD.

motor. The passengers are divided into three classes, the total seating capacity of a car being 34. Three kinds of brakes are used, viz., hand brakes, electric short-circuit brakes, and Standard air-brakes, and each motor car is also equipped with two trolley poles. Trains leave each terminal station every half-hour. The road has developed a quite considerable freight and farm service.

A road which has attracted considerable attention by its novel and unique features is the suspended railway at Elberfeld-Barmen, where the cars are hung from a single rail without any side guards or supports, so that in going around curves the cars may assume an inclined position. Of the eight miles originally planned, only 4½ have been built. The speed of the cars is from 12½ to 14 miles per hour. The switching construction is highly interesting but is not considered safe and is used only by empty cars.

The Swiss* roads are very interesting because of the original engineering methods which they embody. Most of them are mountain roads and are provided with rack rails. They are largely patronized

* The important electric installations of Italy were reviewed at some length by Signor Enrico Bignami in THE ENGINEERING MAGAZINE for November, 1900. For this reason they are omitted from Mr. Gibson's summary.—THE EDITORS.



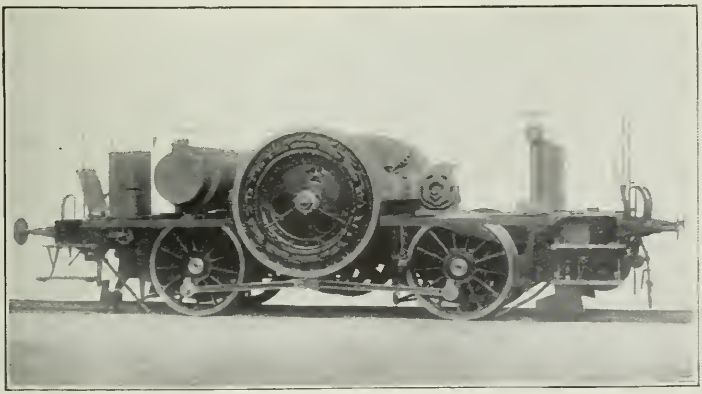
TRUCK OF THE GORNERGRAT LOCOMOTIVE.

by tourists and charge very high fares. The road starting at Zermatt and ascending the Gornergrat has a maximum grade of 20 per cent. and is composed of curves throughout 30 per cent. of its total length, which is 5.7 miles. The entire roadbed was cut from solid rock or built upon projections. The rack system is of the Abt type. The locomotives weigh 10 1/2 tons each and are equipped with two motors having an aggregate of 90 horse power and operating at 500 volts. The speed is only 4 1/3 miles per hour, and double-reduction gearing is used. In addition to the two spindle brakes, one operated on the rack wheels and the other on the surface wheels, there is an electric brake which comes into action as soon as the speed of 4 1/3 miles per hour is exceeded. The motors are of the three-phase induction type with wound rotors and collector rings, and in coasting they may be used as extra brakes by inserting resistance in the rotor circuit.

The longest (25 miles) Swiss three-phase railway is the Burgdorf-Thun road, opened in 1899. The standard trains weigh 56 tons and have a maximum speed of 22 1/2 miles per hour. Current is transmitted at 16,000 volts, which is stepped down, by means of transformers located at an average of two miles apart, to 750 volts for distribution to the trolley line. The cars carry four trolleys, two at each end of the car. The equipment consists of two two-axle locomotives and six four-axle motor cars, with a number of trailers for passenger and freight traffic. The total power of the locomotives is 300 horse power. A small transformer is installed on each locomotive or motor car for lighting, heating, and driving an air compressor, Westinghouse air brakes being used. At present only five trains are operated on the line at any time. The fare for the entire 25 miles is 40 and 60 cents for the two classes.

The Stansstad-Engelberg Electric Railway has a total length of 13.8 miles, of which about one mile is rack construction. Three-phase current is supplied to the trolley line at 750 volts, at which voltage most of it is generated. The trolley line is protected by Westinghouse lightning arresters. The rolling stock consists of three locomotives and seven motor cars weighing 14 tons and seating 46 persons.

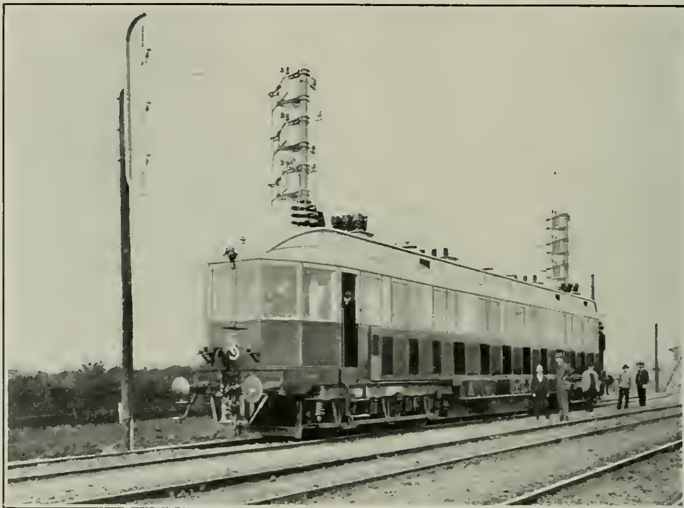
Perhaps the most remarkable of the Swiss railways is the Jungfrau line which runs for 1 1/4 miles along the base of the mountain and then ascends by means of a tunnel, 6 1/3 miles long, to an altitude of 13,435 feet. After leaving the terminal station, the passengers are raised a further 240 feet by an elevator. The grade is 25 per cent. along the entire road, with the exception of a 2.2 mile section which has a 67 per cent. grade. The rolling stock consists of five locomotives, ten passenger cars, and two freight cars. The locomotives in reality form the rear truck of the cars, but can only be used without the latter. Three independent brakes insure safety during the descent. The locomotives are equipped with two three-phase motors, having a normal capacity of 25 horse power each, and the speed is 4¾ miles. The forward motor is coupled to a continuous-current dynamo, which serves to excite both motors during the descent, thus turning them into gen-



THREE-PHASE LOCOMOTIVE, BURGDORF-THUN ELECTRIC RAILWAY.

erators. There are but few days when the summit presents a clear view of the surrounding territory and the traffic is, therefore, concentrated in a very short time, when the rush is very great, and at such times eight trains per day operate.

The Berlin-Zossen high-speed electric-railway experiments are already so well known to the engineering public that I shall give here only a few of the most pertinent facts. These experiments were carried on by a company known as the Studiengesellschaft für Elektrische Schnellbahnen over a single-track standard-gauge road, which was laid with 75-pound T-rails upon wooden cross ties and ballasted with cut stone. The total length of the line is 13.7 miles and the minimum radius of curves 3,300 feet, the steepest grade being 5.43 per cent. The



EXPERIMENTAL HIGH-SPEED CAR, MARIENFELDE-ZOSSEN LINE.
Showing details of trolleys, tracks, and general arrangement of the railway designed to run at 140 miles an hour.

test car was designed to seat 50 passengers and its total weight of 207,880 pounds was carried upon two trucks, each having three axles. Two of these carried motors of a normal capacity of 250 horse power and a maximum capacity, when starting, of 750 horse power. The conducting system was three-phase, operated at 10,000 to 12,000 volts and 45 to 50 cycles per second. Three trolley wires were placed vertically, one above another, contact being made by three bow-trolleys carried upon a vertical spindle. A transformer on board the car reduced the voltage to 1,150 while running or 1,850 while accelerating, at which pressures current was supplied to the motors. The latter were governed by means of resistances cut into the secondary circuit, the resistances being placed in flat boxes along the two sides of the car, which were provided with gills to produce a circulation of air. The motors were designed to run at 900 revolutions per minute and were mounted directly upon the axles of the car wheels, the latter being 49 inches in diameter. In the trials a speed of 100 miles per hour was reached, but it was found impossible to go above this speed on account of the condition of the track. The results, however, were entirely successful as far as the equipment of the car was concerned, and higher speed could easily have been made had the roadbed permitted it.

RECORDING AND INTERPRETING FOUNDRY COSTS.

By Percy Longmuir.

Reference has been made many times in this Magazine to the frequent neglect of the foundry, and to the large influence which it neverthless may have on the economy of the machine shop. This, of course, is more particularly true of the actual work of moulding, melting, and casting. But the foundation of all improvement is the analysis of present conditions, and if we begin with an accurate study of practice as it is, we shall not stop far short of discovering practice as it should be. Mr. Longmuir's article, therefore, though concerned more particularly with the commercial side of foundry management, has a strong practical interest for the machine-works manager also. Mr. Carpenter's article on cost keeping for the machine shop, concluding his series begun in February, has been unavoidably postponed by the serious illness of the author. It will appear in our next issue.—The Editors.

USUALLY, the method of estimating the labour cost of castings is to divide the total labour charges as shown in the wages book by the output of the foundry and so obtain a cost factor per ton or per hundredweight. Such a method can be satisfactory only when the work produced is of a uniform and unvarying character. This would be the case if the castings produced were all moulded by one method, as for instance, all green- or all dry-sand, and were of fairly uniform weight. But in the ordinary foundry the methods of moulding practised usually include green-sand, dry-sand, and loam, and in many cases machine and plate moulding. The castings so produced may range from those of several tons down to small ones of an ounce or so each. Obviously, then, the plan of dividing total labour cost by total output can yield only an average cost factor. This average cost factor may serve as a very fair guide if the various classes of castings bear a constant relationship to the output—a supposition hardly tenable in the case of the average foundry; for instance, loam casting may predominate one week, green-sand another, which again may be followed by a period in which dry-sand work forms the greater portion of the output. Further, in using an average method for the purpose of estimating cost it is quite possible that the good features of one section may be neutralised by the bad ones of another section; for example, the dry-sand and machine-moulding sections may be making an excellent margin of profit, whilst the green-sand and loam sections are working at a loss. The good work of the profit-making sections is thus lost sight of or swallowed up by the non-profit-producers, and assuming that the profit made by the former be such as when distributed over the whole to show fair working, then the backwardness of the latter may escape detection for a considerable period.

In urging that a more detailed analysis of costs be adopted for all branches of foundry work, I do so entirely from the foundry manager's or foreman's point of view; and further—this analysis, if actually made in the foundry, will possess the greater value and be the more readily accessible to those directly concerned.

A form of labour-cost analysis often adopted is shown in Figure 1.

Week Ending February 16th, 1902.

Output of Good Castings=38½ Tons.

	CLASS OF LABOUR	WAGES			COST PER CWT.		
1	Furnacemen	£9	8	8	£0	0	2.94
2	Labourers	25	0	10	0	0	7.80
3	Dressers	14	8	8	0	0	4.49
4	Moulders	73	10	0	0	1	11.00
5	Clerks, Timekeeper, etc	10	4	0	0	0	3.17
6	Foundry Foreman per cent	11	17	10	0	0	3.70
		£144	10	0	£0	3	9.10

Labour costs per ton, £3 15 2.

FIGURE I. ORDINARY FORM OF COST ANALYSIS.

This form is—from a foundry manager's point of view—defective in that it does not indicate the cost of various classes of moulding nor the apportionment of the charges due to labourers—that is to say, items number *2* and *4* do not yield the information they should do.

The output represented on this table is that of a foundry doing no machine or plate moulding and engaged on a general class of work in green-sand, dry-sand, and loam moulding, none of which, however, is of an exceptionally heavy character. Dividing the work into representative classes and apportioning the unskilled labour as employed by each class, and taking the weight produced by each class, we get the hundredweight cost as in the following table. Owing to inherent difficulties, the core making could not be distributed in this manner and it is therefore regarded as a factor of the whole output. Item number *6*—that of general labouring—includes such labour as is not directly chargeable to one class of moulding; of this there is always a fair amount in every foundry; it is essentially labour from which all classes of moulding benefit, but not necessarily proportionately.

	CLASS OF WORK	WAGES: MOULDERS	WAGES: LABOURERS	WEIGHT PROD'C'D: TONS	WEIGHT PROD'C'D: CWTS.	COST PER CWT: MOULDING	COST PER CWT: LABOURING
1	Loam	£7 10 0	£3 12 0	5	8	£0 1 4.6	£0 0 8
2	Dry Sand	20 0 0	4 10 0	13	7	0 1 6.0	0 0 4
3	Green Sand	32 6 0	5 8 0	16	3	0 2 0.0	0 0 4
4	Apprentices	3 10 0	18 0	3	12	0 0 11.7	0 0 3
	Totals	£63 6 0	£14 8 0	38	10	£0 1 7.7	£0 0 4.5
5	Core Makers	£10 4 0	0 18 0	38	10	0 0 3.3	£0 0 0.3
6	Gen. L'bour'g		9 14 10	38	10		£0 0 3.0
		£73 10 0	£25 0 10	38	10	1 11	£0 0 7.8

FIGURE 2. DETAILS OF MOULDING COSTS.

Assuming that such detailed analysis be adopted with each week's output of the foundry, then the man in charge has exact information laid before him, week by week, as to the cost of the work produced. He can at once put his finger on any branch in which costs are beginning to creep up, and if a remedy is required he knows exactly where to start its application.

Figure 3 represents a series of costs so obtained over a period of four weeks, and plotting these graphically the results shown in Figures 4 and 5 are obtained.

	I	II	III	IV
MOULDING	s. d.	s. d.	s. d.	s. d.
Loam	1 4.6	1 7	1 3.5	1 5
Dry Sand	1 6	1 9	1 5	1 7
Green Sand	2 0	2 2	2 1	2 0
Apprentices	11.7	1 3	1 0	1 1
LABOURING	s. d.	s. d.	s. d.	s. d.
Loam	8	10	7	8
Dry Sand	4	5	4.5	5
Green Sand	4	4.5	3.5	4
Apprentices	3	2.5	3	3 5
Core Making	.3	.2	.2	.4
General Labour	3	4	3	3.5
Melting	3	3.5	2 5	3.0

FIGURE 3. DETAILS OF LABOUR COST PER CWT. FOR PERIOD OF FOUR WEEKS.

These charts illustrate most forcibly the value of graphic repre-

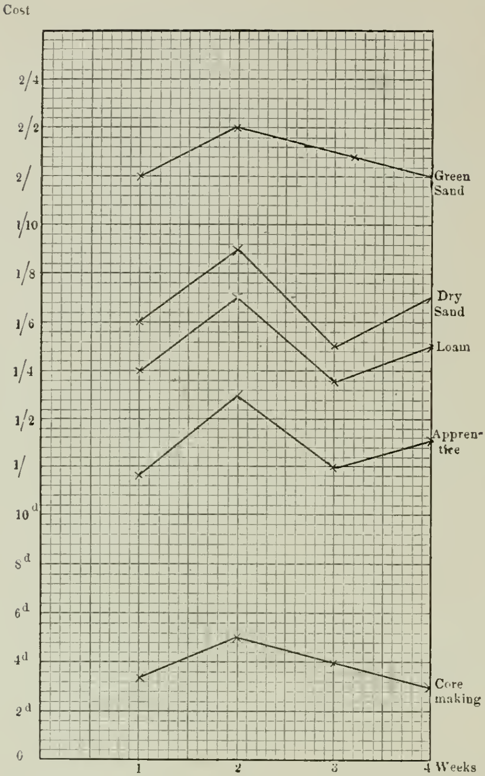


FIGURE 4. GRAPHIC PLOTTING OF FOUR WEEKS MOULDING COSTS.

sentation, and to the busy foundry manager a chart so prepared will serve to direct his attention instantly to the department really requiring it. The success of this detailed analysis and graphic representation lies in the fact that it instantly and almost automatically directs the attention of the responsible man to the weak places of his department. The labour involved in preparing them is not at all excessive and can be readily done at a trifling cost by the clerical staff of any foundry.

This of course must be regarded as distinct from prime cost—that is to say, the cost of individual orders for such work very properly belongs to the accounting side of the management and the details of them are seldom worked out until too late to be of service to the foundry manager. Then, further, prime-cost details are often worked out on the time records kept by the man working on the orders so treated. To be of real value, cost information supplied to the foundry manager must be given on the completion of every pay, whether these be weekly, fortnightly, or monthly, and this can be most readily done by grouping the men into classes according to the variety of their work, weighing the product of each class, and getting a cost factor from the wages paid. Experience will readily give standard factors for each class of work, and these standards may be plotted on the chart as a fair curve (straight line), the departures from which of the actual weekly cost line will instantly show the degree of good or bad working.

Should any difficulty lie in the adoption of the foregoing system of weekly detailed cost factors—as, for instance, where the wages books are not made up in the foundry office, or where they are not accessible to the foreman or his clerk—then an output chart may be plotted each week which to some extent will show the conduct of the department.

It is recognised that the capital invested in the buildings and equipment of any foundry demands a definite return, and in this case the return may be very conveniently regarded as the production of a certain weight of castings each week. The weight necessary to yield this return may be arrived at by a careful survey of past working for as extensive a period as possible. A higher output is recognised as good working, and a lower one is fixed which represents the amount necessary to meet all charges and keep just on the margin of profitable production. These three figures, once estimated, may be regarded as comparative standards, and in the accompanying charts are distinguished as good working, caution, and danger lines.

Figure 6 shows the weekly output of a representative brass foundry. In this case a turn-out of 80 hundredweights per week is essential to meet all charges, 90 hundredweights produce a fair profit, and 100 hundredweights yield what may be regarded as an essential or requisite profit. The three abnormal points represent broken weeks due to stoppages for holidays.

Viewing the matter in the light of output only, it is readily apparent that a foundry may be producing castings at a very low cost and yet be working at a decided loss. Thus if the output is constantly below the danger line, no matter how low the cost of production be, the establishment is working at a disadvantage. Taking an extreme view, an establishment fitted to produce 50 tons of castings per week and only turning out one ton will be working at a loss, even if that single ton is produced for noth-

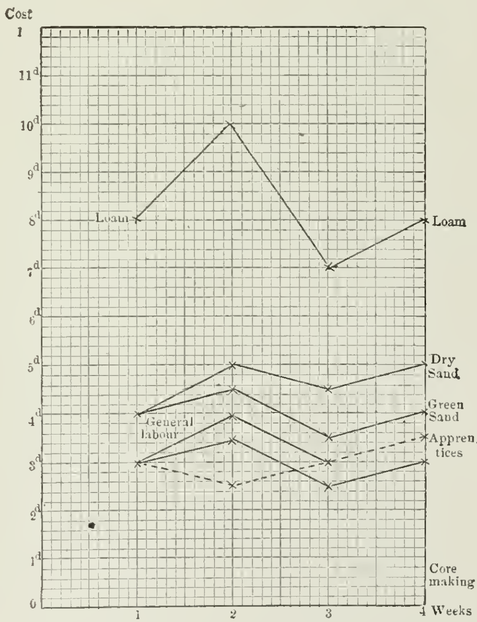


FIGURE 5. CHART SHOWING FLUCTUATION IN FOUNDRY-LABOR COST OVER A PERIOD OF FOUR WEEKS.

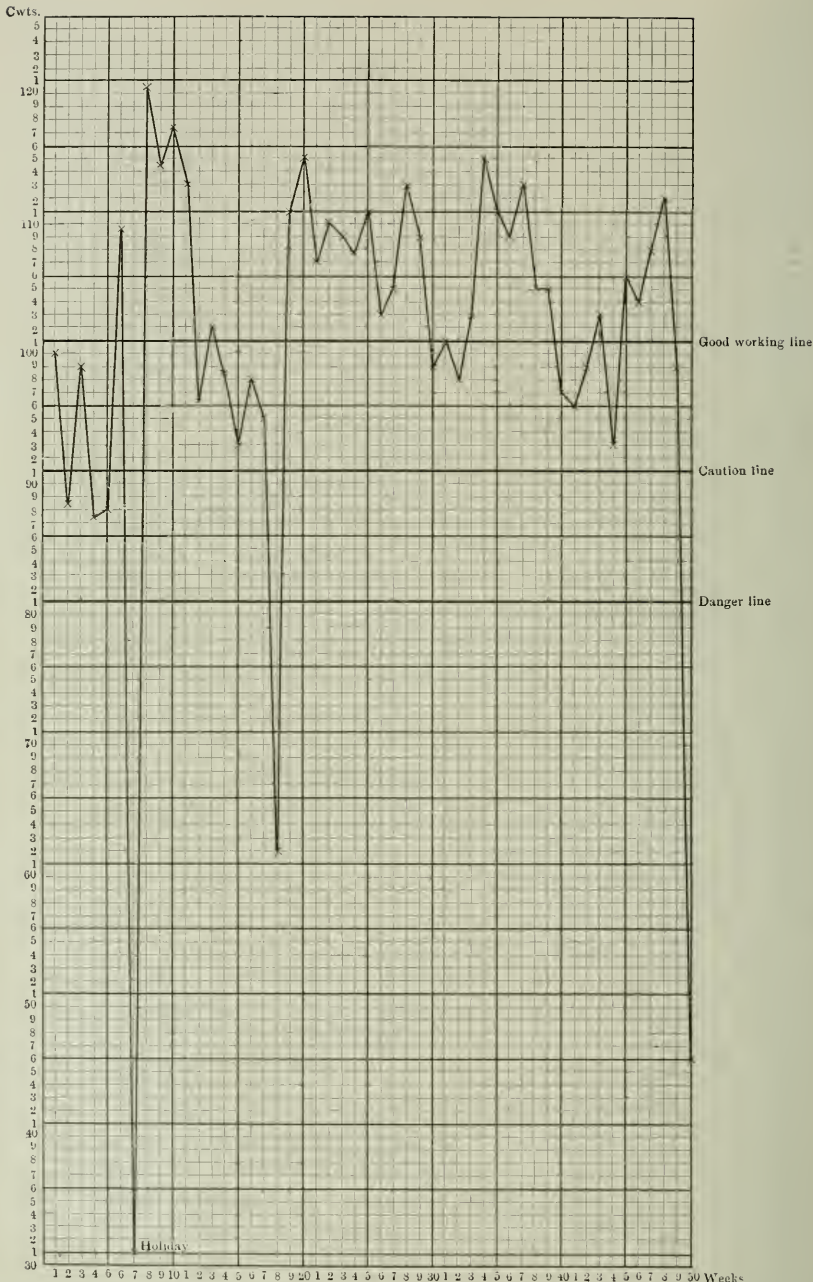


FIGURE 6. WEEKLY OUTPUT CHART FOR A REPRESENTATIVE BRASS FOUNDRY.

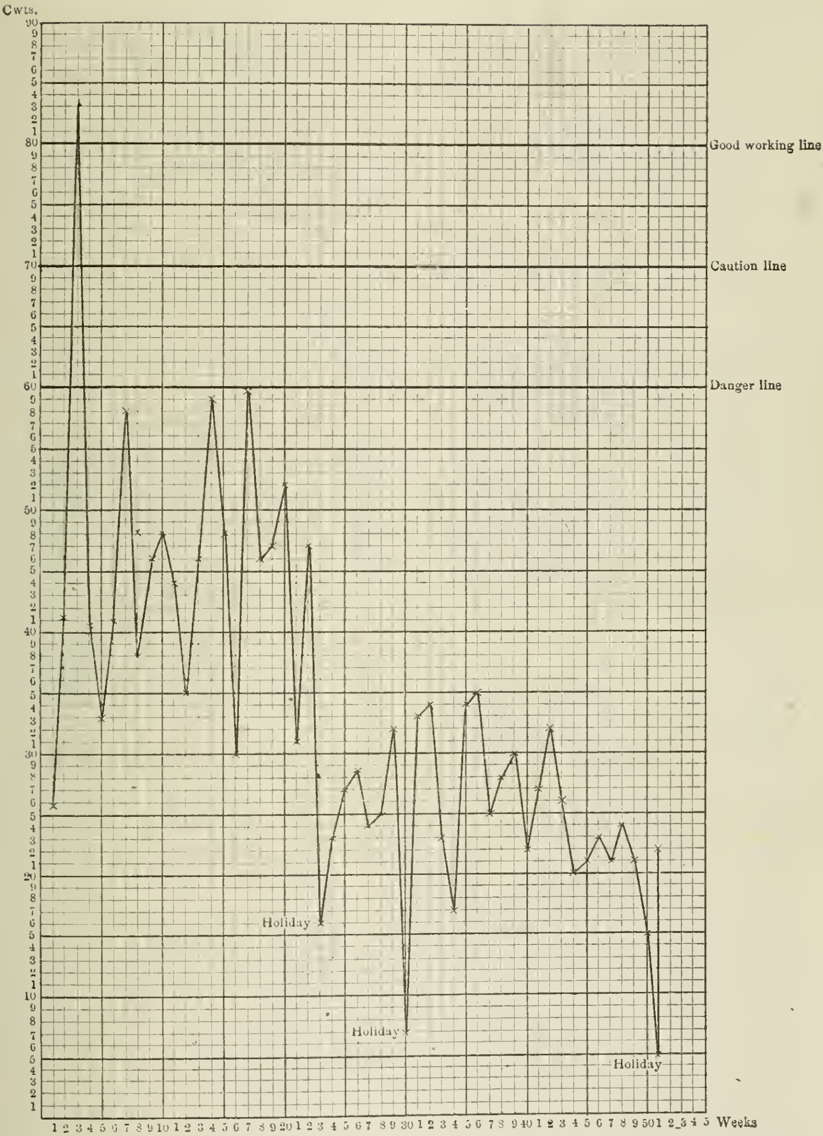


FIGURE 7. CHART OF WEEKLY OUTPUT OF A BRASS FOUNDRY WORKING BELOW THE PROFIT LINE.

ing. An example of a non-profit-producing department quite irrespective of cost of production is shown in Figure 7. This chart shows the weekly outputs of a brass foundry of which a careful estimate fixes the three guide lines at 60, 70, and 80 hundredweights per week

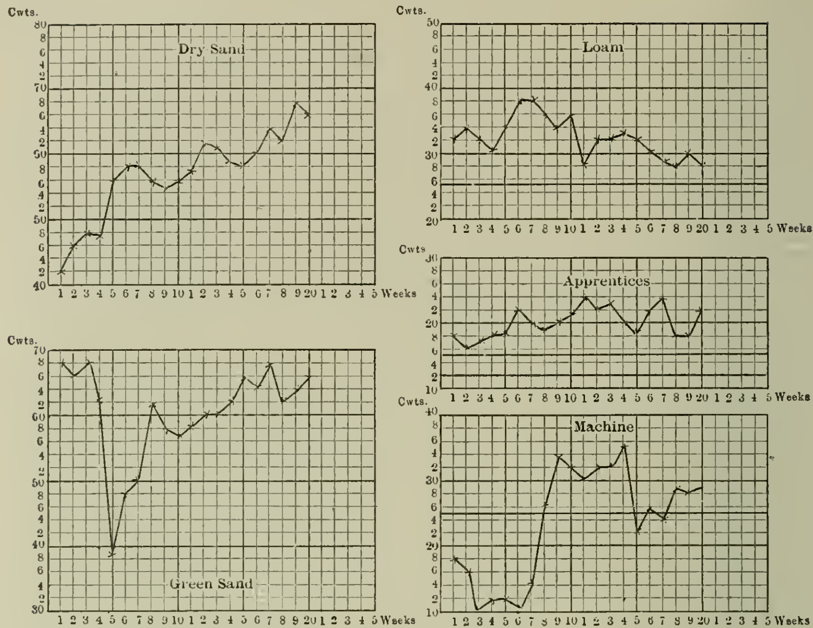


FIGURE 8. WEEKLY OUTPUT CHART SPLIT UP ACCORDING TO VARIOUS METHODS OF MOULDING.

respectively. An output of 80 hundredweights is essential to yield a business return on the capital invested.

The examples given in Figures 6 and 7 illustrate most forcibly the value of plotting outputs in the manner indicated, and though not yielding the definite information given by a system of cost factors, they nevertheless form good working guides and such as may be very readily prepared by any foundry foreman.

Figure 8 shows the weekly output of a foundry split up into the various methods of moulding by which the castings are produced. In each case guide lines are fixed and the weekly plottings very readily demonstrate the progress of the foundry. This method, being essentially a "foreman's one," will be worked to best advantage if fairly large charts are used and the co-ordinates and abscissæ so arranged as to accentuate sharply any departure from a horizontal line. The accompanying charts are all so plotted, and in this sense may be regarded as exaggerated—a pardonable fault when considering that the purpose is that of graphic representation and its chief aim to direct attention automatically to departures from normal working.

In conclusion I must state that the data included in this article are of a representative rather than an actual character.

INTENSIFIED PRODUCTION AND INDUSTRIAL INVESTMENT.

By William D. Ennis.

Mr. Ennis's central idea is that a true theory of production must comprehend every factor from the time plans for the works are undertaken till the product reaches the consumer. His article is particularly interesting in its recognition of the variables which should, and must, modify the decision upon particular items, sometimes apparently running counter to the general policy of "intensification."—The Editors.

ONE indication of high industrial development is the shipping abroad of products. Tariffs may stimulate domestic sales and bring prosperity to a particular business, may even give time and opportunity for such economical equipment as will ultimately permit of export trade; but large and steady foreign consumption of a domestic manufacture can result only from such marked superiority in conditions and methods as will be of manifest effect in competition with the world. The home market is the natural market. Ocean freights and national prejudices inevitably handicap foreign trade. Only an excess of supply over demand at home, or an excess of demand over supply abroad, will justify export. The latter condition prevails, with regard to the United States, in agricultural products, and in some few lines of highly specialized machinery. The former is the condition to which the average manufacturer must look forward. Shall he then reduce output, go out of business, or enter foreign trade? In a highly "protected" industry he will do the first. In a business where results are uncertain and small, he will adopt the second course. If he is a master of his craft, able to compete with the best anywhere, he will cross the seas with his goods, seeking abroad that outlet which his own country cannot supply. In order that he may thus enter the world's market, he must be at least fairly well situated with regard to accessibility of raw materials, quality of labor, and economical methods of operation. Without all of these, his case is hopeless.

The availability of raw materials is the characteristic advantage in the United States. The quality of labor is credited with large influence on volume of output; but it is largely due to the economy of operating and managing methods, with which it will be considered, that American labor is of high efficiency per unit of cost. Large production per unit of plant or of investment is not in itself sufficient for competition in a world market. Just as in a steam plant, where too high a rate of combustion results in a loss of economy, so in manufacturing, too great an output may increase the cost per unit of output. It is the object of this paper to discuss some of the factors affecting commercially both volume and cost of production.

Seizing the Opportunity and Reaping a Loss.—Capital is quickly attracted to a profitable business. When, as has been and is now sometimes the case, industrial investments net twenty, forty, and sixty per cent. return each year, construction of new plants is undertaken without much hesitation. The architect or engineer is engaged and instructed to begin operations at once. Nothing must delay the work. Frantic efforts are made to impose impossible contracts on builders and machinery dealers. Every day lost in construction represents a loss of possible profits. The plans are rushed through without time for deliberation or investigation. Buildings are constructed of the materials nearest at hand, almost without regard to quality. Machinery is purchased from the quickest and cheapest source. Any defects are corrected by makeshifts called "temporary," but destined never to be improved. The plant begins operation. Breakdown succeeds breakdown. The time lost in the first year of production would have sufficed to design, build, and equip the mill properly. But business is good, the construction period has passed, and by hook or crook the mill is kept running as nearly as possible at its normal output. After a time, prices fall. Other plants are now running, and the sixty per cent. profits dwindle to twenty, ten, five. It is close work to show any gain at all. The hastily equipped mill, with its wasteful machinery, bad arrangement, and constant breakdowns, cannot meet competition. It loses money, and eventually goes out of business.

There is a reverse condition. Rapidity of construction must sometimes supersede considerations of economical operation. A case in point in my experience was this: a certain mill was so designed that it could be operated only at half capacity or at full capacity. The engine power was insufficient for the latter. A 250-horse-power engine running five hours each day would make the power equipment ample. A careful and conservative engineer recommended the purchase of a highly economical engine, which would have required four months to build. Instead, a high-speed engine was secured from stock, and was running within sixteen days from the date it was ordered. The saving of three and one-half months in time caused a gain of $6,700 in reduced operating expenses. The engine installed consumed more steam than a Corliss; but the loss through excessive steam consumption of this particular engine will not aggregate $6,700 in the next twenty-three years. This was a case where a too economical engineer would have made a very bad bargain.

When opportunities for economy are perceived, they must be grasped quickly. To make the saving at once may mean a greater gain than could possibly be secured by any dilatory refinements in design or cleverness in purchasing. Whether they do mean such greater gain is the first thing to be ascertained in each case, and the decision then made between speed and refinement of installation. Where two or more improvements are proposed, and only one can be executed at a time, that which offers the largest percentage of return is the first to be made.

The Value of Money.—With every different set of capitalists, and in every different section of the country, the economist must figure on a different rate of interest as representing the money required for an investment in operating economy. This rate is determined by the value in general of the investments open to the body of capital in question. There is, however, another, sometimes a higher, rate of interest, that should properly be assumed by the engineer or manufacturer in estimating on investments toward operating economy. In every business there is a certain normal rate of return for the capital engaged. Unless that capital be, for the purpose in hand, unlimited, the return from money-saving investments must be sufficient to pay a rate of interest equivalent to that paid by the industry as a whole. For example, a railway paying six per cent. return, whose capital and credit can all be employed in extending the volume of traffic, would not be justified in investing in improved locomotives unless those locomotives would decrease operating expenses after six per cent. interest had been paid on the investment. A factory earning ten per cent. profit should not estimate the net economy of a new engine on a basis of five per cent. for interest on the initial expenditure. An improvement must first return its own depreciation charge *plus* an income on its cost equal to the rate of profit on the entire business done; anything over that is the measure of its actual commercial value.

This analysis fails to take into account one factor. "In time of peace, prepare for war." Profits in the business as a whole depend upon the state of the market and the force of competition. If the latter be too strong, the return may shrink, may even become negative. An improvement is an investment that baffles competition and strengthens profits. A reduced rate of profit will increase the value of the formula. An improvement of little benefit when business is good may be its salvation in hard times. The man of forethought will not inevitably dismiss from consideration every project less profitable than his general enterprise, but will weigh it in view of future contingencies, looking upon it as he would upon low-interest-bearing government bonds—safe, and a last resort when more lucrative channels fail.

The Control of Fixed Charges.—This is the point at which the average manager files a disclaimer of responsibility. He considers that such expenses as interest and taxes are largely beyond his control. To a certain extent, his position is tenable, because in most cases he has had no jurisdiction over the cost of construction of his plant. No matter how economical that construction may have been, the sinking fund therefor is invariably looked upon as a handicap more or less serious. The possibilities in this respect lie in two directions: In the reduction of fixed charges as proportioned to output, and in the current treatment of and distinction between *repairs* and *improvements.*

Assuming that the actual amount of fixed annual expense has been scaled down to its lowest point, the only way of reducing the rate thereof is to increase the volume or the value of output, either absolute or in relation to the volume or value of raw materials consumed. Intensified production, refinement of output, increased yield, decreased cost of supplies—these mean greater return on the capital involved, or less capital for a given return, and result in decreasing the ratio of fixed expense to net income. How shall these conditions be attained? By uninterrupted operation, commensurate mechanical units, specialized organization, incentives to efficiency, reliable equipment, reserve installations; by expert superintendence, progressive and receptive management, study and control of the markets, intelligent purchasing; by economizing devices, utilization of by-products and wastes, improved machinery; by storage space for raw materials, wise contracts for supplies, an unrestricted field for the purchase of materials, and ample capital and credit.

A few only of these essentials call for remark. By uninterrupted operation, reference is made not to freedom from breakdowns nor to absence of protracted idleness, but to such operation as will give the greatest volume of product—whether it be ten-hour or twenty-four-hour, six-day or seven-day, nine-month or twelve-month. In a highly organized industry—such, for instance, as paper-making—the fixed expense is so important an element of cost that it is almost essential to operate day and night. In industries involving small investment, where the principal cost is that of labor, a twenty-four-hour day is not a means of economy.

The effect of twenty-four-hour service on operating economy is not invariably beneficial. True, it keeps machines running, it leaves no idle fires in the furnaces; but it is hard on machinery, harder still on men. On some planet where the days were either twenty or thirty hours long, this last objection could be overcome; but here, three shifts of eight hours make the work too easy, and two shifts of twelve make it hard. Scheduled details, such as six to eight hours on and sixteen or eighteen off, complicate system and play havoc with the efficiency of the workmen. Inactive labor, on night duty, is a constant temptation to junketing of days and dozing by night; active labor kills the man, or is so high-priced as to handicap the owner. Sunday operation is successful according to the nature of the work. In most cases it is essentially a day for repairs. Depreciation is high on a twenty-four-hour seven-day system.

Excepting in industries rapidly developing, so that intermittent improvements are a necessity, a seasonal shutdown is a serious handicap. A smaller plant, with outgoing storage capacity, is preferable when possible, if the market for the product has periods of quiescence.

One important constructional feature is the uniform alignment of equipment, ensuring that production shall not be limited by the capacity of some one machine. The ultimate load should be about the same throughout.

There is a science for every market. The manager should aim to know as much of the conditions affecting prices of raw materials as he does of those affecting the value of his output. Given opportunity for storage, he can use this knowledge by developing the speculative side of his business, and buying when the market is right. On a large scale, his supply of stocks will give him more or less control of the raw-material market. He may even find it to his advantage at times to supply his competitors. In the same manner, his storage of outgoing goods is a basis for control of the market for his products.

The manager who is solely an engineer is an economist of operation. No charge that can be avoided will he permit against his running expense. The shrewder financier seeks to wipe out his outlays in his accounts current. The one swells his improvement account, the other his repair account. What is the proper line of demarcation? A new engine replacing one worn-out is a repair. Belting is repair. A platform scale, a water meter, a bath room, are improvements. Whatever displaces some existing asset is a repair. Whatever adds to the equipment for volume or quality of output is an improvement.

The conservative manager will incline toward the repair account as a place for the final disposal of most of his equipment charges. Once there, they are out of existence. Estimated as improvements, they will burden the entire existence of his plant. More than this, he will anticipate large outlays by gradually charging off to repairs those items which he sees are likely to require replacing in the future.

Intensified Construction.—What is known as "mill construction," as compared with old-style carpenter-built manufacturing plants, typifies the advanced industrial methods of today as compared with the rule-of-thumb procedure of the past. The engineer has replaced the profane and unclean "boss," and sagging floors and shingle roofs have been superseded by monuments of stone and steel. With refinement of construction has come refinement of maintenance. The next step will be toward such standardized and massive equipment as to approximate a mill without a repair account.

The balance between opportunist speed of construction and philosophical economy of operation must be struck by considering the questions of reserve equipment, extension, and storage. Such apparatus as is liable to fail on short notice should be duplicated or interchangeable. Where one unit is cheaper than two of joint equivalent capacity, and early extension is probable, the larger unit should be purchased. Where space is valuable, the larger unit should be purchased even if no advantage in price exists. Storage, adapted to the commodity in question, should be provided at every incoming and outgoing channel. For extension of storage capacity, the site should be ample. Possible extension should be borne in mind in every construction. The gable ends of buildings must be exposed; trackage and transportation should be designed for future as well as for present contingencies. According to the force of probability of extension, the line shafting, piping, and handling machinery should be designed. The steam-fitter leaves plugged tees for future connections on his pipe lines. The constructor must likewise provide plugged tees at each critical point. Better design the extended mill and lop it off to the specified size, than to design the specified mill without the most ample and thorough provision for extended capacity.

Intensified production and economical operation are both warranted and limited by the degree of thoroughness of construction.

THE CHANGES OF A HALF-CENTURY IN THE MARINE-ENGINE SHOP.

By Egbert P. Watson.

Mr. Watson's review deals with what might be termed the dawn of the second cycle of the modern age of machinery. The first cycle covered the introduction of the machine to relieve manual toil; the second developed, perfected, expanded the machine to the present stage of automatic and mass production. The story of pioneer conditions always is fascinating; but perhaps the most striking point brought into clear view by Mr. Watson is the wonderful rise in the condition of the mechanic which has resulted from the growth of mechanical enginering. This should be more than sufficient answer to those who fear that the working classes, in the large, can ever suffer from the introduction of labor-saving machinery.—The Editors.

FIFTY years ago the marine machine-shop was carried on very differently from the way it is now, both in the shop and counting room, yet the changes are in degree only; the machine shop of today is practically the same as in 1850, at which time I went into one to learn the trade. The changes lie chiefly in the direction of the introduction of systems, the use of measuring instruments of precision, closer refinements of measuring, and rapidity of execution; but in actual workmanship the man of fifty years ago was just as good as his modern successor. True, plane surfaces and good mechanical fits were not lacking then, but they were produced at the expense of time, with but slight aid from machine tools; moreover, with some exceptions, close workmanship was not required or desired, much greater latitude in matters of detail being admissible than now. So far as durability is concerned, there are plenty of machines running today which were made by our great-grandfathers.

Much heavy work that should have been done on a lathe—fly-wheels and heavy gears of large diameter, for example—was done by hand on the floor for want of a tool that would swing it; and there are many modern machinists who would not care to tackle a fly-wheel 25 feet in diameter, in six sections, chip and file all the rim joints and the arm joints where they enter the central hub, drill the bolt holes in the rim flanges, so that every part of the structure and every bolt would be iron and iron and the wheel run true on its shaft when completed, without the use of a single machine tool. Yet this is what our forebears had to do, and they did it—in the course of time. They understood the difficulties and the requirements of every job they undertook, and had to surmount them as well as they could with the facilities at command. Gears of 4 and 5 inches pitch and 6 to 8 feet in diameter had to be chipped and filed to templets laid out by scribers and dividers, because the art of gear casting was in its infancy. The teeth were full of fins and swelled spots where the sand gave way, and would not mesh, or even run, as they came from the foundry floor. Cutting gears with a hammer and chisel was not a job for an apprentice, for if the chipper was not aware of the possibilities of error and where they lay, he would find himself in difficulties by over- or under-running his templets before he got a quarter of the way around the periphery.

Naturally, it will be said, this was an expensive method of working; but for one thing, there was no other way to do the work, and for another, the best machinists received very low wages—$1.50 per day—large numbers of fairly good men getting only $1.25, and they worked steadily from bell to bell. The amount of work a good chipper could turn out would surprise modern mechanics, both as to quality and quantity. No such work is done with the hammer and chisel now; the race have died out for want of practice; the planer has supplanted them. The planer was not then entirely unknown; there were plenty, but they were rarely used upon rough or large and heavy castings unless there was a straightaway job and a lot of metal to come off, being chiefly employed upon finished work. Small hand planers, in lieu of shapers, were also used to a considerable extent for planing gibs and keys, nuts of large size strung on mandrels, etc.

In the shop where I learned the trade there were some very large lathes of home manufacture, which would swing 8 feet on the face-plate and about 25 in the pit under it, taking shafts 40 feet long and 24 inches diameter for marine engines. They would carry very heavy cuts, and I never saw one of them stalled, however large it might be. The Novelty Iron Works had two lathes of peculiar construction that would be considered very powerful today. They would not swing more than 5 feet over the shears, but they would carry any chip the tool would stand and get away with it. They were triple-geared and the belts were round, of raw hide, and ran at a very high speed—so high that it was dangerous to attempt to shift them from one speed to another without stopping the lathe. Many fool-hardy workmen hurt themselves badly by trying to do this. The same shop had the forerunner of the gigantic drill-presses of the present day. We used to call it "the giraffe," for it was 30 feet over all, from top of spindle to bed plate, and had all kinds of feeds on it. It was used for drilling, from a one-inch hole upward, and boring small cylinders. Its great forte, or principal use, so to speak, was in boring the hubs of the huge wrought-iron cranks (weighing about four tons) for the shafts. These cranks were forged solid as to their hubs, which last were sometimes 40 inches across by 24 inches deep, and a 2-inch hole was first bored in them to take the spindle of a cutter head fastened to the main spindle of the machine; this head (exactly like a flue-hole cutter used in boiler shops) was then put on and a solid core very near the finished size cut out of the crank hub. I never timed this job, but—quoting from memory only—think it took about fifteen hours, which would not be so bad even now. All tool speeds, however, were comparatively slow in those days, for we were afraid of the steel, and had good reason, for it was very unequal in quality. American steel was still in its infancy; the discouragements attending its introduction were many, and it is wonderful, with their small capitalization, that steel makers remained in business. Slotting machines were just being generally introduced; but for anything except slugging off masses of iron they were unfavorably considered. I remember very well the first slotter that was set up in the finishing shop of the Morgan Iron Works, somewhere about 1854. Up to that time all key ways for connecting rods were cut out by drilling, chipping, and filing. This was slow and costly work, for in the large rods some of the key ways were 12 and 15 inches wide by about 1¼ to 1½ inch deep. Chipping off the segments left by the drill in the center of such key ways without marring the edges of them was a very nice piece of work, and a trying one as well; none but the best talent in the shop was intrusted with it, so it was resolved to see what a slotter could do. The first experiences were not at all satisfactory, for instead of moving in a straight line, as there was every reason to expect that it would, the tool itself dodged in and out, going far beyond the lines and evading the triangular segments in an exasperating way. Moreover, when finally the operator, after taking twice as much time as a chipper and filer would, had achieved some rough resemblance to a key way, it was found that the surfaces had been so glazed by using water on the cutting tool that a file would not touch them, and for a time the slotter was abandoned; but it had to be used, and after doing a great deal of bad work it was mastered. The same difficulties occurred with bolt cutters; the men would rather use stocks and dies wherever they could than try to cut bolts in the machines; they stripped a large proportion of the bolts until the proper way to make the dies was discovered. It seems anomalous now, in some aspects of this detail of machine work, that trouble should be encountered in so simple a matter; but every operation in a machine shop has its right and its wrong way, and usually the latter is the first.

There was a large proportion of the work which could not be dealt with on machines, and some of it that could have been, as late as fifty years ago, was still done by hand—for example, long valve stems for double-beat poppet valves. These stems were about 36 inches long by 1½ inches diameter, and had threads on one end for, say 10 inches. The whole affair was turned up in a hand lathe, threads chased and finished, by a fat old German machinist ("Joe Winkler," to wit,) and when completed they were perfect in all respects. There were plenty of screw-cutting lathes in the shop which could have done the job in much less time, but "Old Joe" never cut a drunken thread in his life (that was ever discovered) and, considering the character of the lathe he had and the nature of the job itself, that is a great deal to say. Similarly, for a long time, small slide-valve seats, say of 144 square inches, were chipped, filed, and scraped to nature in lieu of planing them, the contention being that a man could chip and file them while the planer man was getting them ready to work on. As they would have to be scraped afterward, there was nothing gained by the use of the machine; the scraping of surfaces in those days was honest work, not pseudo scraping, or blotching with an oil-stone; *that* some enterprising person invented later.

The character of the lathe work done was, upon the whole, very good. I qualify this remark for the reason that some of it was quite poor. Very little attention was paid to either the centers of the lathes themselves, or the center holes in the job; too often these last were simply dabbed in with a center punch. It would sometimes be found that the lathe center had "bottomed" on the hole, and when the lathe man who did the work had his attention called to his delinquency he scornfully repudiated the view that the shaft could not possibly be true. There was not such a thing as a center drill, or a lathe for such work, known, and this in a shop that employed three thousand men in good times. As for mandrels, they were made out of any old piece of iron that came handy, and were thrown under a vise bench by the shop sweeper when they were in his way; the centers (so-called) in them were monstrous. Universal chucks were not in general use; all work that could not be held by the common jaw chuck was fixed in wooden chucks, these last being found very convenient for the shop sweeper to start the fire in the shop stove in winter. When universal scroll chucks were introduced the first ones usually lasted about a week; the lathe men, finding that the work slipped in them, had a trick of getting levers about four feet long, and using a sledge on the end, with the result of putting the chuck out of business speedily.

The machine work fifty years ago was not as good as it is now, one reason being that the machines themselves were defective not only in weight and design, but in workmanship as well; another reason was that in many cases the fitter had to go over the work again in any event, so that it would be time wasted to complete the lathe work in the lathe. To be truthful, I must add that the fitting was by no means what it should have been, not so much through carelessness on the part of the men as from the lack of instruments of precision for measuring. First and last, these consisted chiefly of calipers, inside and out, and a two-foot boxwood rule. Now if this last had been a consistent member of a large family it would have been in harmony with the others; but the trouble was that it differed in minute degrees of assertion as to the length of an inch and fractions thereof, so that where different men went by various rules, all of them giving false testimony, the results were not at all surprising, and the boxwood rules fell into disrepute as guides to accuracy.

It came to pass that where a detail was bored to receive another that had to pass through it, such as a pulley for a shaft, absolute driving fits being needed, the sizes had to be taken from one or the other; no reliance could be placed upon sixteenths, or thirty-seconds; the sixty-fourth, not being visible to the naked eye, was not recognized at all. There were, in the days of which I write, some men with phenomenal delicacy and sensitiveness of touch, and it is curious to note that one of them (William Paul) was afflicted with a nervous disorder to such an extent that his hand shook like a telegraphic sounder when he used calipers; but in spite of his disability his sizes were always right. Moreover, through faulty spindles, bad centers, and other defects the work was not always round, and after a man had endeavored to fit a brass vainly, possibly for half a day, he would at the last measure the bearing upon transverse diameters, and finding it to have two sizes would go to the lathe man and make remarks which hurt his feelings and, not unfrequently, resulted in fisticuffs.

One feature of the practice of fifty years ago stands out very prominently, which was that the main reliance for good work depended chiefly upon the vise hands, the machines being subsidiary. The fitters were supposed to detect and correct faults of measurement and manipulation, and were, in a sense, sub-foremen, whose dicta settled disputes without question. They exercised their prerogative, for the most part, judiciously, seldom or never bringing any personal bias into the discussion, and they relieved the foreman proper of a great deal of petty inspection.

The foreman of a large machine works was in those days a person of some importance, and did more or less posing and strutting to impress it upon some who were disposed to be too familiar. Early in the day he would begin his duties by promenading the main shop, glancing around furtively to see how many men were on hand, and what they were doing; he would nod to the principal fitters but pass Tom, Dick and Harry without recognition. Apprentices received close scrutiny, not only as to their work, but in their general walk and carriage. They needed this last very much, for most of them considered that their principal duty consisted in dodging the foreman and being as useless as possible, and they were not without some justification for their behavior. The apprentice in those days was considered a necessary evil, by no means a necessity, and if not exactly a walking gentleman as to his duties, was a peripatetic youth sent upon all sorts of errands by the men and hounded mercilessly by the foreman upon general principles. What time the apprentice was not thus engaged he spent in his own pursuits, usually surreptitious smoking in remote condensers, or the fireboxes of boilers. When detected he was punished by being put to ratchet drilling in prominent places, which is a job that permits of no loafing whatever, because the sound of it can be heard all over the shop.

As to teaching them the trade, they had but slight instruction, except what they could pick up by observation, and occasional practice upon machine tools that were useless for any purpose. They were not bound by articles, but were expected to stay until of age, say five years from their entrance, and were paid about $2.50 a week for the first two years, $3.50 the next year, and $4.50 to $5 for the last years of their time. Toward the end they were given much better opportunities and were put as helpers with good workmen, so that they could show their abilities if they had any. A "smart boy," or one who learned easily, was a favorite with all, and every boy who had finished his time was given a certificate to that effect, setting forth in more or less circumspect phrases that: "the bearer, John Doe, has worked in this establishment for several years, as apprentice and journeyman; he is a good workman and attentive to his duties. I cheerfully recommend him to all who may desire his services," and this eulogium very often made the skylarker in youth mend his ways and buckle-to in earnest.

General foundry work, both iron and brass, fifty years ago was first-class in every respect, and in the marine-engine shops, at least, the men in charge had great responsibilities. The bulk of the work was very heavy, steam cylinders from 30 to 90 inches diameter by 10 and 12 feet piston-stroke, large bed plates and condensers, etc. I do not now recall that a single one of these big castings was ever lost, or "unmachinable," to coin an apt word. The metal was homogeneous, wholly sound, and neither too hard nor too soft in temper. This refers chiefly to the steam cylinders, which were costly details if not right all over. As for bed plates, they did not matter so much; there was little or no machining on them, and I fancy they consisted largely of scrap; but the smaller parts, such as valve gearing, were all that they should have been. Sometimes, indeed, the foundry foreman might be seen looking ruefully at a casting that had a pronounced case of small-pox, but it was very seldom.

The blacksmith work was first class in all respects; there was no complaint about it in the shops from any cause. There was no steam hammer in the works, everything, including heavy welds on shafts up to 6-inches diameter, being done with sledges wielded by gigantic strikers. It was a sight to see six or eight of these men, or as many as could get a place on the job, wielding sledges weighing 25 pounds coming down with rythmic regularity in exactly the spot indicated by the smith's hammer; never missing a stroke or making a foul one, and keeping it up untiringly until "rung off" by the tap of the hammer on the anvil. For shafts of large size there was in later years another shop in which there were steam hammers, and here very heavy shafts were made out of the best scrap, fagoted up and welded together from the center. The central core, so to call it, was long enough to form a porter bar, and the scrap slabs were welded onto this like putting layers of paper about a pencil. It is asserted that while many such shafts were made not one of them ever broke or showed defects. Aside from the heavy work there were many artistic smiths, so to call them, who could do as neat a job in their line as any today. One of them once made a pair of draughtsman's compasses, having triangular legs so close to size that it required nothing but fine filing and polishing to fit it for work.

Fifty years ago the waste of stores and supplies for the shop was astonishing. No one seemed to care what became of red lead, waste, washers, oil, bolts, or even files. They were handed out indiscriminately to all comers without question. Men used to wash their hands in good lard oil, used lavishly, and the quantity of it that two or three thousand men could get away with in a week, to say nothing of annually, must have been large; sometimes they were detected and threatened with discharge if it occurred again, and after that the men went into more secluded places, but the oil was used just the same. As to files, they were scandalously abused, and if a man spoiled a new one by putting it on a rough casting he could not get another that week unless he produced the old one. This rule was easily evaded by picking up an old file and sending an apprentice to the store room for another. The men themselves used to notice the mismanagement in the direction mentioned, and wondered that it was permitted. As I remember there was no administration of the business that could be called so. The proprietors relied upon the foremen to keep their departments in full work, a portion of their duties being supposed to be oversight and care that nothing was wasted; but the foremen had no ideas of what was right and proper in the use of supplies, because they had been brought up themselves under the same system, and saw nothing wrong. This and the waste of time strike me at this late day as really appalling. Men would openly leave their jobs for an hour sometimes, wander into a secluded part of the pattern-shop store room where no one ever came, except at rare intervals, and take a nap. Some loitered behind castings with bolts in their hands, pretending to be looking for another one if detected, and stealing time unconscionably by all sorts of tricks and devices. This occurred in not one only, but all the large shops, and seemed to be permitted as an incurable evil. Workmen of the better class deplored it, and wondered how it was possible for the employers to make any money; some of them said they could not if it were not for the bill of "extras" which was always rendered, even upon contract work.

The matter of time keeping was very crude indeed, and the workmen used to laugh at the system in vogue, regarding it as worthless, so far as knowledge of the cost of any given job was concerned; so indeed it was. A clerk came around in the morning and just before quitting time at night and asked each man how long he had worked; some gave in all day, when they had sneaked into the works over a convenient back fence in a certain part of the premises at nine o'clock, and the job executed was "shop work." This last meant anything, from lacing a big belt to waiting for a job until the foreman came around. Everything was accepted as a correct time charge, and a man might say he had worked five hours upon "Number 60" when he had possibly worked one hour; five hours were then charged by the time keeper on "Number 60," when practically no time whatever had been spent on it. In other words, the men kept their own time and the clerk might as well have stayed in the office, so far as the question of costs was concerned. The men were paid on Saturday night without failure in any case, and very speedily, too. They all fell into line at the watchman's gate, each class by itself, all machinists in one section, boiler makers in another, laborers, carpenters, blacksmiths, etc., in another, and each man passed through on a fast walk receiving his pay envelope as it was handed out to him with hardly a pause.

One of the most serious losses of time in the marine shops of fifty years ago was the handling of details, or heavy parts, both in and out of the shops. The facilities for this consisted of inadequate cranes in the shops, which had only a limited radius of action, and a gang of laborers for transporting work about the shops to and from machines. The laborers were of the opinion that the more time they took to do their jobs the longer they would last, and they had the velocity of an ox team, which is the slowest thing in animated nature. It required about half-a-day's notice to the foreman of the gang to insure their presence at all; meanwhile, the machine would be standing idle. A little thing like this did not seem to trouble anyone, and if the workman got restive at his enforced idleness and tried to hurry things up a little he would be told where to go in words that would not look very well if printed. For lifting large boilers in and out of ships there was the Bishop derrick on the dock, but the boilers had to be brought to it first, and when they were heavy this meant sliding them for a considerable distance along greased ways of heavy timber. There were no chain blocks then, but about 1855-58, Richard Doyle, a common laborer in the Novelty Iron Works, invented and introduced the first differential pulley hoist made in the United States. Doyle had been a schoolmaster in his native country—Ireland—and was an accomplished mathematician. Upon all other subjects he was densely ignorant, but he worked out the block and, more to humor the old man than anything else, the foreman had one made. Much to his surprise it acted as Doyle said it would, and it was the wonder of the shop for a few weeks. About the same time a similar block was invented in England by Thomas A. Weston, and its success there led to its general introduction, so that through the work of Doyle and of Weston the differential chain block has come into use all over the world.

Although metallic packing for pistons, and valve-stems as well, had been in use for some time prior to the year 1850, the hemp (oftener jute) gasket was not wholly abandoned. The Cromwell Line steamers had engines whose pistons were packed with hemp gaskets—huge things as large as a man's forearm, driven in tightly with a sledge; in one case I was the man behind the sledge, so I am pretty sure of my premises. How long they remained I do not know, for they were not countenanced by the works that built the engines but were ordered by the superintending engineer of the steamship company. The metallic packing for valve stems consisted of a series of beveled rings put into the stuffing boxes in halves, and some of the packing was merely babbit-metal shavings as fine as excelsior; but it did not work well, speedily clamping the valve stem or leaking.

The material used for steam and hot- or cold-water joints, was, in the first instance, red-lead putty (white lead and red lead made very stiff, with sometimes iron borings mixed through it) for faced joints, these having annular grooves turned in them at intervals of an inch. They never leaked, but the pressures were very low, 25 to 40 pounds at the most. Pasteboard, made from straw paper under pressure, was used for water joints, on feed pipes, etc. This was first soaked to soften it; then a coat of red paint was given in making the joint and when screwed up it was tight; it could be easily broken if the pipes had to be taken apart for any cause. A joint which could not be taken apart, but lasted forever, was the "driven," sometimes called rust, or calked joint; this was cast-iron borings saturated with sal-ammoniac, or, in the absence of it, urine, driven by thin calking tools into or between the joint flanges, which were left one-quarter of an inch apart for this kind of work. It rusted fast and was a part of the pipes thereafter.

Not long ago I visited one of these old shops, and although it had been changed in some departments, and curtailed in extent, there was enough left to make it the old shop of my youth. But one alone, of all the apprentices of fifty years ago, remained; he has been there nearly fifty years, and is now general superintendent in charge. The others, thirty or forty more, are scattered far and wide. Some have passed away; others have filled and are now filling posts of responsibility with honor; one is now writing this memoir; but by far the greater number will never answer "here, sir," to the roll-call again. Let me say "peace to their ashes"; they were good comrades, for out of the whole number I never received anything but abiding, steadfast friendship. They acted well their part on life's stage, and "there all the honor lies."

EDITORIAL COMMENT

By the untimely death of Professor John Butler Johnson, which occurred recently under tragic circumstances, the engineering profession in America has lost one of its most useful and valued members. The story of his life has been told elsewhere in detail, and indeed his work as an educator and as an author of engineering works is well known to the readers of this Magazine. It is of his monumental work in a special field that we desire to speak in this place; of the founding and seven years' development of the Engineering Index.

Early realizing that the latest and most useful expression of the progress of engineering lay in the pages of current technical periodicals, Professor Johnson began, immediately upon his installation as Professor of Civil Engineering in Washington University, to index the chief sources of such literature, and it was through his initiative and influence that the index of current technical literature appeared in the Journal of the Association of Engineering Societies from 1884 to 1891. As he said in the introduction to the last volume of the Index, edited from the pages of this Magazine for the years 1895-1900, he was the undoubted originator of this style of indexing, in so far as it required a perusal of the article and an estimate of its value named in the descriptive note; that is, in practically all that renders such indexing of real value to the engineer and professional man.

The value and importance of the Engineering Index of the present day is realized and appreciated by many, and both by those who use it and those to whose care it is now entrusted it will always be regarded as embodying the wise purpose of its founder.

* * *

Professor Johnson's measure of the importance of the great work which he inaugurated can be given at this time with peculiar fitness. It is the man's own estimate of his own work, as he saw it from without after the lapse of years and the transfer to other hands had removed any tendency to strong bias—after distance had brought it into due perspective and proportion. This view is stated in a letter written a few months before his death, and is given in part in the following extracts, expressing his judgment of the five year volume of The Engineering Index:—

"This is indeed a great professional triumph. It is an honor not only to you, but to America and to the engineering profession. * * * I know of no greater aid to engineering progress today than the index to the world's knowledge of engineering problems. It is certainly true that such an index, without a library containing the original communications, is more valuable than a library containing all such communications without an index. * * *

"From a casual inspection of the work it would seem to my mind to be above criticism. Genius has been defined as 'the ability to take infinite pains,' and under that definition this is truly a work of genius. * * *

"I consider your use of my portrait and your complimentary reference as the highest honor that has been paid me in a professional way, and I am glad that it has been done in this particular connection. I think I am prouder of my services to the profession in this matter than of anything else I have done, and I believe it is likely to lead to greater benefits."

* * *

THE work of the engineer is becoming so intimately connected with matters of daily life and experience that it is almost time that the daily press should realize the advisability of exhibiting some small degree of intelligence in chronicling technical matters for the information of the general reader. That some improvement in this respect is necessary is certainly apparent to the intelligent reader of even the most highly self-esteemed of the metropolitan dailies.

Thus we are gravely informed by a New York daily, in a letter published in the midst of other serious information, that the original amount of electricity in the universe was apportioned, along with other elements (?), so as to produce a harmonious action of the whole, and hence that the subsequent enormous addition of "indestructible" electricity by the humanly established dynamo is destroying the original equilibrium, with the result of creating the recent destructive storms and other manifestations! Another interesting illustration of newspaper science is seen in the announcement that a boat operated by an internal combustion motor is propelled by explosions, the oil being "fed into an iron ball heated by a kerosene torch."

Not so very long ago one of the great dailies described some blasting as being performed by the aid of "four side" (forcite?) powder, this being explained to be a new explosive which acted in four directions at once, in distinction to ordinary powder, which, we were told, acted in but one direction at a time.

Is it not almost time that room was found for some small degree of technical intelligence in the newspaper office?

MR. GOOD'S article in our August issue was severe in its charges against a certain class of British shop foremen, but the arraignment is only too well sustained by other authorities and too closely paralleled by conditions existing in certain American shops. One highly valued correspondent of the Magazine, who does not desire in this particular connection to be named, carries the matter a little further than Mr. Good by tracing the abuses to their causes, or at least pointing out the conditions under which they exist. He finds them varying with the discipline dominating the establishment. Given a conscientious and energetic principal thoroughly devoted to his business, and his staff will not include any managers or foremen who cling to their positions by mere toadyism, nor will these in turn measure any workman except by his efficiency. Where organization and discipline are lax, however, practices of bribery, cajolery, and flattery creep in. And they are especially common in works (especially small works) whose principals have some weakness or fad by playing upon which the shrewd and not over-scrupulous official may ingratiate himself. As organization progresses, however, and system takes the place of individual relation, *results* become the only test. The employer bases his opinion of his foreman not upon personal feelings, but upon an analysis of the output of his department. The foreman must apply a similar measure to his workmen. Efficiency alone fixes tenure of office.

A good deal is said of the lamentable decline of the old personal relations between master and man. It had, doubtless, its amiable features. But there is another side, and it is hopeful to find that System—like her stern-browed sister, Law—with the manner of a severe governor really offers a better freedom than was ever enjoyed before she was enthroned.

Engineers in the Navy.

In a recent issue of *Engineering* there is a letter from Mr. D. B. Morison, accompanied with editorial comments, discussing again the question of the status and efficiency of engineers in the navy, and the subject is of sufficient importance to demand additional comment in this place.

Mr. Morison examines the facts in connection with the difficulty in obtaining engineer officers for the navy in comparison with the numerous applications for similar positions in merchant steamship companies, and says that practically continuous advertisement by the Admiralty for engineer officers has for a long time past yielded such inadequate and unsatisfactory results that, unless prompt measures be taken to deal with the vital question, the efficiency of the fleet will be very seriously impaired.

That this is a mild statement of the case is evident to the most casual observer. The fleet is already undermanned, so far as engineers are concerned, both in numbers and capability. The standard has been so far lowered that its accumulative effect has appreciably diminished the homogeneity and efficiency of the entire engineering personnel.

"Warships, which were formerly in charge of officers of chief engineer rank, are now in charge of junior officers, whose increased responsibilities are not compensated for by accelerated promotion; and many ships having engines up to 4.500 indicated horse power, with Belleville and other water-tube boilers, which admittedly require highly-skilled and experienced attention, carry no commissioned engineer officer, but are in charge of an artificer engineer. The whole tendency of modern education is to raise standards in all professions, and with the immense and rapid developments in mechanical science as applied to naval warfare, the lowering of the standard of engineer officers is a highly dangerous expedient."

However this state of affairs may be regarded at the Admiralty, it must be observed with the greatest satisfaction by the enemies of the Empire, who, knowing that the national defence must always rest with the fleet, are doubtless inwardly delighted at the multiplying evidences of the disintegration which is being permitted, and even ignorantly encouraged, in high quarters.

As *Engineering* well says editorially:

"The fighting efficiency of the fleet has already been very seriously impaired, as we should soon find were fighting to be done; and not only prompt, but vigorous measures are now needed to repair the defect. The danger to the country from defective administration in regard to the engineering branch of the navy has grown year by year as engineering has become more and more the predominant factor in naval operations. Masts and sails have disappeared: the propelling of a war vessel is entirely a matter of steam, and there is hardly a feature in the economy of a war vessel the effective operation of which is not dependent on the highest skill of the engineer. This is a fact that a certain section of those who influence the administration of the navy constantly ignore. They argue that the war vessel, once designed and constructed, needs no longer the application of high engineering knowledge and ability; that it will keep itself efficient if only ordinary mechanical skill be applied to maintain its upkeep; in short, that engineers are not needed, but merely engine-drivers. How fallacious such a view is need not be here insisted upon. Even if true of times of peace—which it is not—it would be entirely false for a state of war. But foolish as such a position appears, at any rate to engineers, it largely animates the spirit of opposition which now prevents the science of engineering taking its proper place in the administration of the navy.

"There is no getting away from the fact that the Board of Admiralty do not consider high engineering attainments necessary for running a war vessel and keeping it efficient.

It is plain and indisputable that engineer officers of high professional attainments cannot, by present methods, be brought forward in sufficient number for the needs of the navy; and no steps are being taken to improve these methods. Mr. Morison's facts and figures place the question beyond dispute, whatever gloss may be put upon them by official apologists in Parliament and elsewhere. Keyham has failed; direct entry has failed; temporary appointment has failed. The strongest evidence—deficiency of numbers—show that; and the Board of Admiralty is giving additional proof in attempting to get round the difficulty by substituting handicraftsmen for properly trained and educated engineers."

For a fair and impartial presentation of both sides of the subject, reference may be had to the papers of Mr. Johnson and of Mr. McFarland, elsewhere in this issue. It is hardly possible to find two men who are better informed upon the state of affairs in the navies of Great Britain and the United States respectively than are the authors of these important papers.

That the system advocated by the Personnel Board, and adopted in the United States Navy has not yet been a pronounced success, is due to the fact that it has not yet been really carried out at all. Both the text and the spirit of the personnel bill demanded that line officers should stand watch in the engine room in the same manner as engineer officers. That, through the exercise of influence, they have been able to shirk this portion of their obvious duty does not reflect creditably upon them as officers and gentlemen, but it is solely due to such failure to carry out the clear intent of the bill that it has thus far failed of its purpose.

Time, which tries all things, will, however, make this defect clear in the end. There is no test like that of experience, and it needs only a general naval war to reveal which men have been standing honourably by their duty and which have been neglecting it.

Those nations which are most dependent upon their naval strength for their supremacy are those which must necessarily feel the pressure first, but we may rest assured that those which are wise enough to realise that the era of the fighting engineer is even now with us will have least reason to fear the outcome.

Improvements in Space Telegraphy.

There is probably no one branch of applied science in which progress has been more rapid than in the domain of electricity. Under these circumstances there is small wonder that there should be more or less of what Humboldt calls the "horrid wrangling about priority," or that much of the wrangling, when sifted down, should prove to be based largely upon misunderstandings, or upon the natural coincidence of results attending the simultaneous work of many able men in a common field.

It was just as natural that the experimental researches of Hertz upon magnetic waves, and of Branly and Lodge upon molecular conductivity should be followed by the work of Marconi and others, as that the experiments of Oersted and Henry should have produced the results of Morse and of Wheatstone. It is also natural that the extensive experimental work of Marconi should inspire others to examine into the possible methods of detecting and recording the impulses produced by magnetic waves in the transmission of messages through space, and all such researches should be welcomed as contributing to the advent of practical communication.

Starting with simple forms of coherer and sparking coils, Mr. Marconi has gradually extended the scope of his work until it has impressed many resources which had lain dormant in the laboratory until the arrival of a working enthusiast to give them practical application. While others have been elated with results extending over a range of a few miles, Marconi has increased the distance of communication to an extent to alarm the transatlantic cable owners and arouse general attention. Under such circumstances it is almost amusing to find that his frank announcement that he has experimented with the so-called "Royal Italian Navy Coherer" is construed in some quarters into an admission of what every one at all familiar with the subject has long ago known, namely, that Mr. Marconi's inventions are necessarily skillful practical combinations of well-known elements, for attaining hitherto undreamed of results.

An interesting communication in the *Electrical Review* from Professor Angelo Banti, gives some information concerning the origin of the Italian Navy Coherer. It appears that experiments made by Castelli, a corporal in the Italian navy, led him to construct a coherer composed of a tube with electrodes of carbon, holding two drops of mercury separated by a short cylinder of iron. This he found to be self-decohering, and by its means he successfully received messages with a telephone. About the same time that Castelli was thus experimenting at Leghorn, Lieutenant Solari, at Spezia, constructed a similar coherer, using one electrode of carbon and one of iron, with a single drop of mercury between. These results were communicated to Mr. Marconi by Lieutenant Solari, and in consequence the latter experimented with this construction. His opinion based upon his own experiments can best be obtained from his statement in his lecture before the Royal Institution, already reviewed in these columns. He found that these mercury coherers, although very convenient for experimental work, could not be relied upon to decohere with certainty. While well adapted for use with a telephone as a receiver, the changes in resistance were found to be not sufficiently abrupt to permit a recording instrument by its means.

These devices, therefore, while interesting additions to the possible methods of receiving local messages, have but a limited application, and create only a passing interest.

The real element of progress in space telegraphy lies in the production of a receiver which shall be capable of operating a recording apparatus at a rate comparable with the working of existing submarine cables, and it does not appear that this can be practically accomplished with any form of coherer. Far more promising is the improved magnetic detector, described in Mr. Marconi's lecture, acting by the variation in hysteresis produced by the magnetic waves upon a bundle of magnetised wires under the influence of a rotating magnet.

In all this evidence of activity in the development of improvements in space telegraphy there is nothing but cause for congratulation. The world at large is far too deeply interested in the progress of means of communication with all parts of the globe to take heed of petty squabbling as to the priority of the many experimenters, these are matters which they may well be left to settle as other commercial disputes are arranged. Fortunately the fundamental principles have been so widely thrown open to the public by the researches of Hertz and his followers in the physical laboratory that there is little fear that progress may be hindered or suppressed. Doubtless the most satisfactory apparatus of to-day will be relegated to the technical museum in a brief time, and new devices will take their places only to be supplanted in turn. All this must necessarily make for progress, just as similar results have been observed in the development of other branches of applied electricity, and the outcome can well be awaited with interested satisfaction.

Coal-Cutting Machinery.

In his recent paper on coal mining methods in England and America in this magazine, Mr. Ackermann called attention to the great disparity in the use of coal cutting machinery in Great Britain as compared with the United States. This matter is emphasised in a paper recently presented before the Midland Institute of Mining, Civil, and Mechanical Engineers by Mr. W. E. Garforth, and published in the *Colliery Guardian*. Apart from any discussion as to the probable duration of the British coal fields, there is the vital question as to whether coal can in future be raised and sold at such a price as will enable the British manufacturers to compete successfully with those of other countries.

"The rapid exhaustion of the thicker seams at shallow depths—the necessity for working the thinner seams, and enquiries if such seams are unduly injured by the present methods of working the thicker and underlying seams, the tonnage lost in working, the increased percentage of small coal, the loss by barriers left for boundaries and by pillars required for the support of surface property, difficulties of scarcity of labour, especially hewers, higher wages any other matters, have already caused anxiety as to the future prosperity of the coal and other trades of Great Britain. Hence, all methods of getting or dealing with coal which seek to meet these difficulties, or by which the greatest proportion of workable coal can be raised in the best condition, at the lowest cost of production, and with the greatest safety and comfort to those employed are subjects that should be fully and often discussed by those interested in mining.

After discussing at length the nature and formation of coal seams, Mr. Garforth shows that the existing methods of working are largely empirical, and have persisted in the form of pillar and stall, or stoop and room methods, the longwall method being employed only under the most favourable conditions. With the increasing depth of workings, however, the effects of superincumbent pressure have made themselves apparent to an extent which has rendered the pillar and room system most unsatisfactory, and hence the longwall system, removing all the coal at one time, has been practically made compulsory. This has unconsciously led up to the introduction of coal cutting by machinery. The long straight coal face enables machines to be employed to the best advantage, the proportionate gain over hand working being greater also for thin seams than for thicker ones.

A most important requirement for undercutting machines is that they shall be able to compete with hand holding as regards depth of cut. The earlier cuts of 2½ to 3 feet are altogether too small and a satisfactory machine should be capable of cutting 5, 6, or even 7 feet, thus dispensing as far as possible with the use of explosives, and reducing the cost of cutting to a minimum. The height of the cut should also be 5 inches or more in dirt, so as to cause a complete vertical fracture of the coal, while at the same time providing sufficient clearance to prevent the coal from being wedged or crushed by the subsidence of the roof. The mechanical arrangements of the machine should also be such as to render it capable of easy control, and the details of operation should be such as to insure complete and clean work. With such machines the output ranges from 6 to 8 tons per man per day, one hundred and seventy thousand tons having been wrought per annum from one seam 960 feet deep and 4 feet thick.

Mr. Garforth prefers compressed air to electricity for underground work, this preference being mainly on the score of safety. At the same time there are many locations in which electric power can be safely and conveniently used, and these will doubtless be extended as improvements are made.

At the present time, in the United Kingdom, coal got by machinery bears only a small proportion to the output by hand holing. The next decade will undoubtedly mark a large increase in mechanical cutting. Coal-cutting machines made in Great Britain have now passed the experimental stage, and the opinion of a large number of workmen, based on ten years' experience with the machine, as compared with a similar experience with holing by pick, is in favour of machine holing, inasmuch as higher and more regular wages can be obtained, less arduous work is required, combined with greater safety, besides other advantages.

Boilers for the Navy.

With the appearance of the final report of the committee appointed by the Admiralty two years ago to examine and report upon the subject of boilers for the navy, there comes opportunity for comment upon the whole subject in the light of the information thus made public.

Notwithstanding the high reputation and wide experience of the members of the committee, the members thought it advisable to conduct extensive experimental trials and upon the results of these trials and upon the previous experience obtained from the navy and from the merchant marine, the conclusions given in the report are based.

Space will not permit of an exhaustive analysis of the entire report in this place, but in addition to the specific recommendations of the committee, some of the special features of importance may be mentioned.

In the first place the favourable expression of opinion as to water-tube boilers given in the interim report, has been confirmed by the experience since gained. In like manner the committee sees no reason to alter its expressed opinion as to the unsuitability of the Belleville boiler for use in the navy. Since this latter matter is practically the most important question before the committee the reasons for rejecting the Belleville boiler demand full publication.

"The disadvantages of the Belleville boiler, as compared with the cylindrical boiler, are as follows:

"The circulation of water is defective and uncertain, and the water gauges do not indicate the amount of water in the boiler.

These causes have led to serious accidents.

"An automatic feeding apparatus of a delicate and complicated kind is necessary, in order to make the safe working of the boiler possible.

"A great excess of pressure over that in the boiler is required in the feed pipes and pumps.

"A considerable excess of boiler pressure over the working pressure at the engines is necessary.

"The quantity of water varies at different rates of combustion, although the same level may be shown on the water gauges.

"Separators with automatic blow-out valves on the main steam pipes are required in order to provide for water thrown out of the boilers when the rate of combustion or the speed of the engines is suddenly increased.

"A constant and excessive loss of feed-water.

"The upper generator tubes are liable to fail by pitting or corrosion, and, in economiser boilers, the economiser tubes are still more liable to fail from the same cause. The trouble from this cause has diminished recently, but the liability of these parts to corrosion still exists, and must be regarded as a serious disadvantage.

"The upkeep of Belleville boilers has proved to be exceedingly costly, whereas that of cylindrical boilers is trifling, and this disproportion is likely to increase materially with the age of the boilers. On account of the necessity for more repairs, ships with Belleville boilers will be laid up more frequently and for much longer periods than similar ships with cylindrical boilers.

"The additional evaporating plant required with Belleville boilers, and their greater coal consumption on ordinary service as compared with cylindrical boilers, has hitherto nullified to a great extent the saving of weight effected by their adoption, and in considering the radius of action of ships fitted with them, no real advantage has been gained by their use."

While it is believed that many of these defects may be obviated by the use of some other type of water tube boiler, yet it does not appear that there is at present any boiler of the water-tube type which has impressed the committee as possessing sufficient advantages to be suitable for general adoption exclusively. In view of the excellent economy of the cylindrical boiler, and also taking into consideration the fact that a large percentage of coal is expended for auxiliary purposes in harbour, the committee recommends that, for the present, both cylindrical and water-tube boilers be installed in naval vessels. Battleships and large cruisers are therefore recommended to be fitted with cylindrical boilers of sufficient power to work the auxiliary machinery, and to drive the ship at her ordinary cruising speed, water-tube boilers being also supplied for emergency service, and to drive the vessel at the maximum speed which may be demanded; both systems of boilers being adapted to carry steam at 210 pounds pressure, so as to give 200 pounds at the engine.

In this way the water-tube boilers will be kept clean and perfectly efficient, and by virtue of their rapid steaming qualities they will be ready for prompt service upon demand.

This idea is by no means novel, having been adopted in the United States navy in the case of the coast defence vessel Monterey several years ago, and according to Rear-Admiral Melville, the combination of cylindrical boilers and Ward water-tube boilers proved most satisfactory in that instance. The combination system has also been used for several years in the German navy with good results.

Although favourable opinions were expressed by the committee as regards the Babcock & Wilcox, the Niclausse, the Dürr, and the Yarrow boilers, yet the fact was clearly stated that no type of boiler at present in use is as economical as the cylindrical boiler, and that the above recommendation is made for use "until a thoroughly satisfactory type of water-tube boiler is obtained."

This should certainly be a stimulus to inventors and engineers especially as the committee also gives a synopsis of the advantages which a satisfactory water-tube boiler should possess.

Thus, as compared with the cylindrical boiler, a satisfactory water-tube boiler should offer less delay in steam raising; less liability to damage if the boiler be struck by a projectile; greater ease of repair and renewal of parts; less weight for power generated, ability to carry a higher steam pressure; and greater fire-grate area for the same floor area. These advantages are all to be had without the introduction of counterbalancing disadvantages. This program being indicated, it is a matter for the engineering ability of the world to meet the requirements, and solve the problem. In the meantime, the most promising types now available are to be given practical trial, in connection with cylindrical boilers, as stated above.

There is one feature in connection with the whole subject which the committee has apparently seen fit to ignore, namely the fact that the more highly organised character of the water-tube boiler, in general, demands that it should at all times be in charge of thoroughly trained engineers. This is only one phase of a subject to which reference has already been made in these columns, but it is a most emphatic confirmation of what has been advanced on this point by such competent judges as Mr. D. B. Morison, Mr. Charles M. Johnson and others. The undoubted introduction of water-tube boilers in the navy is but another step in the conversion of the war ship into a fighting machine, demanding the presence and control of skilled engineers for its efficient and successful use. There is little doubt that the small measure of success which has been attained with the Belleville boilers has been largely due to the fact that they were placed in the hands of sailors rather than engineers and no matter how completely designed any form of boiler may be, it might as well be understood now as later that the machine is but a part of the equipment, and that its appearance is invariably a notice served upon the sailor that he must step back and make way for the real fighting man of the immediate future, the fighting engineer. It is but another step in the evolution of warfare, and as Huxley said to the dogmatic opponent of evolution, we must consider, not what we would prefer, but what is true.

Engines for Generating Stations.

With the introduction of the dynamo-electric machine there has been an interesting evolution occurring in the design of the steam engines by which the electric generators are driven. At first the dynamos were mainly of the continuous-current type, with armatures of comparatively small diameter and high rotative speed, and after experience with belt driving from existing engines, came the now well-known form of high-speed automatic engine, these involving a much lower ratio of speed multiplication, and ultimately permitting direct connection with the dynamo armature. About the time that this form of engine was perfected, the electrical practice changed. Long-distance transmission demanded the use of higher voltages, while the perfection of the transformer and converter made alternating currents not only practicable, but often preferable. The result was the general introduction of the large generating set, consisting of a slow moving engine with an alternator of large rotor diameter, the latter itself frequently forming a portion of the fly wheel of the engine. In view of the extensive experience which has now been had with both forms of driving, some recent discussion as to the advantages or disadvantages which both possess is of interest.

In a paper recently presented before the Incorporated Municipal Electrical Association by Mr. A. A. Day, the subject of the correct type of engine for large generating stations is discussed. So far as present practice is concerned, Mr. Day is quite correct in stating that the trend of opinion is in favour of slow rotative speeds.

His preference is for a horizontal low-speed compound or triple expansion engine, with direct-coupled generator between cranks. This is practically present practice on the Continent, and in support of this view, Mr. Day presents the following points in its favour:

"The most economical engines have been built of this type, and certainly it can hold its own, if properly built, with any results obtained in electric light stations. The author has recently had occasion to inquire very closely into the question of the cost of producing power in large cotton factories such as there are in Bolton, and the figures obtained were equally a good advertisement for the horizontal type of engine which is almost universally employed, and also very useful as a guide to the price at which it is necessary for power to be supplied in order to make its use become general. Such engines are found to give an indicated horse power hour for less than 1d. with coal about

7s. per ton and this on a load having a variation of 10 per cent.

"The horizontal engine does away with the necessity for steam pipes in the engine room or rather above the engine room floor, and enables the steam pipes to be reduced to a minimum.

"The engine can be kept clean at a minimum of expense and trouble.

"The repairs to such an engine will be found to be reduced to a minimum if the valve gear be of the Corliss tripped type, which appears to frighten some engineers by its complication. The complication seems to the author to be far more apparent than real. It is no more necessary that the gear should be more complicated than in the case of an enclosed high speed engine, but it is seen in the one case and not in the other.

"The engine can be easily got at for repairs, and the same applies to the dynamo. It seems to the author that the weak point of a similar type of engine to that under discussion, but vertical instead of horizontal is that to remove the top half of the field magnet ring, or to get at anything of importance on the dynamo, necessitates the dismantling of the engine.

"The dynamo being placed between the two cranks, the shaft is not in any way cut up. We all know the difficulty that has been found to exist in making a crank shaft with built cranks strong and able to withstand the throwing off and on of the full load repeatedly, as must necessarily be the case with electrical generators for power purposes and traction.

"The bearings of such an horizontal engine can be adjusted both vertically and horizontally, so enabling the armature to be adjusted inside the field, which it is very advisable should be possible. It is, of course, of the utmost importance that the turning moment should be very even in the case of three-phase or polyphase transmission, but a good deal more has been made of this point than is necessary, as there are three-phasers running on the Continent, and running satisfactorily, with engines that have only a single crank, the percentage variation being 3 per cent. of the angular velocity, and it is not all difficult to make a two-crank engine such as has been described with a far more even turning moment.

"This proves conclusively that there can be no need for the fly-wheel of a low-speed generating set being made abnormally heavy to obtain a sufficiently even turning moment, especially if the engine is not a single crank one."

The principal advantage which can be offered for the horizontal engine as opposed to the vertical form is the better drainage of the cylinders which is practicable, and it is also urged that the working parts are more accessible in the horizontal type than in the vertical. So far as the question of space is concerned, it is maintained that a certain amount of space is required for the boilers in any case, and an engine room of equal length with the necessary boiler house will always give sufficient space for slow-speed engines.

If high speed is to be advocated, Mr. Day maintains that it should be an extreme high speed, such as is produced by the turbine.

This side of the question was well presented before the same society by Mr. S. E. Fedden, whose remarks on this subject are well worth reviewing. Mr. Fedden shows that if turbines are to be used successfully they must always be used condensing, and that they should not be of small size, 200 to 300 kilowatts being the lower limit, but under these conditions they offer many advantages. Wet steam is no impediment to the operation of the turbine, although it offers especial facility for use with highly superheated steam, owing to the absence of rubbing surfaces. Its other advantages are as follows:

"Absolutely steady nature of turning moment.

"Entire absence of cylinder lubrication, which, therefore, allows of all the condensed steam being returned to the boilers. The saving in this one item alone materially assists in the reduction of station costs.

"The time occupied in cleaning down is brought to a minimum, and is about one-sixth of that required with a reciprocating engine of similar capacity.

"The entire absence of rubbing surfaces and packed glands within the steam chamber will permit of the use of superheated steam without fear of injury. The turbine specially lends itself to the use of superheat of a high temperature, and in this respect possesses a considerable advantage over a reciprocating engine.

Exceedingly small costs for attention and repairs, and great reliability of working."

It is evident that there is much to be said on both sides of the question, and there is no doubt that local conditions must always enter largely into the choice of the type of engine to be used. The engineer is too apt to look upon such subjects from the engineering side only, and he is just beginning to learn that engineering and economical general administration are necessarily united. Economy of steam is not always economy of money, and it is the ultimate advantage which must always be kept in mind. Large power houses and slow-moving big engines mean a large original outlay, upon which interest charges must be earned. Often the high cost of a site in an otherwise desirable location makes the area occupied a limiting factor.

The question of durability of the slow speed engine is much the same as has already been discussed in connection with locomotive engines. A well built slow-speed engine will almost last forever, but that is a great deal too long. It is much better economy to make the durability of the engine no greater than its economic life, and then to scrap it for something later and better.

The whole subject is one which must always remain unsettled so long as progress is maintained, and the wise engineer will plan for the immediate present with his eye on the near future, realising that in electrical engineering especially "the world do move."

Structural Work in America.

In the course of a very interesting series of papers on structural costs recently published in the *Engineer*, the practice in tall building construction in America is set forth in a manner which shows clearly how economy is attained by keeping down the labour costs.

The framework is so designed that the metal shall be handled the least number of times in the making. Planing is generally conspicuous by its absence, rolled or sheared edges taking its place. Rivets are so disposed that power driving can be used to the best advantage. Joints are so arranged that they require the minimum of work on site, and their rivets can be readily put in by pneumatic tools. Hand work is seldom to be detected—everything is as the machine has left it; as many girders, stanchions, beams, etc., are duplicated as is possible; stanchions are throughout spaced regularly; girder riveting is made alike in like spans—plates being added or dropped off as required for strength, thus one girder web plate template will often answer throughout the building; cast iron bases, pockets, shoes, and connections, where used, are just as the fettler or the tumbling barrel has left them; holes are cored or punched according to material; everything, in fact is made most evidently for work and not for show. When first seen one is tempted to think off-hand that there seems much waste of material in places and much skimping of it in others. Brackets seem large and unwieldy, whilst cleats seem small and insufficient; girder flanges appear light, and stanchions ruggedly gigantic, or vice versa, according to the object of the building. But one has only to study things out a little to realise that all this is of set purpose. We are so used at home to providing against so many chances that are never likely to happen concurrently, that our structures have taken a character of their own, and we miss these characteristics when viewing other work. If workmanship can be saved by a slight sacrifice of material, the American carefully considers it. In no land are scientific principles better understood than in his, but he is much keener after the dollar than to sacrifice it for the sake of theory, and he will unerringly fix on the cheaper way of carrying out his principle. He keeps as far away from the smith's fire as he can, and does not enlarge his scrap heap with useless croppings and clippings, and as a direct consequence gets work made very much quicker, on the whole much cheaper, and quite as good and sound and equal to what is demanded of it as though it had been made to a Government specification and was finished all over.

It may be argued by some that this sort of thing is not compatible with good work, but there is no reason why it should not be so. In masonry structures there is no attempt made to dress the inner faces of stone which is to be backed by rubble or brickwork, and since the structural work of a modern steel skeleton building is entirely imbedded it should be made to fulfill only those demands which legitimately come upon it.

REVIEW OF THE CONTINENTAL PRESS

Hydraulic Power in France.

For several years there has been much attention directed towards the possibilities of developing the immense hydraulic power available in the numerous streams of moderate size but rapid fall descending from the Alps into the lower levels of Switzerland, Italy, and France. So far as France is concerned, an extensive report was made to the Minister of Public Works about three years ago, after an investigation of the hydraulic resources of the French Alps by engineers of the *Ponts et Chaussées,* and this report was reviewed in these columns at that time. During the interval there has been a rapid growth of hydro-electric installations both in Italy and in Switzerland, but France, with opportunities equally favourable, has made far less progress. The entire subject of hydraulic power in France, together with some discussion as to the comparative tardiness in its practical utilisation, forms the subject of an important paper, presented before the Société des Ingénieurs Civils de France by M. R. Tavernier, and published in the *Memoires* of the society, from which we make some abstracts.

The principal difficulty in determining the true amount of power available appears in the variable flow of the mountain streams.

For the winter season, when the supply from melting snow is almost cut off, the water is very low, while during the spring and early summer there are frequent floods. Thus gaugings on the Isère show a flow of 150 to 250 cubic metres per second in the high waters of summer, while during the winter months the discharge falls to a mean of 14 cubic metres, and occasionally descends to a minimum of 6 cubic metres; a fair annual average being 20 cubic metres per second. Similar figures are obtained from other streams, the conditions being entirely different from rivers at lower elevations, in which the low stages of water occur in the summer months. The natural provision against these variations is the construction of storage reservoirs, but these are naturally dependent upon the topographical configuration of the surface and are not to be constructed everywhere.

M. Tavernier examines the various estimates which have been made as to the available hydraulic power existing in the French watershed of the Alps, and considers that a conservative valuation may be taken as 3 million horse power during low water, and 5 million horse power based upon the average annual flow. Naturally all of this power is not directly available. Existing installations of less than 200 horse power are not included, and a portion, about 100,000 h. p., is already in use.

These facts have been known for several years, but nevertheless little or nothing has been done of late to develope these sources of power. In this respect a comparison with Switzerland and with Italy is instructive. Thus, the estimate made by the Italian engineers in 1884, showed that there was available about 2 million horse power. Since that time the practical utilisation of many of the streams has shown that this estimate was below the facts. Thus, in the single province of Turin there was allowed in the estimate of 1894 but 227,450 h. p., while already 100,000 h. p. is in progress of utilisation, and there is nearly 600,000 h. p. undoubtedly available. In Switzerland, also, in which the earlier estimates allowed but 582,000 h. p., the existing installations clearly show that this is far below the actual amount which can be easily utilised.

The success which has attended the development of hydro-electric plants in Italy and Switzerland, as compared with the comparatively slow progress in France, may be accounted for in several ways. In the first place Italy and Switzerland are both without coal, and hence the advantage of developing natural sources of power is more apparent. In the second place the question of the legal status of the property rights involved in the development of the hydraulic power is not yet fully settled in France, besides which certain important sources of power are held for speculative purposes, instead of receiving immediate practical exploitation.

Apart from the mechanical details, now fairly well settled by the practice of many successful installations in various parts of the world, the main question which should determine the development of the power of the melting Alpine snows is that of cost. In this respect, as M. Tavernier points out, the use of a moderate volume of water at a high head, such as is offered in numerous places in Haute Savoie and elsewhere, possesses a great advantage over the older plants using the large volume and low head of great rivers.

This is naturally to be expected, the transmission of energy by water following the same general economic law which governs the flow of electricity, and which determines the superiority of the transmission by high voltages over conductors of small section as compared with the use of lower voltages. The great element in cost is found in the interest on the investment charges, and in the depreciation, the operative expenses forming a much smaller portion of the cost. The second element in economy results from the generation of energy in large quantities at a time, the advantage of this being well understood in all kinds of power plants.

The importance of the capital charges will be realised when it is understood that the installation cost of a hydro-electric plant may range from 100 francs per horse power to several thousand francs.

According to the figures of Blondel, the installation cost of a steam-power plant of 1,000 to 10,000 h. p. is from 250 to 300 francs per horse power, and allowing interest and depreciation at 8 per cent., and taking coal at 20 francs per ton, the cost of power is as follows:

60	francs	for	1,000	hours
140	"	"	3,000	"
240	"	"	6,000	"
300	"	"	8,000	"

The first figures correspond to the work of an electric lighting station of which the full power is required only 3 hours per day.

The second serves for a manufacturing establishment operating 10 hours per day.

The third example is that of a central power station operating for a mixed service, 20 hours per day.

The fourth represents the service of an electrochemical or metallurgical works, operating continuously with but the necessary intermission for repairs, this latter being assumed to require one month per year.

These figures show the great effect which the continuity of the service produces upon the cost of power. It is for the continuous generation of power that the hydro-electric station shows its great superiority while for intermittent and discontinuous service the steam engine will probably be able to compete successfully.

Taking 100 kilogrammetres per second of water power as required to produce a horse power on the motor shaft, the experience of existing plants shows that under favourable conditions a minimum price of 30 francs per horse power per year at the power station may be made. This price must be increased to provide for the cost of transmission, averaging probably about 100 francs per horse-power-year, but necessarily varying according to local conditions.

M. Tavernier rightly emphasises the value to France which may follow the distribution of electric power to the small manufacturers and household workers, as compared with the factory system, a feature which has already been discussed at length in these pages.

Technical Laboratories in Europe.

The importance of the mechanical and technical laboratory as a means of scientific education has already been discussed in these pages by Professor Boulvin, but although the value of such laboratories is unquestioned, it is remarkable that France is sadly lacking in such facilities, both for education and for research. For this latter reason the report of the committee of the Conservatoire des Arts et Métiers upon the great mechanical and testing laboratories of Germany, published in the *Annales* of the Conservatoire demands interested attention, giving, as it does, the impression made by inspection upon outside and disinterested observers.

The principal object of the investigations of the commission was the acquisition of information of service in connection with the proposed establishment of a testing laboratory in connection with the work of the Conservatoire des Arts et Métiers at Paris, and hence the comments made in the report must be received with this ultimate object kept in view.

Naturally the principal point of investigation was the Reichsanstalt at Berlin, and here the commission found much to admire, especially as no analogous institution exists in France. With this were also examined the establishments of the Aichungs-Kommission, the Versuchsanstalt, and the Maschinen-Laboratorium, in other words, the government institutions for research and standardisation at Berlin.

So far as the general research work of the Reichsanstalt is concerned, although the commission examined it with the greatest of interest, aided by the cordial co-operation of the administration, no detailed discussion was required, since its province is beyond the scope of the work of the Conservatoire des Arts et Métiers, either present or projected. The verification of standards of length and weight, also, is considered to belong rather to the Pavilion of the International Bureau at Breteuil, and hence the most important studies for the commission were found in the mechanical and electrical testing laboratories.

Naturally the work of the testing laboratory at Charlottenburg, under the efficient directorship of Professor Martens, comes most nearly to that which it is desired to establish in Paris, and a large portion of the descriptive part of the report is devoted to this institution. The work of this laboratory is so well-known that it is needless to go into a detailed account of it here. In addition to the conduct of a great number of tests by tension, compression, torsion drop, etc., as well as by the action of various tools, there have recently been carried on original researches of an important nature. These latter include investigations upon the strength of steel balls, upon the effect of oxidation upon the strength of steel wire, upon the strength of reinforced rubber tubing, etc. The laboratory has also performed valuable work in calibrating and standardising testing machines intended for use in private establishments and workshops. Much of this work has been for private parties, and the fees received have amounted to nearly as much as the operating expenses of the laboratory, although the receipts are not directly available for the administration of the laboratory, but are turned into the general treasury of the Technische Hochschule, from which the appropriations for maintenance are made.

The mechanical laboratory, founded by Professor Riedler, and now under the direction of Professor Josse, comes in for a share of commendation, and the laboratories of Dresden, Munich, Vienna, and Prague were also visited, and included in the report.

The most interesting portion of the report is that in which the recommendations are made for the establishment of a public testing laboratory in connection with the work of the Conservatoire des Arts et Métiers at Paris. It is suggested that the laboratory be divided into three sections; for the testing of materials, including metallic and non-metallic substances, and for lubricants; for testing the performance and efficiency of machines; and for physical tests, including optical tests and measurements of temperature and pressure. If possible it is considered desirable that the Bureau of Weights and Measures, now at Breteuil, should be incorporated with the latter section, or that in any case there should be a department in the proposed laboratory for the public comparison of standards of length and weight, analogous to that in operation in Berlin. This is justified by the record of the interest which the Conservatoire has always taken in metrology, from 1795, when the provisional adoption of the metric system went into effect, down to 1869, when the International Commission was created.

The report discusses the detailed arrangement of the work of the proposed laboratory at length, recommending an expenditure of 200,000 francs for equipment, and an annual appropriation of 80,000 francs for operation. The question of location, itself most important, is also considered. In the present buildings, formerly the abbey of the Benedictines, there are but limited quarters available, but at the same time it is most desirable that the laboratories shall be within convenient access of the professors and the public. The suggestion is made in the report, that a limited amount of space for the erection of a new structure may be obtained in the courtyard of the old buildings, but this plan is open to the objection that it places restriction upon future growth. It is altogether practicable, however, to place certain of the departments in the present buildings, with an annex situated at a distance, for the bulkier portion of the work, such as the testing of machines.

It is most encouraging to note this interest in the establishment of public testing laboratories in Paris, and there is certainly no institution under whose auspices such work can be more effectively conducted than the Conservatoire des Arts et Métiers. In Great Britain and in the United States bureaus of standards and physical laboratories have recently been undertaken, and the general outlook for the scientific establishment of precise and accurate data for public use is most encouraging.

Flash Boilers.

The demands for light motive power machines for automobile service have resulted in the production of numerous devices, many of them modifications of engines already well-known but little developed, and it is interesting to notice how some of the earlier inventions, originally lacking the demand and the means for their proper development, have since been revived.

Among these may be mentioned the so-called "flash" boiler, for the rapid generation of steam without requiring the use of a large and heavy boiler full of water. In a recent issue of *Glasers Annalen* is given a review by Inspector Max Unger, of the progress and present state of perfection of the Serpollet steam automobile, practically the only steam motor vehicle which has successfully competed with the heavy gasoline and petrol machines in the speed and road trials of Europe.

As is well known, the essential feature of the Serpollet machine is the steam generator, this consisting of various arrangements of coiled tubes of small bore and thick walls, heated to a high temperature by petroleum or alcohol burners or by a coke fire. Into one end of the tube the water is injected by a suitable pump, while steam is drawn off at the other, the water being flashed into steam as it comes into contact with the heated metal. By regulating the supply of water to correspond with the demand for steam the operation may be carried on continuously without the accumulation of any water in the tube. By maintaining a high temperature and providing sufficient heating surface it has been found possible to obtain large volumes of high-pressure steam by this form of generator, and its use has been the main factor in the success of the Serpollet vehicles.

Naturally an important portion of such a generator is that which provides for the regulation of the quantity of water supplied with the volume of steam demanded, and in Herr Unger's paper is given a detailed description of the ingenious devices by which the feed pumps for the water and the liquid fuel are controlled. The engine, also, is ingeniously designed for use with high-pressure steam under the difficult conditions of road service, and the present type of Serpollet machine doubtless unites many of the advantageous points of both steam and gasoline vehicles. The engine resembles a gas engine rather more than it does a steam engine, and the method of generation, avoiding, as it does, the presence of a mass of highly heated water, while delivering what has been called "steam-gas," contributes to the resemblance.

We have thus, in the Serpollet automobile an example of the modern development of an old idea, into the history of which it may be interesting to glance.

As long ago as 1824 this idea of flashing water into steam in a highly heated tube of small section was advocated by Paul, a Swiss engineer, then in London, and it is remarkable to note that he then proposed to use his generator in a mechanically propelled vehicle.

Paul made a generator composed of a coiled tube of three-sixteenths of an inch bore and 150 feet long, and used it to furnish steam for a two horse-power engine. In the same year, 1824, the flash principle was used by an inventor named McCurdy, who employed the feature used in the Serpollet generators by making his tubes, or "chambers" as he called them, with very thick walls, this giving a high degree of strength, and at the same time enabling heat to be stored in the mass of metal to aid in the rapid generation of steam for sudden demands.

Since the time of Paul and McCurdy the

flash method of generating steam has been re-invented many times, but it has not come into practical use until the demand for a light and powerful steam generator for automobile service produced the Serpollet form. This is an excellent illustration of the manner in which a promising idea has fallen still-born when produced before the real demand for it has appeared, and before the period when the constructive methods for its application were sufficiently perfected. It has often been said that great inventions are "epoch-making," but experience has shown that certain epochs are "invention-making." The present period of automobile development has certainly done much to facilitate the production of powerful motors of light weight, and the influence of the effort which has been made in this direction cannot but develop many other applications besides those most closely before the inventors.

Waterways in Europe.

NOTWITHSTANDING the continual increase in railway communication, the superior economy of water transport renders it of increasing importance for certain classes of merchandise, and in fact each method of conveyance creates new demands for greater facilities. These facts are well emphasised by the continual discussion of plans for a system of internal waterways for central Europe and although there has been a determined opposition in certain quarters to the dislocation of commercial arrangements which some of these plans might produce, there is little doubt that ultimately the scheme in some modified form will be executed.

In an exhaustive paper by Alfred Ritter v. Weber-Ebenhof, published in a recent issue of the *Oesterreichische Wochenschrift für den Oeffentlichen Baudienst*, the whole subject of the proposed water communication in central Europe is discussed at length, together with some excellent maps of existing and proposed canals. From this paper we make some abstracts, giving a general idea of the situation.

Naturally any system of internal waterways in Europe includes the canalisation and connection of the important streams which are already the highways for important communication. Thus the watershed of central Europe includes the Rhine, Weser, Elbe, Oder, and Vistula, flowing into the North Sea, and the Po, Adige, Danube, Dneiper, and Dneister, communicating with the Adriatic, Mediterranean, and Black seas, and it requires only a rational system of canals to connect these navigable streams with each other in order to perfect a vast network of internal water communication.

After a review of existing ocean traffic, including the dimensions of important steamships and an account of existing ship canals and harbour accommodations, the present state of internal waterways in the principal countries of central Europe is examined in order to determine how they might best be united in a general international system. A portion of this work is already under construction, as, for example, the Dortmund-Ems canal, which, when completed, will connect the most important industrial centre of Germany with the Prussian port of Emshäfen. The canalisation of the Oder as far as Cosel, is also an important work, affording an outlet to the coal traffic of Silesia. The Elbe-Trave canal, completed in 1900, is another example, this enabling the commerce of the Elbe to be extended to the old Hanse town of Lübeck.

The most important canal scheme of Germany, however, is the much discussed Mittelland-Canal, or system of waterways to unite the navigation of the Rhine with the Weser and the Elbe. This scheme, which includes canalisation work on the rivers as well as the construction of new waterways, has been strongly opposed by the agrarian party and by many landholders because it is assumed to open the way for the importation of foreign grain and foodstuffs. The details of the plan, which cannot be given here, but which are detailed at length in the paper to which reference has been made, involve the expenditure of about 400 million marks. If, with this, the Danube-Moldau-Elbe canal is constructed according to the project of 1893, and also the Danube-Oder Canal, and the proposed connections with the Vistula and the Dneister, we have to add the sum of 600 million kronen (the mark and the krone being about equal to each other, and about the same value as a shilling, makes this total about £50,000,000).

The principal feature of present importance about all this work from a constructive point of view, is the necessity of adopting a standard cross section of waterway, and one which shall be sufficiently large to admit of barges of modern dimensions. A single stretch of contracted section practically limits the capacity of the entire system, and some international agreement upon this vital point is essential.

The commercial importance of a system of waterways which shall provide cheap transport between the vast grain fields of southern Russia and Hungary and the rest of Europe and her seaports can hardly be overestimated. That it would involve rearrangements in agricultural and industrial relations must be admitted, but that these would be for the general and great benefit of the interested nations cannot be denied. The railways, so far from being injured, would be the gainers, since the waterways would handle a traffic which is impossible of profitable rail transport, while the general gain and stimulus to business would add to the volume of general railway traffic. Such a system of waterways would also act to promote such close commercial and industrial relations between the nations most nearly concerned as to render the possibility of war still more remote than it is at the present time, and hasten the time when national differences will necessarily be settled upon a scientific and commercial basis.

Ejector Condensers.

With the increasing demand for better steam economy, especially in connection with central power plants, there has come a general desire to profit by the advantages due to the condensation of the exhaust steam, and consequent maintenance of a vacuum on the exhaust side of the piston. Many large engines are equipped with their own condensers and air pumps, the latter being connected directly with the operative parts of the engines, but in addition there have been put upon the market various combinations of independent condensers, using direct-acting water and air pumps, and these find ready sale.

A few years after the invention of the injector by Giffard, Mr. Alexander Morton, of Glasgow, conceived the idea of applying the same principle to the condensation of steam, utilising the energy of the steam and water to remove the whole of the products, including the entrained air. Although such "ejector-condensers" have found a limited application since that time, their true value has not been fully appreciated, nor has their theoretical action been fully investigated experimentally until very recently. From a paper in a recent issue of the *Revue de Mécanique,* however, by M. A. Rateau, well known for his extensive studies in all kinds of jet apparatus, we abstract some interesting information concerning this important apparatus.

Broadly described, an ejector-condenser is a device in which the exhaust steam is delivered into an annular space surrounding a vein of water. Such an ejector-condenser consists of three essential parts: the converging nozzles by which the steam and water arrive; the mixing tube, in which the steam is condensed by contact with the water; and the diverging diffuser, in which the resultant current issuing from the mixing tube has its velocity retarded and partially transformed into useful pressure.

M. Rateau proceeds to examine the mathematical theory of the ejector-condenser, showing that the principle is that of the utilisation of the head due to the velocity with which the steam and water enter the apparatus, and deduces mathematical formulas from which the sufficiency of this velocity to maintain a good vacuum is demonstrated. Even when the condensing water is delivered to the condenser without head and the discharge has no fall this velocity is more than sufficient to produce a good vacuum, but the presence of air in the steam and water, and the desirability of maintaining the steady action of the apparatus for varying discharges of steam render it preferable that a certain amount of head be furnished if possible.

Theoretically, if the head due to the velocity is greater than that supported by a vacuum, the apparatus will operate in a satisfactory manner. If, however, the engine, for any cause, discharges less than the assumed volume of exhaust steam, this velocity will be diminished. In order to provide for the regular action of the apparatus under such conditions various modifications may be employed. Thus an auxiliary jet of live steam may be used to aid in maintaining the velocity, but this is obviously wasteful, and only to be used in emergencies. Again, the cross-section of the steam nozzle may be reduced, and the velocity correspondingly increased, but the range of regulation by this method is evidently limited. A third method, as already intimated, is to deliver the condensing water with a sufficient head to insure operation, even with but a partial supply of steam, and this may be replaced, or preferably, supplemented by providing such a fall to the discharge, in the form of a draft tube, to aid in maintaining the velocity.

M. Rateau shows that with a properly proportioned apparatus, a head of water equivalent to about 6 metres is sufficient to maintain a vacuum, even when there is no discharge of steam at all, and if it were not for the entrained air this head might be reduced to 4 metres. It is the influence of the air which modifies the action of the apparatus very materially, and this feature is investigated very thoroughly in the paper. The presence of a comparatively small proportion of air suffices to affect the vacuum very materially, and it is most desirable that sufficient head should be provided to take care of the maximum amount of entrained air.

Apart from the above considerations, the most important condition of effective operation is naturally found in the elevation of the temperature of the condensing water. It is the mixture of the steam and water which effects the condensation upon which the action of the apparatus depends. The condensation takes place with great rapidity, since, in a condenser of medium dimensions, the steam and water are in contact but about the fiftieth part of a second in the mixing tube. According to the experiments of M. Rateau, there appears to be no effect upon the elevation in temperature of the condensing water by any change in the temperature of the entering steam, the effect being produced by the volume of steam to be condensed.

The paper contains a description of a modified form of Morton condenser, devised by M. Rateau, and gives the data and results of exhaustive experimental tests which he has made, and upon which his formulas and computations are based. With a head of 6 metres upon the condensing water, there appeared to be little difficulty in maintaining a vacuum of 700 millimetres of mercury with the barometer at 760 mm., this corresponding to about 13.5 pounds per square inch.

Ejector condensers appear to be especially applicable to installations of steam turbines where the high rotative velocity renders it difficult to instal direct-connected air pumps.

In cases where there is not room for a satisfactory head of water, a good arrangement is that in which the discharge is delivered into a well which latter is drained by a centrifugal pump, such an installation being much simpler than the old type of air-pump condenser, and equally effective in maintaining a good vacuum.

The Voltaic Arc.

There are few phenomena more interesting than those connected with the passage of electric currents. Thus, a wire, otherwise inert, becomes heated or even fused by the heat produced by the current; again, the mere passage of a current through a wire coiled about a piece of iron renders the latter magnetic; also, the flow of a current through a wire deflects a magnetic needle in the vicinity; these and many other phenomena have formed, and will continue to form subjects for research, study and extension.

Even more interesting than the effects of the passage of currents through solid conductors are those observed when the action takes place through gaseous substances. Here the great variability of the conditions introduces phenomena so varied and curious as to render them worthy of special study. This branch of the question, the study of the voltaic arc, forms the subject of a paper by Professor Paul Janet, in a recent issue of the *Revue Generale des Sciences,* from which we make some abstracts.

At one time such a study would have been thought of interest only to the student, and physicist, but now the electric arc is an important feature in various industries, notably in the electric furnace in the production of the metallic carbides as well as of carborundum and carbon. Another, and more recent application has been found in the method of fixing atmospheric nitrogen, discussed elsewhere in this issue.

Defining the voltaic arc as the passage of an electric current through a gaseous substance at the ordinary pressure, Professor Janet reviews the various forms which have been studied since the first production of the arc between carbon points by Sir Humphrey Davy in the year 1800. The most apparent characteristics then and since are the high temperature and the brilliant light produced, but these are so well known that the present paper proceeds at once to phenomena which have been called secondary, rather because they have been more recently observed, than for any lack of importance.

In order that the current may pass through a gas, it is necessary that the temperature should be raised sufficiently high to make it a conductor; this may be done by bringing the terminals into temporary contact, or by producing a high voltage discharge as from a Leyden jar, between the carbons, either action being to raise the temperature of the air sufficiently high to render it a conductor.

In some modern applications the solid carbons have been replaced by cores of more porous carbon, charged with certain salts, generally silicate of potassium, the result being the production of vapours which mingle with the arc, permitting it to be maintained with lower voltages than would otherwise be possible. This arrangement also permits much longer arcs to be produced, a matter of some importance in electric smelting where the material is fed through the space between the carbons.

Professor Janet examines some of the peculiarities of arcs between other terminals than those of carbon, and proceeds to discuss especially the behaviour of arcs produced by alternating currents. In the case of alternating currents, the direction of flow is reversed rapidly, generally 40 to 50 times per second, and as a consequence the arc must be extinguished and re-established as frequently. This is only possible by reason of the presence of the heated vapour, which persists long enough to re-establish the arc, and with metallic terminals it is practically impossible to maintain an arc with an alternating current. When one terminal is metallic and the other a carbon it has been found that the current passes more readily from the metal to the carbon than from the carbon to the metal, a curious property discovered in 1882 by Jamin and Maneuvrier. In consequence there is an excess of interrupted current, so to speak, passing in one direction, so that a continuous-current motor placed in the circuit will be operated, although the alternating current supplied is entirely incapable of driving it.

Among the most interesting properties of the electric arc are those which may be termed acoustic, since they relate to the production of musical and articulate sounds.

The so-called "singing arc," discovered by Mr. Duddell, is a most curious application of the theory of electric oscillations. In this apparatus there is an auxiliary circuit connecting the upper and lower carbons of an arc, there being a condenser and a resistance coil inserted in this circuit. When a proper adjustment is made between the condenser and the resistance with regard to the length of the arc, the latter is found to emit a musical note, corresponding to the period of the electric vibrations in the circuit, this varying from 1,000 to 10,000 per second. Apart from the curious effects which may thus be produced, we have in this arrangement a means of obtaining quantitative data about currents of high frequency with a precision heretofore unattainable.

These results of Mr. Duddell's are in a similar field to the interesting investigations of Dr. Simon, who has succeeded in causing the electric arc to transmit articulate sounds. This interesting experiment is based upon the variations in the arc which follow the production of sounds in its vicinity. An auxiliary circuit, similar to that employed by Mr. Duddell, but including a battery as well as a condenser, and also a microphone, can be so arranged as to reproduce in the arc articulate sounds uttered in the vicinity of the microphone. This action is explained by the minute variations in temperature produced in the gaseous envelope of the arc by the currents of the microphone. A reverse arrangement has also been devised, in which the arc is employed as a transmitter, the sounds being emitted by a telephone receiver.

Professor Janet refers to the selenium receiver, already described in these columns, by means of which the variations in the electric arc may be photographed and used in a form of cinematograph for subsequent reproduction of the sounds, and while considering these devices as possessing at present but a curious interest he believes that all these phenomena may lead to practical results of value in the approaching future.

The Fixation of Atmospheric Nitrogen.

In his Presidential address, delivered before the British Association at its Bristol meeting, several years ago, and reviewed at the time in these columns, Sir William Crookes discussed in a most interesting manner the probable duration of the world's supply of foodstuffs. At that time he realized that natural methods might ultimately become inadequate to supply the needs of the world's growing population, and showed that recourse would be had to the work of the chemist. He then said: "Before we are in the grip of actual dearth, the chemist will step in and postpone the day of famine to so distant a period that we, and our sons and grandsons may legitimately live without undue solicitude for the future." The immediate method which he then predicted for the prolongation of the agricultural vitality of the soil lay in the discovery of some method of the fixation of atmospheric nitrogen, and the consequent regeneration of the soil by an inexhaustible artificial fertiliser.

Since then the attempt has been made to extend the laboratory experiments made by Priestley, more than a hundred years ago, and the result is the work of the Atmospheric Products Company, of which a discussion is given in a recent issue of the *Electrical World and Engineer.*

The early experiments of Priestley showed that when an electric spark was discharged through air a chemical change was produced. This change included the closer union of the oxygen atoms, producing ozone, while at the same time there was caused a union of oxygen and nitrogen, forming minute amounts of nitric oxide and nitrogen peroxide.

No systematic investigation of this subject appears to have been made until 1899, when Mr. C. S. Bradley and Mr. B. R. Lovejoy took up the problem, but these two investigators undertook the application of modern electrical machinery to the question of the production of the oxides of nitrogen on a commercial scale.

Broadly, the method consists in the passage of large quantities of air through a confined space in which powerful electric arcs are maintained. A static spark is found to be not very efficient, but experiments with alternating and direct-current arcs of different voltages have demonstrated that the best results are obtained with high-voltage direct-current arcs. It has been found best to use a pressure of about 10,000 volts, and allow it to jump electrostatically through the air for a short distance, thereby establishing the arc, and then rapidly separating the contacts until the arc breaks.

In order to produce these effects on a commercial scale, Mr. Bradley has modified a large direct-current series arc machine by a rearrangement of its circuits, and has connected this with a special device for producing the arcs in the air chamber. This arc device consists of a case containing fixed projections, within which is a revolving cylinder carrying projections, approaching the fixed ones very closely. By revolving the cylinder about 500 turns a minute, more than 400,000 arcs per minute are formed, and as the air is driven through at the rate of five cubic feet per arc per hour it will be seen that the apparatus is of considerable capacity.

The air emerges charged with about 2½ per cent. of oxides of nitrogen, and by passing it through absorption towers, nitric and nitrous acids are formed, the latter being ultimately converted into nitric acid, from which saltpetre or nitrate of soda may readily be made by contact with caustic potash or caustic soda.

The commercial importance of this process naturally depends upon the operative costs, and these again are controlled by the cost of electrical energy, but admitting that the nitrates can be produced at prices at all comparable with the natural deposits, it can be seen that the process is one of great industrial importance.

Over one million tons of nitric acid are manufactured every year by treating natural nitrates with sulphuric acid, hence this field alone is one of great magnitude. Nitrogen compounds have heretofore been produced only by utilizing the fixed nitrogen as found in combination in nature. Thus nitrogen in combination is taken from the earth in the form of Chili saltpetre and distilled with sulphuric acid. The nitric acid thus formed disappears in the arts and is made practically unrecoverable as a fixed nitrogen compound. This means that we are continually taking from the earth a most important compound which is limited in supply. Upon the fixed nitrates vegetation of all kinds depends, and several scientists, including Sir William Crookes, as above noted, have stated that very shortly nature will cease to honor these drafts upon her resources. It is estimated that twelve million tons a year of fixed nitrates will be required to bring the wheat crop of 1930 up to the amount required. It is therefore most gratifying to see that there is a prospect that we may be able to draw upon nature's reserve supply of nitrogen in the atmosphere to meet the impending deficiency.

Superheated Steam for Turbines.

We have already referred in these columns to the peculiar adaptability of the steam turbine for use with superheated steam, and now we note an interesting report of a test made of a De Laval turbine using saturated and superheated steam, showing very well the advantages of superheating.

The test, which was made by Messrs. Dean and Main, and published in a recent issue of the *Engineering Record*, was made upon a turbine of 300 brake horse power, the turbine being used in driving the new works of the De Laval Company at Trenton, N. J.

Testing a steam turbine is not practicable according to the precise lines generally adopted for reciprocating engines, and special methods must be adopted. In the first place no method of indicating being possible, it is necessary to use brake horse power in all power determinations. It is also impracticable to measure the precise amount of steam consumed except by conducting at the same time a test of boiler evaporation, or else by condensing and weighing the whole of the exhaust steam. The latter method is much to be preferred, as it gives a full account of all the steam which has passed through the engine, without the necessity for making any deductions or corrections. Unfortunately this was not practicable in the test under consideration, since a Worthington jet condenser was employed, and the condensed steam and condensing water were discharged together. The steam consumption was therefore measured by weighing the boiler feed water, and thus introducing the necessity for several corrections. In this case the comparisons of the hourly rates of evaporation in the various tests showed such a degree of uniformity that the tests possess greater value than would otherwise be considered, and in any case they afford an interesting comparative study of the operation of the same machinery under the desired conditions.

The boiler pressure was about 200 pounds per square inch, and when testing with saturated steam the entrained water was removed by a separator and deducted from the evaporation to determine the true volume of steam going to the turbine. For the superheating trials the steam was raised to about 84°F. above the temperature due to the pressure, this superheating being effected by a Babcock & Wilcox superheater used in connection with the boiler.

Since the electrical generators were connected directly with the turbine, the power developed was readily determined by measurement of the current. By a careful preliminary determination the efficiencies of the generators were measured, and corresponding corrections in the results made, while the electrical instruments were also fully tested and calibrated immediately before use.

The data and results of the tests are fully tabulated in the report and can only be given here in general. At full load, ranging from 333 to 352 brake horse power, the steam consumption for saturated steam was 15.17 pounds per horse power, while with steam superheated 84°F., the consumption was reduced to 13.94 pounds, a saving of 8.8 per cent. This is an excellent showing for the moderate degree of superheating employed, and shows that even with an engine of the moderate power used in this case a very material advantage results. With superheating of 200 degrees or more, as has been successfully employed by Schmidt in a special design of reciprocating engine, the steam consumption should be brought down very close to the record for engines of the piston type.

The greatest objection which has been made to superheating has been the injurious action of high temperatures upon the working surfaces, especially by carbonizing the lubricant and inducing cutting of the cylinders and valve faces. Another difficulty has been found in the distortion of parts by unequal heating by reason of the distribution of the masses of metal. Thus, Corliss valves has been found unsuitable for use with highly superheated steam, the warping of the valve seats causing leaks and excessive wear, and lift valves have been found necessary.

With the turbine these difficulties disappear. There are no rubbing surfaces to become scored, and no lubricant to be carbonized. The wheel and nozzles are readily heated to a uniform degree by the steam, so that unequal expansion is avoided, while the absence of rubbing surfaces again renders this objection of no moment. Apparently the principal difficulty in the application of highly superheated steam to the steam turbine rests rather with the superheating device than with the motor. High superheating is hard on the superheater, and when the latter forms a portion of the boiler care must be taken that the apparatus does not become dangerous. It is not impossible that there may be a return to the independently-fired superheater, where the degree of superheat can be regulated with little difficulty, and where the possibility of interfering with the action of the boiler is eliminated. In any case the turbine offers advantages for the use of superheated steam which cannot be found in any form of reciprocating engine, and this is not the least valuable of its features.

Practical Cement Testing.

THE importance of a systematic testing of materials used in important structures has often been discussed, and we take satisfaction in calling attention to the manner in which the materials used in the new power station of the Manhattan Railway Company have been examined during the progress of its construction. From a paper by Mr. Thomas S. Clark, the resident engineer in charge of construction published in a recent issue of *Engineering News* we abstract some account of the manner in which this important work has been done.

Mr. Clark's paper relates entirely to the testing of the cement, mortar, and concrete used in the masonry and floors of this important structure. Recognizing the importance of good work in such an important building, the company has maintained a field laboratory on the site, in which all cement was tested before being used, and during the twelve months that concrete construction was being carried on, more than 3,500 briquettes were made and broken. Apart from the immediate value of the results to the company, the work forms an excellent contribution to the general knowledge of materials of construction, and as such the publication of the results is to be commended.

Apart from the immediate determination of the strength of the materials in actual use, Mr. Clark's paper brings out the following points of interest and value:

So far as the common practice of retempering cement mortar is concerned, this receives unqualified condemnation, and the records fully bear out this opinion. Rosendale cement mortar, retempered after 60 minutes, showed a reduction to one-third to one-sixth of its original tensile strength. The tests are indisputable on this point, and it is shown that the same disastrous results were obtained even when the cement was moistened every 15 minutes. Similar results were shown with Portland cements, except that a longer time was required for the injurious effect to manifest itself. While 60 minutes was sufficient to show this action for Rosendale cement it required about two hours for Portland cement to show the effect, but the safest rule is undoubtedly to allow no retempering under any circumstances.

In making tests the method of moulding the briquette is to be considered. The idea that hard packing in the mould gives the highest result is contradicted, it appearing that the hard packing diminishes the proportion of water, thus actually reducing the strength and giving irregular results. This effect appears more especially in the longer tests, the first set being of a different nature than the ultimate process of hardening.

In regard to the strength of concrete, much emphasis is laid upon the selection of the stone. In the case of the power-house work under consideration the stone came from the excavations on the site, and by the selection of sharp clean stone, containing a minimum of mica, an excellent concrete was obtained. When the rejected stone was used in certain test cases, it appeared that the crushing strength of the concrete was only about half as great as that made with the selected stone. It is an interesting fact that when beams of concrete were tested, the modulus of rupture of cross breaking was about 1½ times greater than the strength in direct tension. The fracture in beams often showed the plane of rupture passed directly through the stones of the aggregate, so that the strength of the stone was largely a factor of the strength of the beam.

It is often the practice to demand high strength in a short time and a common rule is to specify tensile strengths for 24 hours, for 7 days, and for 28 days. These requirements can be met by the use of a sulphate, but it is found in practice that cements which show high results in short times invariably lose strength after the second month. The adulteration seems to exhilarate the first process of set, but when the second action of hardening takes place, the cement loses the strength attained at first, and settles back to the strength which it would probably have shown had the adulteration not been added.

Experiments which were made with cement briquettes with imbedded wires showed some interesting results, mainly as to the adhesion of the cement to the wires, but as these tests were made under direct tension only they are not of much practical service. The real value of metallic reinforcement in cement and concrete structures lies in the possibility of combining the tensile strength of the metal with the crushing resistance of the concrete. Tests for this purpose should be made with beams containing imbedded metal on the tension side, the proportions being so made that the elastic limit of the metal in tension should be reached at the same time as that of the concrete in compression, and any tests in which both materials are subjected to tension fails to reproduce the actual conditions of service.

Apart from the interesting results shown by Mr. Clark's paper it is interesting and gratifying to observe that in this important work the materials were tested on the ground by the engineers by whom they were to be used. It is too common a practice to specify materials by brand, by maker's name, or by nominal compliance with a previously prepared specification. If the dealers understand that all materials are to be subjected to a strict series of tests upon delivery, and that failure to meet the tests would be sufficient cause for rejection, regardless of the brand or of other considerations, the standard of materials would be maintained at a far higher point than could otherwise be possible, and it is to be hoped that this practice of rigid acceptance tests will become more general than has hitherto been the case.

Electric and Hydraulic Analogies.

In view of the fact that many phenomena in connection with electricity are somewhat difficult of comprehension to those not trained in the fundamental conceptions, there have been various attempts to devise mechanical or other analogies which shall make the relations intelligible. A very interesting paper was presented by Professor Henry T. Eddy at the Pittsburg meeting of the American Association for the Advancement of Science, setting forth the manner in which nearly all the phenomena of continuous, alternating, and variable electric currents may be shown to have corresponding hydrodynamic analogies.

The similarity between a steady flow of water in a long pipe under the action of a constant head and the behaviour of a continuous current of electricity under a constant pressure, has long been perceived, but Professor Eddy has extended the analogy much farther.

As he clearly shows, all the complicated phenomena of long-distance electric power transmission, by any combination of land lines and cables, with their sending and receiving apparatus may be completely reproduced in all its details of operation by simple pumping machinery with its transmission pipes and air chambers, whose manner of operation may be made clear to any one without the aid of higher analysis.

Thus taking the case of a double acting pump as corresponding to an alternating generator, it may be supposed to operate a hydraulic motor of the piston type at a distance, the pressure being transmitted through pipes. Making these pipes of elastic hose, we have a set of analogies. The friction of the water in the hose corresponds to the resistance of the wires to the passage of the electric current, the inertia of the water represents inductance, and the elasticity of the hose to capacity. This relation may be pushed still further, and used to investigate other phenomena. Thus, by increasing the effect of the elasticity of the hose by the introduction of air chambers along the line a wave of pressure may be passed along the line and at the same velocity a wave current will pass, having its maximum flow at points where certain high-pressure air chambers are discharging into those next along the line. By these progressive pressure and current waves, energy will be transmitted to the motor cylinder. which need not be of the same cubic contents as that of the generator pump.

Several complete waves may be in progress of transmission along the pipe at once. The frequency of oscillation in the motor cylinder will be equal to that of the generator pump to an amount which may be completed in any given case, but it will lag in phase behind that of the force pump to an amount due to the number of waves and fractions thereof in progress of transmission along the line.

It is also easy to see how, when the second, or motor cylinder is running idle it will originate transmission waves similar to those of the original generator cylinder, but in the opposite direction. The resultant of these equal and opposite progressive waves will be a system of stationary waves along the line. We have thus analogies for practically all the phenomena of alternating electric transmission.

Similar analogies may be found for variable waves, as in telephony. Here the distortion of the waves of different pitch gives an analogy to the distortion of sound in long-distance telephone transmission.

The utility of such analogies as those suggested by Professor Eddy has been questioned, it being maintained that each series of phenomena should stand upon their own foundation, and not explained by reference to some other basis. This is doubtless correct theoretically, but at the same time it is by analogy that we obtain a great part of our knowledge, and indeed it forms the fundamental manner in which our first impressions are broadened and developed into a capacity for further extension.

The method of analogy, used with care and judgment, and not confounded with identity, may be made a valuable feature in technical training, care being taken to pass from the analogy to the fact as the grasp of the student's mind will permit. For this purpose the analogies suggested by Professor Eddy should be most useful in the preliminary training in electricity which should form a portion of every educational course of the present day, and his paper is in this respect eminently valuable.

The Essentials of Technical Education.

We have referred many times in these columns to the importance of correct methods in technical training, but the subject is one which can hardly be discussed too much.

In a valuable paper in a recent issue of the *Popular Science Monthly*, Dr. David Starr Jordan writes of university building, and although he naturally treats the subject in a general manner, yet he makes some points bearing strongly upon engineering and scientific education. After examining the functions of educational institutions which cover the ground of general culture and of professional training, Dr. Jordan proceeds to consider the crowning function of a university, that of original research.

"On this rests the advance of civilization. From the application of scientific knowledge most of the successes of the nineteenth century have arisen. It is the first era of science. Behind the application of such knowledge rests the acquisition of it. One Helmholtz, the investigator, is the parent of a thousand Edisons, the adapters of the knowledge gained by others. The great function of the German university is that of instruction through investigation. The student begins his work on a narrow space at the outer rim of knowledge. It is his duty to carry the solid ground a little farther, to drive back ever so little it may be the darkness of ignorance and mystery. The real university is a school of research. That we possess the university spirit is our only excuse that we adopt the university name. A true university is not a collection of colleges. It is not a college with an outer fringe of professional schools. It is not a cluster of professional schools. It is the association of scholars. It is the institution from which in every direction blazes the light of original research. Its choicest product is 'that fanaticism for veracity' as Huxley calls it, that love for truth, without which man is but the toy of the elements. Its spirit is the desire 'to know things as they really are' which is the necessary attribute of 'him that overcometh.' No institution can be college, professional school and university all in one and exercise all these functions fully in the four years which form the traditional college course. To attempt it is to fail in one way or another. We do attempt it and we do fail. In the engineering courses of to-day we try to combine in four years professional training with research and culture. This can not be done, for while the professional work is reasonably complete, culture is at a minimum and research crowded to the wall. The subject of law requires three solid years for professional training alone. Three or four culture years go with this and are surely none too many. The same requirement must soon be made in engineering. We can not make an engineer in four years if we do anything else for him, and there are very many things besides engineering which go to the making of a real engineer."

It is this necessity for a greater proportion of general training which has led to the present opposition to too high a degree of specialization, concerning which reference was made last month in these columns. The engineer, of all men, should be an individual of broad general culture, since, from the very nature of his profession and because of its constantly increasing scope in all departments of life. This basic culture must largely be given before the university is entered, and here is the weak point of much of our present day training. Students come to the university before they know how to study, and much of the time is spent in acquiring that systematic habit of work which they should have brought with them.

It is true that we cannot make a man an engineer and also a man of broad general culture in four years, but this we can do.

"We can show the student the line of his professional advancement and can see him well started in its direction before he has taken his first degree. We can give in the college course something of the methods and results of advanced research. In any subject the advanced work has a higher culture value than elementary work. Thorough study of one subject is more helpful than superficial knowledge of half a dozen. To know one thing well is in Agassiz's words 'to have the backbone of culture.' By limiting the range of individual training to a few things done thoroughly it is possible to give even to the undergraduate some touch of real university method, some knowledge of how truth is won. To accomplish this is one vital part of the university's duty. It welds together the three functions of a university, and in so doing it will give the American university its most characteristic feature."

The Manufacture of Pig Iron.

In a very interesting paper presented before the Engineer's Club of Philadelphia, and published in the *Proceedings* of the club, Mr. John Birkinbine reviewed the development of the iron manufacture in America, showing how the progress of the trade has been affected by the development of the American blast furnace.

The fact that America is a young country prevents her from having many historical associations which belong to older nations, but in the evolution of the blast furnace the whole period of development has been sufficiently recent everywhere to permit her to start on practically equal terms with European nations. Passing over the early attempts to make pig iron in New England from 1645 to 1675 Mr. Birkinbine shows that the first blast furnace in Pennsylvania, now pre-eminently the largest producer of iron, was built in 1720, and that the Cornwall furnace, built in 1740 is even yet standing.

The accounts of the old stone stack furnaces, not more than 30 feet high and 9 feet internal diameter, with their bellows, or blowing "tubs" driven by water power, seem very primitive beside the mammoth furnaces of the beginning of the twentieth century. Charcoal fuel, and cold blast of low pressure, limited the output of these old furnaces, but with the introduction of anthracite fuel, about 1840, followed immediately by the use of coke, higher furnaces and heavier burdens became possible, and the product increased rapidly.

In 1850 the average output of anthracite furnaces was 200 tons per week, and but little progress was made in this respect until the time of the Centennial exhibition of 1876. By that time managers began to realize that a knowledge of the chemistry of furnace operation was of material advantage in practical work, and from the record of furnaces and performance which has been kept since 1873 some idea of the progress since that date may be gathered. At the present time there is made eight times as much iron from fewer furnaces than in 1873. Up to 1880 the output of a single furnace of 100 tons per day was considered phenomenal; to-day there are a number of stacks producing 400 to 500 tons per day, and from at least two furnaces 800 tons per day have been obtained on a spurt.

Apart from the improvements which have been made in the furnace proper, much has been accomplished by the auxiliary apparatus.

The early hot-blast devices, constructed of pipes, has been followed by the immense regenerative stoves, many of these being larger than the furnaces themselves of fifty years ago. Water cooled boshes form characteristic features in modern furnaces, and the importance of the water supply for this purpose will be seen when it is stated that measurements by Venturi meter show a consumption of three to four million gallons of water per day for each furnace.

Blowing engines supply more than 50,000 cubic feet of air per minute, instead of the 500 to 1,000 cubic feet of the old tubs, and air pressures of 15 to 25 pounds per square inch are now common.

Much of the progress of the Pennsylvania iron furnaces has been due to the development of enormous iron ore deposits. The old banks in various parts of the state are still worked, but probably three-fourths of the ore mined in the United States comes from the Lake Superior region, and much of it is shipped 1,200 miles to the furnaces. Although the cost of acquiring property and of stripping off the surface soil is great, the cost of mining and handling has been reduced by mechanical appliances to a stage of economy which makes this long transport commercially practicable.

The great product of these large furnaces has hastened the development of pig iron casting machines, this permitting practically continuous operation, and avoiding the old work of the sand bed, which otherwise limited production.

Naturally a factor in the development of the iron trade has been the great masses of capital available by reason of the formation of great corporations. Nevertheless Mr. Birkinbine believes there is a future for individual manufacturers.

"The iron industry has passed very largely from individual ownership to partnership and corporate control. It is now going very largely into combinations. But while an individual firm may be at a disadvantage in controlling its ore and fuel supplies and competing with larger plants, it is not intended to indicate that those who are interested in individual furnaces have little encouragement.

There are possible economies in handling large quantities, and it takes as much skill and knowledge to operate a small plant as a large one. But there is a future for a number of moderate sized blast furnaces, if, as far as practicable, labor-saving devices are used and the practice keeps abreast of the times.

Applications of Telpherage.

The use of that form of aerial electrical transportation named telpherage by Professor Fleemin Jenkin many years ago, has been delayed by many considerations, but it is now becoming of manifest importance, and a paper by Mr. Charles M. Clark, presented before the Civil Engineers' Club of Cleveland, and published in the *Journal of the Association of Engineering Societies,* gives some interesting examples of recent practice.

The early installations were attempted before the modern development of electrical appliances, and necessarily involved the use of separate generating stations, but now, when nearly every manufacturing establishment has its dynamo, and when electric driving is considered on every side, the introduction of one more piece of apparatus to be operated by electricity calls for little notice in that respect.

The modern telpher installation is really a small overhead trolley line, the car running either on a light rail or on a cableway, there being one or two conductors overhead through which the current is transmitted. Since no operator is carried, the car must be controlled from without, and this requirement calls for some ingenious arrangements. Thus, when it is necessary for the telpher to pass a curve or to be slowed up for any purpose, a resistance is inserted in the trolley circuit, whereby the telpher automatically reduces its speed. As soon as it reaches the other side of the curve it receives full voltage and continues its normal speed. In regular service the speeds vary from 300 to 800 feet per minute up to 20 miles per hour. The slower speeds are used when the lines are short and where there are many curves, as in manufacturing establishments, while across country the high speeds are practicable.

Mr. Clark gives a table showing the speeds and capacities of various constructions, and these reveal the great usefulness of the system. As he says, it is somewhat in the nature of a revelation to find that to carry half a ton on a level track at a speed of six miles an hour requires much less than a horse power, including all losses. As a matter of fact, the actual power consumed, at six miles per hour, for 1,000 pounds on a level, is only 0.16 horse power. This economy is partly due to the fact that the motors are attached directly to the driving wheels, and the absence of gearing gives a high efficiency as well as freedom from noise. Naturally the resistance increases rapidly with grades, and when this reaches certain limits it is found advisable to introduce gearing in order to reduce the weight of the motors.

The cost of maintenance of a telpher line can, of course only be determined after a long trial, but from present experience it must be very low. After running for a year and a half there has been no appreciable wear shown on the driving wheels, and similar wheels have stood good service for 10 years on overhead cableways.

One of the most important features of the system is its great capacity. In this respect there is no form of conveyor which shows such flexibility. Practically the same conditions apply here as on electric street railways, with the additional feature of the possession of a clear line. The capacity of the line is dependent upon two factors: first, the speed, and second, the number of telphers and trailers. The line may be originated with but one telpher and a few trailers. More telphers and trailers may be added, and if necessary coupled up in long trains. If it is desired still further to increase the capacity the line may be made double, while the carriers may be made continuous, so as to take boxes, barrels, or other freight as fast as delivered. As a practical example of the capacity of the system, it may be noted that a plant about to be installed, has a capacity of 250 tons per hour, over a distance of one-half a mile, the material to be distributed over an area of about an acre. In this respect the telpher system stands in nearly the same position for merchandise as the travelling sidewalk does for personal transportation. The closer analogy to the latter is doubtless the belt conveyor, but when operated at its maximum capacity the telpher has practically as great a capacity over much greater range.

While long-distance transmission over country was at first considered the principal field for telpherage, it is finding its most extensive applications in manufacturing establishments. In these days of consolidations of companies, factories cover immense areas, and telpher lines are available both within large buildings and also between the various structures themselves. Probably no element is more costly in manufacturing than the employment of human strength to the handling of materials. Telpherage employs machinery to do the work of men at a minimum of cost with a maximum of speed and efficiency. Modern intensified production has produced greatly increased demand for prompt handling of materials, owing to the greater output of machines and men, and it is in this field that telpherage will be found an essential auxiliary.

THE ENGINEERING INDEX

"THE ENGINEERING INDEX IS THE KEYSTONE OF APPLIED SCIENCE"

The following pages form a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world,—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

We supply the articles themselves, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

CIVIL ENGINEERING

BRIDGES.

Bascule.

A Trunnion Bascule Bridge. Brief illustrated description of the Clybourn Place bridge in Chicago. 500 w. R R Gaz—July 11, 1902. No. 49356.

The Grand Avenue Bascule Bridge, Milwaukee. Illustrates and describes a structure with pivoted bascules operated by electric motors. 2500 w. Eng Rec—July 12, 1902. No. 49321.

Brooklyn Bridge.

A New Plan for Improving the New York Terminal of the Brooklyn Bridge. Editorial discussing the plan of Mr. William Barclay Parsons, and reviewing the plans proposed during the last year. 2500 w. Eng News—July 10, 1902. No. 49386.

Parsons' Solution of Brooklyn Bridge Problem. Gives details of the plan proposed for the relief of the present crush, and for providing adequate facilities for transportation. Plan. 2800 w. St Ry Jour —July 12, 1902. No. 49380 D.

The Manhattan Terminal of the Brooklyn Bridge. Editorial discussion of the plan of William Barclay Parsons for the improvement of the Manhattan terminal and relief of congested traffic. 3000 w. R R Gaz—July 4, 1902. No. 49277.

Budapest.

The Schwurplatz Bridge over the Danube at Budapest (Die Schwurplatz-Doaubrücke in Budapest). Alois Meissner. A brief account of the progress of work on this large ornamental chain bridge, with illustrations. 400 w. Oesterr Wochenschr f d Oeffent Baudienst—June 7, 1902. No. 49431 B.

Cantilever.

The Ohio River Bridge at Marietta, Ohio. An illustrated description of a cantilever highway bridge of peculiar design about to be built. It consists of 5 spans, two separate truss spans, and three which form a cantilever, and a viaduct approach between abutments; also a graded approach to the street level. 2000 w. R R Gaz—July 11, 1902. No. 49355.

Construction.

Recent Progress in American Bridge Construction. Prof. Henry S. Jacoby. Pittsburg address before the Am. Assn. for the Adv. of Science. A review of recent construction, and the problems that have been solved. 4800 w. Sci Am Sup—July 19, 1902. No. 49575.

East River Bridge.

Making the Cables on the New East River Bridge, New York. An illustrated description of the method of building these cables which are the largest suspension cables in the world. 1600 w. Sci Am—July 26, 1902. No. 49679.

Girders.

On Permissible Unit Stresses in Railway Girders. James R. Bell. Read before the Civil & Mech. Engrs. Soc. An examination of certain unit stress sliding scales, commending one on the score of its facility of application. 1600 w. Prac Engr—July 4, 1902. Serial. 1st part. No. 49343 A.

Luxemburg.

The Luxemburg Stone Arch (Die Neue Brücke über die Petrusse in Luxemburg). An illustrated description of the greatest stone arch in the world, 275-foot span, connecting the inner city of Luxemburg with the railroad station in a suburb. 1500 w. Schweiz Bauzeitung—June 28, 1902. No. 49472 B.

Metal Bridges.

Metal Bridges (Les Ponts Métalliques). Paul Résal. A general review of the history, the present state and the future of bridges in iron and steel. 7500 w. Rev Gén des Sciences—June 15, 1902. No. 49495 D.

Moving Loads.

Experiments on Railway and Road Bridges. An account of some interesting and instructive experiments made by M. Rabut, to ascertain the results attending the transit of traffic over bridges, with respect to vibration and shock. 1200 w. Engr, Lond—July 11, 1902. No. 49372 A.

Ottawa.

The Royal Alexander Bridge at Ottawa. H. D. Bush. Illustrated description of the bridge and its construction. 4200 w. R R Gaz—July 18, 1902. No. 49610.

Removal.

Moving a Long Railroad Bridge at New Brunswick, N. J. Illustrates and describes the method of moving a 6-span, 900 ft. steel bridge 14½ ft. to one side, with a total interruption to traffic of only 15 minutes. 2000 w. Eng Rec—July 5, 1902. No. 49194.

Renewal.

An Important Bridge Renewal. Illustrated description of an important piece of bridge replacement work in progress at La Crosse, Wis., over the channels of the Mississippi and Black rivers. 1600 w. Ry Age—July 11, 1902. No. 49516.

Rolling Bridge.

The Westchester Avenue Rolling Bridge. New York. Brief illustrated description of a new bridge over the Bronx River. 1700 w. Eng Rec—July 26, 1902. No. 49640.

CANALS, RIVERS AND HARBORS.

Aqueducts.

Canal Bridge over the River Lippe. Illustrated description of one of the three masonry aqueducts carrying the Dortmund-Ems Canal over waterways. Especially describes the Eckelt, or lead-lining system which has been so successfully applied, rendering the stone work safe from all infiltration. 1500 w. Engr, Lond—July 11, 1902. No. 49545 A.

Bohemia.

The Canalization of the Moldau and Elbe in Bohemia, in 1901 (Thätigkeit der Commission für die Canalisierung des Moldau und Elbeflusses in Böhmen im Jahre 1901). Abstract of the report of the commission for improving these waterways of Austria, showing progress of the work, with illustrations. 1200 w. Oesterr Wochenschr f d Oeffent Baudienst—July 5, 1902. No. 49436 B.

The Canalization Works in Bohemia (Die Canalisierungs-Bauten in Böhmen). Johann Mrasick. A paper before the Oesterr. Ing. und Arch. Verein, giving an account of the canalization of the Moldau and Elbe Rivers, and the progress of the work. 3500 w. Zeitschr d Oesterr Ing u Arch Vereines—June 27, 1902. No. 49441 B.

Breakwater.

Haupt's Reaction Breakwater. The report of the Franklin Institute through its Committee on Sciences and the Arts, on the invention of Prof. Lewis M. Haupt. 6500 w. Jour Fr Inst—July, 1902. No. 49293 D.

Dams.

A Concrete Dam Near London, Ontario. Illustrated description of a concrete dam with flashboards and an unusual crib apron. 800 w. Eng Rec—July 26, 1902. No. 49638.

Reconstruction of the Castlewood Dam. Illustrated description of a method of reinforcing a high rock-fill dam by means of an earth embankment on its up-stream face. 500 w. Eng Rec—July 12, 1902. No. 49317.

The Tabeaud High Earth Dam, Near Jackson, Cal. An illustrated detailed description of this dam and its construction. 3000 w. Eng News—July 10, 1902. No. 49384.

Docks.

Dock Construction at Zaandam (Sluis bouw te Zaandam). J. E. Van Niftrik. A general description of the harbor improvement work at Zaandam, begun in 1901, and to be completed in 1903. 2000 w. De Ingenieur—June 28, 1902. No. 49711 D.

Ten Years of Dock Developments at Leith. An article on the port of Leith, with plan and illustrations. Principally a description of the new Imperial Dock. 2400 w. Transport—July 4, 1902. No. 49336 A.

Dredge.

Marine Bucket Dredge for Tsingtau, China (Drague Marine à Godets pour le Port de Tsingtau, Chine). A de Riva-Berni. A well illustrated description of a Smulders dredge for the harbor of Tsingtau, on Kiaochau Bay, and the floating pipe line for discharging material. 1 Plate. 1500 w. Génie Civil—June 14, 1902. No. 49480 D.

Isthmian Canals.

Comparative Characteristics of the Panama and Nicaragua Canals. From a pamphlet by Mr. Bunau-Varilla, showing the relative amount of excavation, quantity of steel, depth of cuts, cost of maintenance and operation, number of locks, etc., etc., giving diagrams. 500 w. R R Gaz—July 25, 1902. No. 49665.

The Common Sense of the Isthmian Canal Decision. An editorial summary of the successive stages of the struggle which ended in the selection of the Panama route for the Isthmian canal. 3000 w. Engineering Magazine—August, 1902. No. 49700 B.

The Panama Canal. Reviews the address of Mr. George S. Morison before the Massachusetts Reform Club, and discusses the present state of the project, and the engineering features. Ill. 3300 w. Engng—July 4, 1902. No. 49365 A.

Why Is An Isthmian Canal Not Built? Lewis M. Haupt. A discussion favoring the Nicaragua route, and urging the commencement of the work under the present administration. 3000 w. N Am Rev—July, 1902. No. 49302 D.

Japan.

River Regulation in Japan (Wildbachverbauung in Japan). Prof. Ferd. Wang. An illustrated description the forestation of hillsides and protection of the banks of brooks and rivers. 1200 w. Oesterr Wochenschr f d Oeffent Baudienst—June 7, 1902. No. 49432 B.

London.

The Port of London. Earl Egerton of Tatton. Reviews the Report of the Royal Commission on the Port of London, discussing facts given, the trade of the port, improvements needed, etc. Map. 8800 w. Nineteenth Cent—July, 1902. No. 49534 D.

Mersey.

Mersey Bar and Channels of Approach to Liverpool. Reviews the report of the Conservator of the Mersey to the Commissioners. 1200 w. Engr, Lond—July 11, 1902. No. 49546 A.

Models.

Hydraulic Experiments with Models (Ueber die Bedeutung von Modellversuchen für den Flusswasserbau). C. Krischan. A paper before the Oesterr. Ing. und Arch. Verein, giving a well-illustrated description of experiments with models of jetties and weirs, showing the superiority of curved lines over rectangular for structures for regulating streams. 5500 w. Zeitschr d Oesterr Ing u Arch Vereines—June 27, 1902. No. 49440 B.

Pribram.

The Pribram Reservoirs and the Floods of July, 1897 (Die Pribramer Werksteiche und das Juli-Hochwasser des Jahres 1897). Julius Divis. An illustrated account of damage done to dams and spillways at these Bohemian silver and lead works and mines, and the new constructions. 1 Plate. 7000 w. Oesterr Wochenschr f d Oeffent Baudienst—July 12, 1902. No. 49437 B.

Public Works.

The River and Harbor Bill. A review of the recently published appropriations, with extracts from the Act. 2200 w. R R Gaz—July 11, 1902. No. 49359.

Reservoirs.

The Time Required to Fill Reservoirs (Die Füllzeit für Beliebig Gestaltete Sammelbecken bei Irgend Welchem Zuflusse). Prof. P. Kresnik. A graphical method for determining the time required to fill basins of any shape with any flow of water. 1200 w. Oesterr Zeitschr f d Oeffent Baudienst—May 31, 1902. No. 49428 B.

Waterways.

The Development of a Uniform System of Waterways for Europe (Die Ausbildung eines Einheitlichen Arterien-Systemes der Wasserstrassen Europas). Alfred Ritter v. Weber-Ebenhof. A general review of the existing waterways all over Europe, and a project for a complete system of canals and canalized rivers. Maps. 3 Plates. 25000 w. Oesterr Wochenschr f d Oeffent Baudienst—June 21, 1902. No. 49433B.

CONSTRUCTION.

Building Construction.

The Battery Place Building, New York. Illustrated description of the steel-work and methods of carrying the face walls of a 20-story office building. 1800 w. Eng Rec—July 19, 1902. No. 49560.

Caissons.

Caisson Foundations (Fondations par Caissons à Air Comprimé). J. Grimaud. Abstract from *Les Travaux Publics* giving a well illustrated review of caisson work for foundation building. Serial. Two parts. 7000 w. Rev Technique—June 25, July 10, 1902. No. 49713 each D.

Contractors' Plant.

The Second Division of the New York Rapid Transit Railroad. Illustrated description of the construction of nearly 4 miles of road by trenching, with particular attention to methods of keeping records of the progress of work, moving water pipes and sewers, supporting elevated railway structures over the trench, and underpinning street railway tracks. 4400 w. Eng Rec—July 19, 1902. Serial. 1st part. No. 49557.

Contracts.

The Duties of Engineers in Enforcing Contracts. Albert J. Himes. A discussion of this subject. 2000 w. Eng News—July 17, 1902. No. 49605.

Fireproofing.

Resistance to Fire of Floors and Doors. Edwin O. Sachs. Considers those two forms of construction, showing what has been done, and giving report of tests. 3800 w. Ins Engng—June, 1902. No. 40081 C.

The Fire-Proofing of High Office Buildings. Peter B. Wight. Considers the effect of fire-proof materials on building design, discussing the plans, materials, and constructive methods. General discussion follows. 6600 w. Pro Engrs' Soc of W Penn—June, 1902. No. 49693 D.

Framework.

Steel Framework for High Buildings. Charles Worthington. Considers the types, loads, design, wind-bracing, foundations, etc. Ill. 2700 w. Pro Engrs' Soc of W Penn—June, 1902. No. 49691 D.

Masonry.

Notes of Experience in Masonry Construction. F. A. Mahan. A discussion on the construction work of different kinds of masonry and some of the difficulties. 1700 w. Eng News—July 17, 1902. No. 49606.

Rigidity of Masonry Construction and the Decay of Stone. Reports some recent failures in stone masonry and gives the greater part of Sir Thomas Drew's report on Truro Cathedral, which contains much valuable information. 4500 w. Stone—April, 1902. No. 49283 C.

Office Buildings.

The Designing of an Office Building. Colbert A. MacClure. A statement of the problem, some of the conditions to be met, etc., giving some mechanical features of the Keystone building, Pittsburg, Pa. Ill. 2000 w. Pro Engrs' Soc of W Penn June, 1902. No. 49602 D.

Roads.

The Permanent Improvement of Public Highways. William H. Evers. Gives general specifications and information concerning the road improvements in Cuyahoga County, Ohio, using brick paving. 4300 w. Brick—July, 1902. No. 49199.

Rust Prevention.

Protection of Iron and Steel in Car Construction, Also as Applying to Building Material. Charles Koons. Remarks on the proper cleaning before painting, the kind of paint, etc. 2000 w. St. Louis Ry Club—July 11, 1902. No. 49621.

Subways.

Telephone Tunnels and Street Railway Subways in Chicago. Information concerning the low-level telephone tunnels, and the schemes for underground railways. Ill. 1100 w. Eng News—July 17, 1902. No. 49604.

Suez Canal.

Through the Suez Canal on a Man-of-War. H. H. Byrne. An account of the project, its early history, the construction, etc. 2000 w. Sci Am—July 19, 1902. No. 49573.

Temporary Structures.

Temporary Timber Structures. Considers the principles to be observed in designing these structures, that they may bear safely the great weight often put upon them. 1700 w. Builder—June 14, 1902. No. 49217 A.

Tunnels.

The Pryor Gap Tunnel; Burlington & Missouri River R. R. F. T. Darrow. Illustrated description of the construction of this tunnel in Montana, of interest because of the simple means used in its excavation. 1300 w. Eng News—July 3, 1902. No. 49271.

The Simplon Tunnel and Its Construction. A description of this tunnel and the methods of working, correcting some of the errors which have appeared concerning this work. 1000 w. Engr. Lond—July 4, 1902. Serial. 1st part. No. 49373 A.

Underpinning.

Underpinning a Tall and Narrow Brick Building. Illustrated description of the method of underpinning a 6 x 12 ft. extension of a brick building 175 ft. high, having a heavy chimney in one corner. 1700 w. Eng Rec—July 5, 1902. No. 49195.

MATERIALS.

Cement.

Cement Works at Grays. Describes the works and the methods of manufacture. Everything, except the main shafting, is driven electrically. 1200 w. Engr, Lond—July 11 1902. No. 49547 A.

Portland Cement. Richard K. Meade. An illustrated description of methods employed in its manufacture, and types of American and foreign cement machinery. 2800 w. Mines & Min—July, 1902. No. 49303 C.

Standard Cement Specifications. R. W. Leslie. Read before the Am. Sec. of the International Assn. for Test. Materials. On the necessity of codifying requirements for Portland cement for different classes of service. 2300 w. Eng Rec—July 5, 1902. No. 49192.

The Advantages of Uniformity in Specifications for Cement and Methods of Testing. George S. Webster. Read before the Am. Sec. International Assn. for Test. Materials. A statement of the advantages and discussion of the causes of present variations in the results obtained. 2000 w. Eng Rec—June 28, 1902. No. 49150.

The Manufacture of Portland Cement with Rotary Kilns (Fabrication du Portland Artificiel par Fours Portatifs). E. Leduc. An illustrated description of Portland cement works at Haubourdin, France, installed by Smidth Davidsen, of Copenhagen. 2000 w. Rev Technique—July 10, 1902. No. 49714 D.

Cement Testing.

Cement Testing in Municipal Laboratories. R. L. Humphrey. A paper, slightly condensed, read before the Am. Soc. of the International Assn. for Testing Materials. A study of the equipment and methods in use in various laboratories. 3800 w. Eng Rec—July 12, 1902. No. 49314.

The Cement Testing Laboratory at Cornell University. Edgar B. Kay. Describes briefly the appointments and apparatus of these laboratories. Ill. 1500 w. Munic Engng—July, 1902. No. 49284 C.

The Testing of Cement. Editorial review of an article by Richard L. Humphrey, in *The Journal of the Franklin Institute,* on the Inspection and Testing of Cements. 3800 w. Builder—July 5, 1902. No. 49333 A.

Concrete.

Some Recent Experiments with Cements, Mortar and Concrete. Thomas S. Clark. An account of tests made of the material used in the construction of the Manhattan Ry. Co.'s Power Station, N. Y. 3000 w. Eng News—July 24, 1902. No. 49661.

The Permeability of Concrete Under High Water Pressures. J. B. McIntyre and A. L. True. Abstract of a graduating thesis to the Thayer School of Civil Engng. An account of experimental investigations. 1500 w. Eng News—June 26, 1902. No. 49147.

Wet, Dry, or Medium Concrete. H. W. Parkhurst. A tabular comparison of two sets of experiments and conclusions, drawn from them. Illustrations and discussion. 5500 w. Jour W Soc of Engrs—June, 1902. No. 49295 D.

Reinforced Concrete.

A New French Method of Cement Construction. Jean Schopfer. Concerning the uses to which reinforced concrete has been put in France, describing and illustrating some buildings constructed of this material. 1800 w. Arch Rec—Aug., 1902. Serial. 1st part. No. 49564 C.

Recent Structures in Concrete and Iron (Neuere Bauwerke und Bauwesen aus Beton und Eisen). Fritz v. Emperger. An illustrated account of the use of reinforced concrete construction in reservoirs, canals and all kinds of hydraulic work, at the time of the Paris Exposition of 1900. Two parts. 1 plate. 6500 w. Zeitscher d Oesterr Ing u Arch Vereines—June 13 and 20, 1902. No. 49438 each B.

Tests of Reinforced Concrete Beams. W. Kendrick Hatt. Read before the Am. Sec. International Assn. for Test. Materials. Describes the methods and records the results of tests made to determine the reliability of the theory advanced by the writer. 4800 w. Eng Rec—June 28, 1902. No. 49149.

Stone.

The Crystalline Rocks of Georgia. S. W. McCallie. An illustrated article describing the road-building material of the state. 1600 w. Stone—April, 1902. No. 49282 C.

Structural Steel.

A Single Grade of Steel for Bridges and Other Structures. Editorial discussion of the proposal to specify steel of 55,000 to 60,000 lbs. ultimate strength for all parts of bridges. 1300 w. Eng Rec—July 19, 1902. No. 49555.

The Desirability of Using a Single Grade of Steel for Bridges. Abstracts of the discussion at meeting of the Am. Soc. for Testing Materials. 3500 w. Eng News—June 26, 1902. No. 49146.

MEASUREMENT.

Instruments.

New Types of Hand Surveying Instruments. Illustrates and describes interesting adaptations of the gun-sight to portable surveying instruments. 1400 w. Engng—July 11, 1902. No. 49537 A.

Surveying.

Mine Surveying. Messrs. De Morest and Silvester. Read at meeting of the Assn. of Ontario Land Surveyors. An account of methods, and the benefit of mine plans. 3500 w. B C Min Rec—July, 1902. No. 49521 B.

Surveying in Central America. An account of the methods used in making surveys for the Isthmian Canal Commission. 2000 w. Eng Rec—July 19, 1902. No. 49559.

MUNICIPAL.

Elmira, N. Y.

The System of the Elmira Water, Light and Railroad Company. An illustrated description of the portion of this combination which is of particular interest to street railway men. 2000 w. St Ry Jour —July 5, 1902. No. 49261 D.

Fire Brigade.

The Reorganization of the Metropolitan Fire Brigade. An editorial discussion of the present state of affairs in regard to the fire protection of London, with suggestions for a remedy as given in a scheme by Edwin O. Sachs. 4000 w. Engng—July 4, 1902. No. 49368 A.

Pavements.

The Cost of Brick and Stone Block Pavements. Halbert Powers Gillette. Information and facts helpful in estimating. 2500 w. Eng News—July 24, 1902. No. 49662.

Sewage Disposal.

Improvements of the Mersey and Irwell Rivers, England. Explains the results attained after 10 years of government oversight of the sewage purification works in an English water-shed. 800 w. Eng Rec—July 26, 1902. No. 49639.

Sewage Purification Works at Depew, N. Y. G. Everett Hill. Illustrates and describes the system which includes a septic tank, coke primary filters or "contact beds," and stone secondary filters on the wave-bed plan. 1500 w. Eng News—June 26, 1902. No. 49145.

Sewage Purification Works at Island Park Resort, Rome City, Ind. George S. Pierson. Illustrated description of plant consisting of a septic tank, combined with purification beds. 1000 w. Eng News—July 24, 1902. No. 49663.

Washington, D. C.

Washington as a Work of Civic Art. Charles Moore. Illustrates and describes the proposed improvements for beautifying this city at a cost of many millions. 3600 w. Munic Jour & Engr—July, 1902. No. 49382 C.

WATER SUPPLY.

Filtration.

Experiments on the Purification of the Springfield Water Supply. Describes investigations to determine the practicability of filtering a supply contaminated by organisms producing offensive taste and odor. 1900 w. Eng Rec—July 12, 1902. No. 49318.

New Filter Plant at Middletown, N. Y. Illustrations with brief description. 400 w. Sci Am Sup—July 19, 1902. No. 49574.

Proposed Filtration of the Water supply of St. Louis, Mo. Statement of Edward Flad describing the proposed plan and the reasons why prompt action is desirable. 1500 w. Eng News—July 3, 1902. No. 49272.

Scrubbers for Preparing Water for Filtration. P. A. Maignen. Abstract of a paper before the Am. W. Wks. Assn. Illustrated description of a rapid filter of broken stone, with notes on results obtained with its use. 1000 w. Eng Rec—July 26, 1902. No. 49637.

Iron.

The "Rust Stains" from Water Containing Crenothrix. Describes experiments by D. D. Jackson to ascertain the cause of the precipitation of iron in water supply and methods of preventing. 1300 w. Eng Rec—July 26, 1902. No. 49636.

Large Cities.

Water Supply of Large Cities. George Y. Wisner. Discusses the methods adopted by various cities, the need of filtration, etc. 2500 w. Technic—1902. No. 40689 D.

Mains.

A Giant Force Main. Illustrated description of the new thirty-inch steel riveted force-main to carry a supply of water to Atlantic City, N. J. 1800 w. Fire & Water—July 12, 1902. No. 49381.

Seven Mysterious Breaks in a 48-Inch Pipe Line on the Boston Water Works. Frederic I. Winslow. Describes these breaks and gives the conclusions regarding the cause. 600 w. Eng News—July 3, 1902. No. 49275.

Paris.

City Water Supplies (Städtische Wasserversorgungen). Martin Paul. An illustrated review of the water supply of various cities at the time of the Paris Exposition of 1900. The present article describes the Paris water supply. Serial. Part I. 5000 w. Zeitschr d Oesterr Ing u Arch Vereines—July 4, 192. No. 49442 B.

Purification.

A Study of Self-Purification in the Sudbury River. A. G. Woodman, C. E. A. Winslow, and Paul Hansen. States the conditions of this river in Massachusetts, describes the investigations and reports results and conclusions. 3000 w. Tech Qr—June, 1902. No. 49323 E.

The Purification and Sterilization of Water. Dr. Rideal. This first lecture considers the purification by uncontrolled natural agencies, natural purification of surface waters, protection of sources, etc. 6000 w. Jour Soc of Arts—July 18, 1902. Serial. 1st Part. No. 49615 A.

Stream Pollution.

Stream Pollution Enjoined in New Jersey. Decision of New Jersey Court of Chancery forbidding a paper company to discharge waste liquids into a watercourse from which a domestic supply is drawn farther down stream. 2800 w. Eng Rec—July 12, 1902. No. 49316.

Valuations.

The Financial Questions in Water-Works Valuations. John W. Alford. Abstract of a paper before the Am. W. Wks. Assn. A discussion of the most equitable manner of ascertaining the value of a water-works plant. 4000 w. Eng Rec—July 12, 1902. No. 49315.

Water Analysis.

An Apparatus for Collecting Samples of Water at Various Depths. Earle B. Phelps. Illustrated description of an apparatus devised by the writer. 700 w. Tech Qr—June, 1902. No. 49326 E.

Water Cost.

Water Cost and Water Waste. A. L. Holmes. Read before the Mich. Engng. Soc. Discusses the great cost which is likely to increase, and also the use of meters to lessen the waste. 3000 w. Munic Engng—July, 1902. No. 49286 C.

Water-Works.

New Water-Works for Loughborough. Illustrated description of the new source of supply and the methods employed in obtaining it. 1900 w. Engr, Lond—July 11, 1902. No. 49544 A.

MISCELLANY.

Chicago.

Early Engineering in Chicago. Reminiscences by Messrs. Morehouse, L. E. Cooley. Liljencrantz, J. F. Foster and Sedden. 7500 w. Jour W Soc of Engrs —June, 1902. No. 49297 D.

Education.

The Evil of Excessive Differentiation in Engineering Courses. Edgar Marburg. Presented at meeting of the Soc. for the Promotion of Engng. Ed. Discussion limited to the bearing of the question on civil engineering. 1500 w. Eng News— July 3, 1902. No. 49273.

Madagascar.

Transportation in Madagascar (Voices de Communication et Moyens de Transport à Madagascar). F. C. Taupiat de Saint Simeux. A review of the present state and the future of the ways of communication and means of transport on the island of Madagascar. Map. 11000 w. Mem d l Soc d Ing Civils de France—May, 1902. No. 49475 G.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cables.

An Aluminum-Sheathed Cable. Charles Bright. A short description of a cable aiming to combine strength and lightness with freedom from corrosion. 500 w. Electro-Chem & Met—May, 1902. No. 49080 A.

Conduits.

Conduits for Telephone Work. A full unabridged telephone conduit specification drawn up by A. V. Abbott. 14000 w. Elec Wld & Engr—June 21, 1902. No. 49076.

Space Telegraphy.

A Magnetic Detector of Electric Waves, Which Can Be Employed as a Receiver for Space Telegraphy. G. Marconi. Read before the Royal Soc. Describes a detector based upon the decrease of magnetic hysteresis which takes place in iron when, under certain conditions, it is exposed to the effect of high-frequency waves. 1700 w. Elect'n, Lond—July 18, 1902. No. 49619 A.

A Simple and Efficient Wireless Telegraph Receiver. A. Frederic Collins. Illustrates and describes a receiver consisting of only three parts, a coherer, an ordinary telephone receiver, and a dry cell; while supplementary to these are the vertical wire and the earthed connection. 1200 w. Sci Am—July 5, 1902. No. 49269.

Long Distance Wireless Telegraphy and Hertzian Waves. Lee De Forest. Describes what takes place in the transmission. 600 w. Elec Wld & Engr—July 5, 1902. No. 49228.

Marconi Telegraphy. An editorial review of Mr. Marconi's recent lecture before the Royal Institution, in which he describes his new magnetic detector which replaces the coherer. Ill. 2200 w. Engng—June 20, 1902. No. 49132 A.

The Brown-Siemens-Halske System of Wireless Telegraphy. A detailed description of this system with illustrations of apparatus used. 2500 w. Sci Am Sup—July 5, 1902. No. 49270.

The "Castelli" Coherer and the "Royal Italian Navy" Coherer. Prof. Angelo Banti. An explanation called out by observations on a previous article. Considers the Castelli Coherer, Solari's experiments, and the coherer adopted by Marconi in the transatlantic transmission. 1300 w. Elec Rev, Lond—July 11, 1902. No. 49528 A.

The Castelli Receiver for Wireless Telegraphy. H. W. Sullivan. Illustrated description with discussion of its advantages and disadvantages. 900 w. Elec Rev, Lond—July 18, 1902. No. 49626 A.

The Practicability of Wireless Telegraphy. G. Marconi. From the *Fortnightly Review.* An account of the earliest paid messages transmitted, the report of yacht races, the United States Navy trials, and other proofs of practicability. 4800 w. Sci Am Sup—June 28, 1902. No. 49096.

The Progress of Space Telegraphy. G. Marconi. Lecture delivered before the Royal Institute. Describes the various problems which have recently been solved, especially the development of the writer's own work in the field. Shows it is now possible to work a number of wireless stations in vicinity of each other without interference; and describes his magnetic detector of electric waves which leaves all coherers far behind in speed, adjustment and efficiency. 8300 w. Elect'n, Lond—June 27, 1902. No. 49168 A.

Wireless Telegraphy and Submarine Cables. Emile Guarini. Briefly explains syntony and discusses multi-communication in submarine telegraphy, and in space telegraphy. Ill. 1100 w. Elec Rev, Lond—June 27, 1902. Serial. 1st part. No. 49164 A.

The Effect of Daylight Upon the Propagation of Electro-Magnetic Impulses Over Long Distances. G. Marconi. Describes results obtained in a series of tests, giving a brief description of apparatus used. 1200 w. Elect'n, Lond—July 18, 1902. No. 49620 A.

The Present and Future Status of Wireless Telephony. A. Frederick Collins. Reviews what has been accomplished in this field, discussing the uses to which it could be applied, and related matters. 1400 w. Elec Wld & Engr—June 28, 1902. No. 49109.

Wireless Telegraphy. E. Rutherford. Considers the history and development of the Marconi system. Ill. 3000 w. Can Engr—July, 1902. Serial. 1st part. No. 49210.

Telephony.

Needed Improvements in Independent Telephony. L. W. Stanton. Read before the Ind. Tel. Assn. Discusses the problems of tariff, traffic and equipment in this field. 3500 w. Elec Rev, N Y—July 12, 1902. No. 49509.

The Collins Wireless Telephone. A Frederick Collins. Briefly describes five methods by which speech may be transmitted electrically without wires, giving illustrated description of the method invented by the writer. 1500 w. Sci Am—July 19, 1902. No. 49572.

The New Telephone System in Paris. J. Bordelongue. Abstract translation from the *Journal Télégraphique.* Describes recent improvements made, eliminating the multiple jacks and making other changes that improve the service and lessen the expense. 2500 Elect'n, Lond—June 27, 1902. No. 49167 A.

The Plant of the Saratoga Telephone Company. Illustrates and describes a fine independent exchange. 1800 w. Elec Rev N Y—July 5, 1902. No. 49206.

The Telephone Service in the River Plate. Illustrates and describes recent developments in Buenos Ayres, and other important cities of the River Plate. 1400 w. Elect'n, Lond—June 27, 1902. No. 49166 A.

DISTRIBUTION.

Accumulators.

Central Station Batteries. Indicating the general causes of trouble, with these batteries, and the best method of dealing with them. 1800 w. Elec Rev, Lond—July 4, 1902. No. 49347 A.

The Use of Storage Batteries in Electric Distribution Systems. A. A. Dion. Read before the Canadian Elec Assn. A plea for the due consideration of the storage battery as a possible factor influencing the design of electrical installations, with a view to their efficient, economical and uninterrupted operation. 3300 w. Can Engr—July, 1902. No. 49209.

Alternating Currents.

The Relation of Single Phase to Multiphase Alternating Current. Fred W. Ballard. An illustrated explanation of the difference. 1800 w. Engr, U S A—June 16, 1902. No. 49074.

Alternators.

The Normal Saturation of Alternator

Fields. R. Beattie. Defines normal saturation as that degree of saturation which makes the regulation efficiency a maximum. 600 w. Elect'n, Lond—July 11, 1902. No. 49530 A.

Fuses.

Standard Electric Safety Fuses (Ueber eine Absolute Unverwechselbarkeit an Elektrischen Schmelzsicherungen). E. Dreefs. A paper before the Verband Deutscher Elektrotechniker giving illustrated descriptions of fuses for a definite current and e. m. f., and which cannot be mistaken for fuses of a higher or lower capacity. 1000 w. Elektrotech Zeitschr—June 26, 1902. No. 49404 B.

High-Voltage Protectors.

High-Voltage Protectors (Spannungssicherungen). Dr. Gustav Benischke. A paper before the Electrotechnische Verein giving an illustrated description of apparatus for protection against high voltages below those due to lightning. 4500 w. Elektrotech Zeitschr—June 19, 1902. No. 49402 B.

Lightning Effects.

The Destruction of Cables by Lightning (Die Zerstörung von Kabelleitungen durch Blitzschlag). Karl Wilkens. A paper before the Elektrotechnischer Verein, giving an illustrated account of damage done to underground cables for heavy currents in Berlin. 2000 w. Elektrotech Zeitschr—June 26, 1902. No. 49407 B.

Phase Angle.

The Definition of the Phase Angle (Ueber die Definition der Phasenverchiebung). Dr. E. Orlich. A mathematical discussion of the proper way to designate and calculate the phase difference between current and electromotive force when the wave form differs from a sine curve. 500 w. Elektrotech Zeitschr—June 19, 1902. No. 49401 B.

Polycyclic.

The Arnold-Bragstad-la Cour Polycyclic Distribution System (Das Polycyklische Stromvertheilungssystem Arnold-Bragstad-la Cour). Prof. E. Arnold. A paper before the Elektrotechnische Gesellschaft of Frankfort-on-Main. giving an account of electrical distribution system in which currents of different voltages and frequencies are superposed on the same conducting network. Diagrams. Two parts. 5000 w. Elektrotech Zeitschr—June 25., July 3, 1902. No. 49405 each B.

Sag of Wires.

The Proper Amount of Sag for Bare Wires of Soft Copper (Welcher Durchhang Soll Blanken Freileitungen aus Weichkupfer Gegeben Werden). K. Krohne. A discussion of the tension and sag in freely-suspended overhead wires, with diagrams, curves and tables. 1000 w. Elektrotech Zeitschr—July 3, 1902. No. 49410 B.

Stray Currents.

The Electrolysis of Gas Mains. James Swinburne. Read before the Gas Inst. (England). An impartial discussion of the subject, explaining the meaning and causes of electrolysis. 9000 w. Gas Wld —June 14 1902. No. 49065 A.

Underground.

All Wires Put Underground. Illustrates and describes the arrangements for placing underground all the wires in New Britain, Conn. 2800 w. Munic Jour & Engr—July, 1902. No. 49383 C.

ELECTRO-CHEMISTRY.

Accumulators.

Some Experiments with Zinc-Lead Accumulators (Einige Versuche mit Zink-Blei-Akkumulatoren). Oscar Gabran. An illustrated account of experiments with accumulators having lead positive plates in a case with amalgamated-copper lining, which serves as the negative plate, and zinc-sulphate electrolyte. Tables and curves. 1200 w. Elektrotech Zeitschr—June 26, 1902. No. 49406 B.

The Edison Storage Battery. Henry F. Joel. Gives brief analysis of the four patents taken out in 1900 and 1901, with detailed descriptions and claims made. Ill. 2500 w. Elec Rev. Lond—June 20, 1902. No. 49123 A.

See Electrical Engineering Distribution.

Caustic Soda.

Caustic Soda by the Diaphragm Process. Clinton Paul Townsend. Illustrated description of the electrolytic method. 800 w. Elec Wld & Engr—July 5, 1902. No. 49229.

Electrolysis.

Persulphuric Acids. Prof. H. E. Armstrong and T. Martin Lowry. Read before the Royal Soc. Reviews various experiments, reporting results. 1700 w. Elect'n, Lond—July 11, 1902. No. 49531 A.

Laboratory.

An Electrochemical Laboratory at the University of Pennsylvania. Prof. Edgar F. Smith. An illustrated description of a laboratory and installation sufficient to accommodate eighteen students. 2200 w. Electro-Chem & Met—May, 1902. No. 49070 A.

ELECTRO-PHYSICS.

Analogue.

Attenuation and Distortion on Long Distance Telephone and Power Transmission Lines Regarded as Hydrodynamic Phenomena. Henry T. Eddy. Presents analogy between a hypothetical hydraulic system and actual electric transmission systems, extending it to the more complicated case of long-distance transmission by alternating currents. 2300 w. Elec Wld & Engr—July 26, 1902. No. 49653.

Arc.

The Voltaic Arc (L' Arc Voltaïque). P. Janet. A general discussion of the physical properties of the electric arc, with especial reference to the recent investigations of Duddell, Simon, and others. 3500 w. Rev Gen des Sciences—May 15, 1902. No. 49709 D.

Electric Discharge.

Investigations of the Electric Discharge in Rarefied Gases. W. Wien. Translated from *Annalen der Physik*. An account of experimental investigations. Ill. 3800 w. Elect'n, Lond—July 18, 1902. Serial. 1st part. No. 49622 A.

Experimental Apparatus.

An Experimental Motor and Dynamo. W. E. Parker. Illustrated description of a simple and inexpensive outfit for illustrating the principles of the electric motor and dynamo in the teaching of physics. 700 w. Sci Am—July 12, 1902. No. 49398.

Fused Quartz.

On the Fusion of Quartz in the Electric Furnace. R. S. Hutton. A report of experimental study and interesting observations made. 1300 w. Electro Chem & Met—May, 1902. No. 49078 A.

Magnetic Properties.

The Magnetic Properties of Annealed Wrought-Iron Manufactured from the Ironsand of New Zealand. Ernest Wilson. Describes the experimental investigations made, giving the results. 800 w. N Z Mines Rec—May 16, 1902. No. 49114 B.

Magnetism.

The Cyclone Theory of Magnetism. Henry E. P. Cottrell. Describes experiments of Mr. C. L. Weyher and the theories advanced by him. Ill. 2000 w. Elec Rev, Lond—June 27, 1902. Serial. 1st part. No. 49165 A.

The dissipation of Energy by Electric Currents Induced in an Iron Cylinder When Rotated in a Magnetic Field. Ernest Wilson. Read before the Royal Soc. Deals with the Energy dissipated by these electric currents, making a comparison between the results of experiment and theory. 1800 w. Elec Rev, N Y—July 26, 1902. Serial. 1st part. No. 49650.

Radio-Activity.

The Radio-Activity of Matter (La Radio-Activité de la Matière). Henri Becquerel. A lecture before the Royal Institution, London, giving a well-illustrated account of radio-active substances and phenomena. 4500 w. Rev Gén des Sciences—July 15, 1902. No. 49497 D.

GENERATING STATIONS.

Armature Reaction.

Field Distortion and Armature Reaction (Feldverzerrung und Ankerrückwirkung). R. Bauch. A paper before the Verband Deutscher Elektrotechniker, giving a general discussion of armature reaction and the distortion of field in dynamo-electric machinery, with diagrams. Serial. 2 parts. 9000 w. Elektrotech Zeitschr—July 10, 17, 1902. No. 49412 each B.

Armature Winding.

Points to Be Observed in Rewinding Coil-Wound Armatures. Illustrated directions. 3300 w. Am Elect'n—July, 1902. No. 49258.

Asynchronous Generators.

Asynchronous Generators for Single and Polyphase Currents (Asynchrone Generatoren für Ein- und Mehrphasenstrom). Alexander Heyland. A paper before the Verband Deutscher Elektrotechniker giving an illustrated description of non-synchronous alternators designed on the principle of an induction motor. Curves and diagrams. 4000 w. Elektrotech Zeitschr—June 26, 1902. No. 49403 B.

Berlin.

The Oberspree and Moabit Power Stations of Berlin, Germany. Arthur H. Allen. Illustrated detailed description of these two large stations. 5000 w. Engr, U S A—June 16, 1902. No. 49071.

Brazil.

Electricity at Manaos, Brazil. Charles S. Seibert. An illustrated description of an electric light plant; also of a railway plant operating 15 miles of single track road; and a third company which furnishes electricity for general use. 1600 w. Elec Wld & Engr—July 5, 1902. No. 49227.

Compounding.

Some Applications of Compound Alternators (Quelques Applications d'Alternateurs Compounds). M. Boucherot. A general review of the theory of compounding and a particular account of his system, in which there are compounded transformers which are connected to the alternator, to line and to the exciter which has an alternating field. A well illustrated account of practical applications and tests of this system are also given. 9000 w. Bull Soc International des Electriciens—June, 1902. No. 49492 E.

The Boucherot System of Compounding Alternators (Note sur les Alternateurs Compound, Système Boucherot). E. J. Brunswick. An illustrated description of this system, in which a compounded transformer supplies current to an exciter, which, in turn, excites the alternator. 3500 w. Génie Civil—July 5, 1902. No. 49487 D.

Cornell University.

A High Potential Direct-Current Plant for Experimental Work. G. S. Moler. Illustrates and describes a plant in use at Sibley College, which has proved very satisfactory. 1500 w. Elec Wld & Engr—July 19, 1902. No. 49597.

Des Moines, Iowa.

The New Power Plant of the Des Moines City Railway Co. Illustrated description of the method of rebuilding a power station without interfering with the traffic. 1700 w. Eng Rec—July 12, 1902. No. 49313.

Double-Current.

Double-Current Generators and their application. E. T. Ruthven-Murray. Calls attention to some of the uses and advantages of the special type of machine known as the double-current generator. Also discussion. 5500 w. Elec Engr, Lond—July 4, 1902. No. 49345 A.

Dynamo Design.

Inductive Reaction and Fall of Potential in Dynamo-Electric Machines (Réaction d' Induit et Chute de Tension dans les Machines Dynamo-Electriques). R. V. Picau. An attempt at a general method of predetermining the principal quantities in dynamo design, with formulae and diagrams. 5000 w. Bull Soc Internationale des Electriciens—June, 1902. No. 49491 E.

Hoboken, N. J.

The Hoboken Station of the United Electric Company. Illustrated description of a steam plant mainly noteworthy for the unusual system of piping made necessary during the reconstruction of the station in order to avoid any interference with the supply of current. 1800 w. Eng Rec—July 19, 1902. No. 47558.

Metuchen, N. J.

A Modern District Supply Central Station. Illustrated description of the plant of the Central Electric Company at Metuchen, N. J. 2700 w. Am Elect'n—July 1902. No. 49253.

Peekskill, N. Y.

New Power House of the Peekskill Lighting and Railroad Company. Illustrated description of a small modern equipment in which provision has been made for expansion and for marked changes in loads. 4000 w. St Rv Jour—July 19, 1902. No. 49570 D.

Pied-Selle.

Electric Installation at the Pièd-Selle Works, at Fumay, Ardennes, France (Installations Electriques des Usines du Pied-Selle à Fumay, Ardennes). C. Dufour. An illustrated description of a hydro-electric plant, transmission line and electric driving in a manufactory of heating apparatus. 1 plate. 2500 w. Génie Civil—July 12, 1902. No. 49488 D.

Pike's Peak.

Power Transmission in the Pike's Peak Region. R. M. Jones. Illustrated detailed description of the dam and reservoir, wood and steel pipe line, power station, electrical equipment, etc. 2700 w. Elec Wld & Engr—July 26, 1902. No. 49651.

The Plant of the Pike's Peak Power Co. R. M. Jones. Illustrated description of a plant comprising a rock-fill dam with steel-plate face, a wood stave and steel pipe line, 26,100 ft. long, and a 1,600 k. w. power station, for which all materials had to be lowered by derrick down the face of a cliff. 3200 w. Eng Rec—July 19, 1902. No. 48556.

Pittsfield, Mass.

Power Plant of the Berkshire Street Railway Co., Pittsfield, Mass. Illustrated description of a plant with two 750 k. w. units distributing alternating current at 13,300 volts, for a 40-mile country road. Describes particularly the piping. 2000 w. Eng Rec—July 26, 1902. No. 49635.

Railway Stations.

Electric Railway Power Stations (Betrachtungen über Bahncentralen). Dr. M. Eisig. A general review of the boilers, engines, gas engines, turbines, dynamos, storage batteries and other equipment of power stations, as well as of sub-stations and distribution. Diagram. Two parts, 10,000 w. Elektrotech Zeitschr—July 3 and 10, 1902. No. 49409 each B.

Regulation.

The Girard System of Regulating Dynamos Driven by Gas Engines (Dispostif de M. Girard pour la Regularisation du Courant Electrique Fourni par un Moteur à Gaz). M. Lauriol. An automatic rheostat varies the separately excited field of the dynamo. General discussion of the problem with diagrams. 3000 w. Bull Soc Internationale des Electriciens—June, 1902. No. 40490 E.

St. Petersburg.

The St. Petersburg Central Station Built by the "Société Anonyme Electricité et Hydraulique" (Centrale der Société Anonyme "Electricite et Hydraulique" in St. Petersburg). W. Multhauf. An illustrated description of a single-phase station with a capacity of 7000 kilowatts. 3600 w. Elektrotech Zeitschr—June 19, 1902. No. 40400 B.

Shoreditch.

The New Shoreditch Electricity Works. Illustrated description of the new works which have been erected at Haggerston, England. 3700 w. Elec Engr, Lond—June 20, 1902. No. 49122 A.

Speed Regulation.

See Mechanical Engineering, Steam Engineering.

Station Expenses.

Expenses of Electric Stations. Alton Adams. Discusses the increase in expenses, the need of economy, and the points where the largest savings have been effected. 1500 w. Elec Rev, N Y—July 19, 1902. No. 49585.

Transformers.

The Grisson Continuous-Alternating Current Transformers. A. Frederick Collins. Illustrated description of an apparatus which changes a direct continuous current into a pure alternating-current. It is recommended especially for wireless telegraphy sets. 1200 w. Sci Am—June 28, 1902. No. 49093.

LIGHTING.

Arc Lamps.

Radiant Efficiency of Arons Mercury Arc Lamp. William C. Geer. Read at the Pittsburg meeting of the A. A. A. S. A study of this subject with results. 600 w. Elec Wld & Engr—July 19, 1902. No. 49596.

The Bremer Lamp. Siegmund Saubermann. Abstract of a paper read before the Elektrotechnischer Verein of Vienna. Illustrated detailed description of the construction and the principle upon which it is based. Also gives photometric measurements of the light. 1800 w. Elect'n, Lond—June 20, 1902. No. 49121 A.

Arcs.

Arc Lighting. C. M. Green. An able and interesting paper read before the Canadian Elec. Assn. Concludes that the enclosed arc is better and cheaper than the open arc; the direct constant current enclosed arc system the best and most economical for plants devoted exclusively to arc lighting; the alternating constant current enclosed arc system the best and most economical for plants which use large 40 to 125 cycle alternating current generators. 4500 w. Can Engr—July, 1902. No. 49207.

The Alternating Current Arc. Ernst Adler. An explanation of phenomena observed in alternating current arcs. 1000 w. Elec Wld & Engr—June 21, 1902. No. 49077.

See Electrical Engineering, Electro-Physics.

Car Lighting.

See Railway Engineering, Motive Power and Equipment.

Decorative Lighting.

The Coronation Illuminations. An illustrated account of the preparations made to illuminate London in honor of the King's coronation. Also some remarks on the attitude of the companies and the precautions taken. 3200 w. Elect'n, Lond—July 4, 1902. No. 49350 A.

Mercury Lamp.

The Hewitt Mercury Vapor Lamp. Abstract translation of an article by Dr. Max V. Recklinghausen, published in the *Elektrotechnische Zeitschrift*, describing this lamp and discussing its properties. Ill. 1200 w. Elect'n, Lond—June 27, 1902. No. 49169 A.

Vacuum Light.

The Moore Electric Light. Illustrated description of the latest improved forms of the Moore vacuum light, with details from recent patents. 2500 w. Elec Wld & Engr—June 28, 1902. No. 49110.

MEASUREMENT.

Instruments.

Electrical Measurements and Measuring Instruments (Ueber Elektrische Messungen und Messinstrumente). Prof. August Raps. Lecture before the Oesterr Ing. und Arch. Verein on the elements of electrical measurement. Serial. 2 parts. 5000 w. Supplement to Zeitschr d Oesterr Ing u Arch Vereines—July 4, 11, 1902. No. 49444 each B.

Magnetic Tests.

Note on Magnetic Tests of Iron (Note sur les Essais Magnétiques du Fer). M. Armagnat. A preliminary report of a committee of the Soc. Int. des Electriciens, giving some data on testing for permeability, hysteresis, etc., making recommendations and requesting information. 1600 w. Bull Soc Internationale des Electriciens—June, 1902. No. 49494 E.

Meters.

Electric Motor-Meters and Electromagnetic Apparatus (Ueber Motorzähler und Elektromagnetische Bewegungsapparate). Dr. Th. Bruger. A paper before the Verband Deutscher Elektrotechniker, giving an illustrated account of various electric meters operating on the motor and other electromagnetic principles. 2000 w. Electrotech Zeitschr—July 3, 1902. No. 49408 B.

Principles.

Electrical Units and Introduction to Alternating Currents (Die Masse in der Elektrotechnik. Einführung in das Wechselstromgebiet). Dr. Johann Sahulka. Lecure before the Oesterr. Ing. und Arch. Verein on the elements of electrical engineering. Diagrams. 6000 w. Supplement to Zeitschr d Oesterr Ing u Arch Vereines—July 4, 1902. No. 49443 B.

Self-Inductions.

On a New Method of Measuring Small

Self-Inductions. W. Mansergh Varley. Describes a method devised for measuring the self-inductions of some small solenoids in the course of an investigation on the magnetization of iron in rapidly-oscillating current fields. 1300 w. Elect'n, Lond—June 20, 1902. No. 49120 A.

POWER APPLICATIONS.

Cement Plant.

An Electric Cement-Making Plant. Illustrated description of a plant at Alsen, N. Y., which shows the adaptability of electric power to meet the requirements of cement-making machinery. 1000 w. Elec Wld & Engr—July 19, 1902. No. 49595.

Coal Cutting.

Three-Phase Electric Driving, Applied to Coal-Cutting. Roslyn Holiday. Gives reasons for adopting it, and some of the experiences met with before success was assured. 1500 w. Ir & Coal Trds Rev—July 18, 1902. No. 49634 A.

Cranes.

New Electric Cranes (Neuere Krane mit Elektrischem Antrieb). An illustrated description of various kinds of cranes operated electrically and manufactured by the Duisburg Machine Company. Serial. Part I. 1000 w. Zeitschr d Ver Deutscher Ing—June 28, 1902. No. 49420 D.

Electric Driving.

Advantages of Electric Transmission. F. J. A. Matthews. Discusses some points concerning the economy of electric power and steam power; the advantages of electric power, etc., showing that each case must be considered carefully to determine whether it will be economical. 3400 w. Mech Engr—July 19, 1902. Serial. 1st part. No. 49648.

Electric Driving for Shops. C. A. Seley. Read at the Saratoga Convention of the Mas. Mechs' Assn. A description of the regular motors for power purposes to be used at Roanoke shops of the Norfolk & Western Ry., the system of lighting, etc. 3200 w. R R Gaz—June 27, 1902. No. 49153.

The Driving of Centrifugal Machines. Illustrated description of an electrically-driven centrifugal made in Glasgow. 800 w. Engng—June 20, 1902. No. 49129 A.

The Electrical Equipment of the Nordberg Manufacturing Company's Plant. Illustrated description of a plant electrically driven throughout and, with the exception of the tool room, all machines are fitted with individual motors. 2500 w. Am Mach—July 3, 1902. No. 49236.

Electric Haulage.

Florence Mine. An illustrated description of some ingenious contrivances used in connection with the electric haulage system of this coal mine. 1500 w. Mines & Min—July, 1902. No. 49308 C.

Elevators.

Electric Elevators (Electrisch Betriebene Aufzüge). S. Herzog. A general discussion and illustrated descriptions of various European systems of electric elevators. Serial. Part I. 1800 w. Schweiz Bauzeitung—July 5, 1902. No. 49474 B.

Fan Motors.

Fan Motor Hints. Harry Hertzberg. Remarks on their design and use with some of the difficulties in their operation and methods of meeting them. 2500 w. Engr, U S A—June 16, 1902. No. 49072.

Hoisting Machines.

The Starting of Electric Hoisting Machines (Das Anlassen von Elektrischen Fördermaschinen). C. Köttgen. A paper before the Verband Deutscher Elektrotechniker, discussing various systems of electric hoisting for mine shafts, and especially the starting of the motor, with many diagrams. 4500 w. Elektrotech Zeitschr—July 10, 1902. No. 49411 B.

Mine Draining.

Electric Mine-Draining Plant at the Düsseldorf Exhibition. Illustrated description of an electric generating installation for working a draining pump. 800 w. Engng—July 11, 1902. No. 49541 A.

Paper Making.

Electrical Power at a Paper Mill. Illustrated description of a complete electrical power installation which has been in operation about a year at the Linwood Paper Mills, Renfrewshire, Scotland. 2000 w. Engr, Lond—July 18, 1902. No. 49632 A.

Pumping.

Electrically-Driven Centrifugal Pumps in the Horcajo Mines, Spain. Illustrates and describes a pumping plant in the lead mines of Spain. 4000 w. Engng—July 18, 1902. No. 40627 A.

Electric Pumping from a 1300-Foot Level. Donald H. Fry. Read before the Pacific Coast Elec. Trans. Assn. A brief description, with illustration, of an electrically driven pump recently installed at the Oneida mine, Amador Co., Cal. Also a comparison of electric power costs with fuel oil. 1000 w. Jour of Elec—June, 1902. No. 49506.

Proposed Electric Pumping for Stock Wells. A. J. Bowie, Jr. Read before the Pacific Coast Elec. Trans. Assn. Map and description of a proposed installation, stating the present conditions. 2200 w. Jour of Elec—June, 1902. No. 49507.

TRANSMISSION.

Continuous Current.

High-Tension Continuous-Current Systems. A. S. Barnard. Showing the advocates of the continuous-current plant are able to offer a reliable alternative to the three-phase generator and transformer. Also brief discussion. 3800 w. Elec Engr, Lond—July 4, 1902. No. 49346 A.

High-Voltage.

The 50,000-Volt Transmission of the Missouri River Power Company. W. G. McConnon. Illustrated detailed description of a plant using the highest transmission voltage, and transmitting power for 65 miles. 2400 w. Jour of Elec—June, 1902. No. 49504.

The 50,000-Volt Transmission Plant of the Missouri River Power Company. W. G. McConnon. Illustrated detailed description. 1000 w. Am Elect'n—July, 1902. No. 49254.

5-,000-Volt Transmission Plant of the Missouri River Power Co., at Cañon Ferry, Montana. W. G. McConnon. Describes a plant for transmitting electric power for 65 miles. 2000 w. Mines & Min—July, 1902. No. 49311 C.

Lightning Arresters.

Lightning Protection and the Static Interrupter. Percy H. Thomas. Considers ground and short circuits, local concentration of potential, effect of discharge of arrester, other causes of static strains, protection of apparatus, and the devices used. Ill. 6200 w. Can Engr—July, 1902. No. 49208.

Long Distance.

Success in Long-Distance Power Transmission. F. A. C. Perrine. A consideration of the problems met by the transmission engineer, the difficulties he must solve which differ from those presented in ordinary electric lines and currents. 6000 w. Tech Qr—June, 1902. No. 49325 E.

Self-Induction.

The Effects of Self-Induction and Capacity in Electric Transmission. G. H. Baillie. Considers to what extent they should be taken into account in practical work, giving formulæ applicable to the different systems of transmission. 1700 w. Elect'n, Lond—July 18, 1902. Serial. 1st part. No. 49618 A.

Surging.

Surges in Transmission Circuits. F. G. Baum. Read before the Pacific Coast Elec. Trans. Assn. Discusses opening a line under a load or short circuit; closing a high-potential line switch to charge the line; opening a high potential line switch to deaden the line. 1700 w. Jour of Elec—June, 1902. No. 49505.

MISCELLANY.

Exposition.

Electricity and Power Gas in Mining and Metallurgy (Der Bergbau auf der Düsseldorfer Ausstellung 1902. Elektricität und Kraftgas im Bergbau und Hüttenwesen). R. Goetze. Illustrated descriptions of electrical apparatus of various kinds of large gas engines. 11 plates. 7500 w. Glückauf—June 28, 1902. No. 49458 B.

Protection.

Protection of Electrical Machines. J. B. Clarke. Examines the reasons for non-protection in the case of a three-wire balanced system, showing what the balancer has to do. Ill. 800 w. Elec Rev, Lond—July 11, 1902. No. 49529 A.

Terminology.

Electrode Terminology. Albert M. Lewers. On the desirability of selecting some accurate system of designating the electrodes of secondary batteries and ending the confusion arising from the use of "positive" and "negative." 1300 w. Elec Wld & Engr—July 12, 1902. No. 49352.

GAS WORKS ENGINEERING

Acetylene.

The Actual State of the Calcium Carbide and Acetylene Industries (L'Etat Actuel de l'Industrie du Carbure de Calcium et de l'Acetylène). Dr. Oscar Münsterberg. Translated from *Zeitschrift für Beleuchtungswesen.* A general review of acetylene lighting, which the author believes is the best illuminating system for small cities and isolated buildings. 4500 w. Rev Gén des Sciences—June 15, 1902. No. 49-496 D.

Analysis.

The Analysis of Blast-Furnace and Generator Gases (Analyse der Hochofen und Generatorgase). A. Wencelius. A supplement to a previous article, giving an illustrated description of apparatus for gas analysis and its manipulation. 2000 w. Stahl u Eisen—June 15, 1902. No. 49447 D.

Blowing and Exhausting.

The Steam Turbine as Applied to Blowing and Exhausting Apparatus. W. D. Child. Read before the Gas Inst. (England). A description of the construction and working of the apparatus. Ill. Discussion. 7700 w. Gas Wld—June 14, 1902. No. 49066 A.

Burners.

Maintenance of Incandescent Gas Burners by Gas Companies. Norton H. Humphrys. Read before the Gas Inst., (England). Describes the methods adopted in regard to both private and public lighting.

2000 w. Gas Wld—June 14, 1902. No. 49063 A.

The Maintenance of Incandescent Burners in Private Houses and Public Lamps. George Helps. Discusses two cases of private lighting maintenance, standard of efficiency in public lighting, results and particulars. Ill. 3800 w. Gas Wld—July 19, 1902. No. 49624 A.

Coke-Conveyor.

A New Coke-Conveyor at the Cassel Gas-Works. Illustrated abstract translation of a description in the *Journal für Gasbeleuchtung*, by Herr E. Merz, of a recent installation of a modified De Brouwer conveyor. 2000 w. Jour Gas Lgt—July 1, 1902. No. 49265 A.

Distribution.

Efficiency and Economy in Gas Distribution. Walter Hole. Read before the Gas Inst. (England). Gives a brief description of remodeling and enlarging of mains in Leeds, and discusses matters affecting the distribution. Discussion. Ill. 7000 w. Gas Wld—June 14, 1902. No. 49068 A.

Enrichment.

Enrichment of Gas bv Benzol. A. Lecomte. Read before the Société Technique du Gaz en France. Describes apparatus employed in the process, giving tests made. Ill. 1200 w. Jour Gas Lgt—July 8, 1902. No. 49565 A.

Explosion.

Movements of the Flame in the Explosion of Gases. Harold B. Dixon. Abstract of a paper read at meeting of the Royal Society, on the extensive researches made by the writer. 6000 w. Jour Gas Lgt—July 1, 1902. No. 49264 A.

Gas Oils.

The Valuation of Gas Oils. John P. Leather. Read before the Gas Inst. (England). Discusses the constitution of the different classes of hydrocarbons found in petroleum and their bearing on the variations of the gas-producing qualities of the different oils. Also gives an outline of a method by which an oil may be examined for the amounts of the compounds composing it. Discussion follows. 4200 w. Gas Wld—June 14, 1902. No. 49067 A.

Heating.

Heating by Gas: A Study of the Gas Radiators of the Société Francaise de Chaleur et Lumiere. M. A. Lecomte. Abstract translation of paper read at meeting of the Société Technique de l'Industrie du Gaz en France. Gives calorimetric experiments and calculations, examinations of the air and the mode of combustion. Ill. 2300 w. Gas Wld—June 28, 1902. No. 49161 A.

Illuminants.

Some Modern Competitors with Coal Gas. A. Lecomte. Read before the recent congress of the Société Technique du Gaz en France. Brings up to date the technical details in regard to the illuminants, carburetted gas, "alcoholene," petroleum, and alcohol, devoting most attention to the last named. 2000 w. Jour Gas Lgt—July 1, 1902. No. 49266 A.

Measurement.

A New System of Gas Measurement. T. G. Marsh. Read before the Gas Inst. (England). A description of an apparatus that may serve the purpose of the station meter in a gas-works, or, within limits, of a consumer's meter. Discussion. 4800 w. Gas Wld—June 14, 1902. No. 49069 A.

Public Lamps.

Automatically Lighting and Extinguishing Public Lamps. W. R. Mealing. Read before the Gas Inst. (England). Describes the Gunning system and its operation. Short discussion. 3200 w. Gas Wld—June 14, 1902. No. 49070 A.

Smoke Prevention.

A New Method of Smoke Prevention (Ein Neues Verfahren zur Vollständigen Beseitigung und Unterdrückung des Schornstein-Rauches). Br. Böhm-Raffay. A description of the Tobiansky d'Altoff process in which the products of combustion of an ordinary furnace are carburetted to make so-called "pyrogas." 3000 w. Zeitschr d Oesterr Ing u Arch Vereines—June 13, 1902. No. 49439 B.

Standardization.

The Standardization of Screws for Gas Connections. J. Payet. Read before the Société Technique de l'Industrie du Gaz en France. Describes the international system in use for rods and bolts and explains how it may be applied to gas connections. 800 w. Prac Engr—July 4, 1902. No. 49342 A.

INDUSTRIAL ECONOMY

Africa.

Labor Conditions in Johannesburg. T. Lane Carter. A statement of the labor conditions of the past, and the future outlook. 2000 w. Eng & Min Jour—July 12, 1902. No. 49393.

Anthracite Mining.

Anthracite Mining Conditions. Review of statement issued by John Mitchell, President of the United Mine Workers, showing that the case of the strikers has not been truthfully presented. 3300 w. Eng & Min Jour—June 28, 1902. No. 49105.

Education.

Commercial Education in Japan. Information concerning the schools and their courses of study. 1800 w. Engng—July 4, 1902. No. 49370 A.

The Economic Need of Technical Education. Victor C. Alderson. Describes the schools for technical education in Switzerland and discusses the need in the United States. 5400 w. Jour W Soc of Engrs—June, 1902. No. 49298 D.

The Efficiency Factor in Engineering Education. Robert Fletcher. Condensed from the presidential address before the Soc. for the Promotion of Engng. Ed. Brief discussion of the substance, methods, machinery and cost of engineering education. 2400 w. Eng News—July 3, 1902. No. 49274.

The Practical Mechanic vs. the Mechanical Engineer. Editorial discussing executive ability, where the college man falls short, where he should begin, etc. 800 w. Loc Engng—July, 1902. No. 49204 C.

Exhibition.

Carlisle Show. Illustrated description of some of the implements exhibited at this show of the Royal Agricultural Society of England. 9700 w. Engng—July 11, 1902. No. 49538 A.

Premium Plan.

Shop Record System of the Pearson Machine Company. Describes methods in use in a shop which manufactures turret lathes, screw machines, forming and drilling machines, and horizontal boring machinery. 1300 w. Ir Trd Rev—July 3, 1902. No. 49224.

The Premium Plan at the Blank Blank Engineering Works. Gives figures showing in detail and in summary the workings of the premium plan as a whole in a plant which employs about four hundred men in all departments. 2000 w. Am Mach—June 26, 1902. No. 49088.

Prices.

The Trend of Prices in Engineering Industries. C. L. Redfield. A discussion of the influence of the increasing output and declining value of gold upon prices in connection with engineering work. 2500 w. Engineering Magazine—August, 1902. No. 49701 B.

Shipping Combine.

British and American Shipping. Benjamin Taylor. A discussion of the recent developments in maritime affairs, known as the "shipping combine ." 6200 w. Nineteenth Cent—July, 1902. No. 49532 D.

The Steamship Merger and American Shipbuilding. Charles H. Cramp. Briefly reviews the history of transatlantic construction and navigation, showing the conditions which existed and the effect which the merger is likely to have, and considering the probable effect upon shipbuilding. 4500 w. N Am Rev—July, 1902. No. 49300 D.

Strikes.

A General View of the Coal Strike. Talcott Williams. An explanation of conditions existing in the coal fields. 1700 w. Rev of Revs—July. 1902. No. 49328 C.

Strikes and the Public Welfare. John Handiboe. Advocating compulsory arbitration in troubles between capital and labor. 3000 w. N Am Rev—July, 1902. No. 49301 D.

Workshop Conditions.

Some Unacknowledged Conditions in British Workshops. T. Good. Interesting revelations concerning the prevalence of exactions by foremen upon the workmen, and their influence upon the works management. 2500 w. Engineering Magazine—August, 1902. No. 49705 B.

Works Management.

Money Making Management for Workshop and Factory. C. U. Carpenter. Mr. Carpenter's seventh paper discusses the various methods of the remuneration of workmen, including day work, piece work, and other wage systems. 5000 w. Engineering Magazine—August, 1902. No. 49708 B.

Some Aspects of Workshop Management. The first of a series of articles from the point of view of the British manufacturer, discussing systems of management, as they should be conducted. 2300 w. Engr, Lond—July 4, 1902. No. 49371 A.

MARINE AND NAVAL ENGINEERING

Boat-Launching.

The Peterson Boat-Launching Apparatus. An illustrated description of a system designed to meet severe requirements. 900 w. Sci Am Sup—June 28, 1902. No. 49094.

Chain Boats.

Chain Boats on the River Elbe. An account of the use of a chain for propelling steamers, which has proved an economical and successful means of navigating the swift current of this river. Ill. 1700 w. U S Cons Repts, No. 1384—July 5, 1902. No. 49148 D.

Coaling Plant.

Coaling Plant for the U. S. Navy at East Lamoine, Frenchman's Bay, Maine. J. A. McNicol. Brief illustrated description. 1300 w. Eng News—July 24, 1902. No. 49658.

Cruiser.

The Russian Cruiser Askold. Illustration, with description, of a type of vessel of interest because it is the result of competition in design, and because it represents a type discarded by all other nations. 1400 w. Engr, Lond—July 4, 1902. No. 49-376 A.

Dry Docks.

Dry Docks—Their Origin and Developbent. Parker H. Kemble in the *Boston Evening Transcript*. Reviews the various systems of reaching the bottoms of vessels for repairs, especially the docking of vessels. 2500 w. Marine Rev—July 24, 1902. No. 49686.

Testing the New Bermuda Dock. Harold J. Shepstone. An illustrated description of the test of this large dock by lifting the battleship "San Pareil." 1000 w. Sci Am—July 12, 1902. No. 49397.

Fog Signals.

Coast Fog Signals. N. G. Gedye. Read before the Civ. & Mech. Engrs'. Soc. Deals with the signals established on the coasts where fog is prevalent, for the guidance of the mariner. Ill. 2800 w. Engr, Lond—July 4, 1902. Serial, 1st part. No. 49378A.

German Fleet.

The Kaiser's Fleet. Archibald S. Hurd. Discusses the naval policy of Germany, the German Naval Bill of 1900, which authorizes the expenditure of 73,000,000 l. on new men-of-war and 13,000,000 l. on dockyards, and related matters of interest. 4500 w. Nineteenth Cent—July, 1902. No. 49533D.

Germany.

The Iron Industry and Shipbuilding in Germany (Eisenindustrie und Schiffbau in Deutschland). E. Schrödter. Abstact of a paper before the Schiffbautechnische Gessellschaft at Düsseldorf, giving an account of the growth of the German shipbuilding and iron industries, and comparisons with other countries. Diagrams and tables. Serial, Part I. 5000 w. Stahl u Eisen—July 1, 1902. No. 49448D.

Launch.

An Experimental Electric Launch. Prof. Oswald Flamm. Translated from *Schiffbau*. Illustrates and describes a boat built by the Watt-Accumulator Works in Zehdenick, on the Havel. 900 w. Marine Engng—July, 1902. Serial. 1st part. No. 49248C.

Marine Engines.

Balancing Marine Engines. Prof. W. E. Dalby. Read before the Inst. of Nav. Archts. A comparison of five types of engines with respect to their inertia forces and couples, their increases in weight due to the addition of balance-weights, and the variations of turning moment on their crankshafts. 4000 w. Engng—July 11, 1902. No. 49542A.

Navigation Congress.

International Navigation Congress at Düsseldorf. Begins a report of the proceedings, dealing very briefly with the subjects presented. 5000 w. Engng—July 4, 1902. Serial. 1st part. No. 49369A.

Oil Burning.

First Oil-Burning Steamship Built in the United States. Brief illustrated description of the "Nevadan," built at Camden, N. J., for the trans-Pacific trade. 500 w. Sci Am—July 19, 1902. No. 49571.

Projectiles.

Capped Armor-Piercing Projectiles. Discusses briefly the penetration of plates, and the action of capped projectiles. 1500 w. Engr, Lond—June 27, 1902. No. 49-179A.

Propellers.

Screw Propellers and Negative Slip. Robert M. Neilson. The writer's opinions on this subject, discussing several forms of propellers, and their action. 1800 w. Prac Engr—June 20 1902. No. 49118A.

Schooner.

Successful Launch of 7-Master. Describes the new seven-masted steel schooner, "Thomas W. Lawson," and the Fore River shipyard. 2300 w. Naut Gaz—July 17, 1902. No. 49578.

Shipbuilding.

A Remarkable Shipbuilding Feat, 13,000 Feet Above the Sea Level. An account of the construction and delivery of a steamship to be used on Lake Titicaca, 13,000 ft. above the sea. Ill. 1700 w. Sci Am—July 12, 1902. No. 49395.

Modern Shipway Equipment and Its Future Development. Tjard Schwarz. Translated from the *Jahrbuch der Schiffbautechnischen Gessellschaft*. Illustrates and describes recent devices for handling materials and for machine work. 8000 w. Marine Engng—July, 1902. Serial. 1st part. No. 49249C.

Progress of Warships and Machinery Building in England. A résumé of progress made in naval construction during the last six months. 2200 w. Engr, Lond—June 27, 1902. No. 49180 A.

Steamboat Building Under Difficulties. Edwin B. Sadtler. Illustrated discription of the building of the hull of the new steel steamer "Sagamore," which has been constructed on the shores of Lake George, in the village of Caldwell. 2200 w. Marine Engng—July, 1902. No. 49244 C.

Shipping.

The Messageries Maritimes. Information concerning this great French steamshipping concern, especially a report of this last year. 1000 w. Engng—July 4, 1902. No. 49367A.

Shipyard.

The Fore River Ship Building Shed. Illustrated description of a roof with 185 ft. clear span and 60 ft. overhang on either side and rising about 100 ft. above the floor. 1200 w. Eng Rec—July 26, 1902. No. 49641.

Steamboat.

New Excursion Steamboat. Brief description, with illustration, of the Nantasket, latest addition to the fleet in Boston harbor. 700 w. Naut Gaz—July 24, 1902. No. 49673.

Steamers.

New Passenger Propeller. Illustrated description of the "General Putnam," built for the New York and Greenwich route. 3300 w. Naut Gaz—July 10, 1902. No. 49517.

Pilot Steamer for Port Philip Harbor. Illustration and brief description of a steamer constructed completely in Australia. 300 w. 2-page plate. Engng—June 27, 1902. No. 49177A.

The Twin-Screw Steamers "Winifred" and "Sybil." Illustrated description of sister-boats built for the Uganda Railway, and intended to ply on the Lake of Victoria. 1300 w. Engng—June 20, 1902. No. 49128A.

Submarines.

Submarine Weapons in the Nineteenth Century. (Le Armi Subaquee nel Secolo XIX). Quintino Bonomo. A general review from the early experiments of Fulton, with especial reference to torpedoes. 10000 w. 3 plates. Rivista Marittima—June, 1902. No. 49710 H.

Tail Shafting.

Tail Shafting for Marine Engines. J. P. Badenhausen. Discusses the causes of breakage in propeller shafting, under the heads of poor material, strains, and corrosion. Ill. 2000 w. Marine Engng—July, 1902. No. 49246 C.

Turbo-Steamers.

Marine Steam Turbines. Comments on the experience gained with the turbo-motored steamers, "King Edward" and "Queen Alexandra," and the probability of this class of engine being extensively used. Ill. 600 w. Sci Am—July 19, 1902. No. 49570.

Yachts.

Steam Yacht Helenita. Illustrated detailed description of a handsome new steel yacht built for Frank J. Gould. 1300 w. Marine Engng—July, 1902. No. 49243C.

The President's Sumptuous Yacht. Describes the refitting of the *Mayflower,* the official yacht for the use of the president of the United States. 1000 w. Bul Am Ir & Steel Assn—July 25, 1902. No. 49612.

Yawl.

The Cruising Yawl "Windward." Brief illustrated description of a vessel designed to be as safe as possible and easily handled by a small crew. 700 w. Marine Engng—July, 1902. No. 49245 C.

MECHANICAL ENGINEERING

AUTOMOBILES.

Accidents.

The Causes of Automobile Accidents. M. C. Krarup. A presentation of the principal new factors introduced through automobilism, and affecting the safety of traffic on the highways. 4200 w. Horseless Age—July 16, 1902. Serial. 1st part. No. 49554.

Berlin Exhibition.

The German Automobile Exhibition at Berlin, 1902 (Die Deutsche Automobil-Ausstellung in Berlin, 1902). A general review of the automobiles exhibited, with some details. Ill. 1500 w. Zeitschr d Ver Deutscher Ing—June 14, 1902. No. 49415D.

Brakes.

Brake Test Demonstrations in Philadelphia. An account of a series of braking demonstrations before members of the city government, with results. 2300 w. Horseless Age—July 2, 1902. No. 49215.

Carburetter.

The Buck Carburetter. Illustrated description of a carburetter used in connection with a small stationary petrol engine where its carburetting action has been shown to be economical and efficient. 800 w. Autocar—July 19, 1902. No. 49613 A.

Condensers.

Atmospheric Steam Condensers. J. S. V. Bickford. An article objecting to some statements made by Mr. Stevens in regard to the efficiency of air condensers, and giving a report of experiments made and their results. 1800 w. Horseless Age—June 25, 1902. No. 49082.

Gasoline Vehicles.

How to Operate a Gasoline Carriage. Albert L. Clough. Discusses important points in the handling of the machine. 2800 w. Horseless Age—July 2, 1902. No. 49213.

Industrial Vehicles.

Commercial Possibilities of the Electric

Industrial Wagon. Frederick J. Newman. Discusses some of the problems to be solved, and considers the outlook encouraging. 2200 w. Horseless Age—July 2, 1902. No. 49214.

Kerosene Burners.

Experiments with Kerosene Burners. Henri G. Chatain. Gives illustrated descriptions of burners which represent the general line along which most burners are constructed, endeavoring to show why they fail. 2000 w. Horseless Age—June 25, 1902. No. 49083.

Long Run.

A 97 Mile Run by an Electromobile. An account of a run of ninety-seven miles on one charge, made by a British electric vehicle. 1400 w. Autocar—June 21, 1902. No. 49117 A.

Races.

The Paris-Vienna and Gordon-Bennett Races. An account of these interesting races, with illustrations of the vehicles. 6000 w. Auto Jour—July 5, 1902. No. 49-341 A.

The Paris-Vienna Motor Car Race. Begins a review of these races, the race for the Gordon-Bennett cup having occurred at the same time, with interesting comments on the industry and illustrations of vehicles. 2800 w. Engr, Lond—July 11, 1902. Serial, 1st part. No. 49543 A.

The Paris-Vienna Race. A full account of the race, with illustrations of the vehicles. 6500 w. Autocar—July 5, 1902. No. 49330 A.

Racing Car.

The 40 H. P. Gear Driven Napier, Built for the Gordon-Bennett Race. Brief description with illustration. 600 w. Autocar—June 28, 1902. No. 49160 A.

Speed Trials.

American Speed Trials. An account of the Staten Island races on May 31, describing the track, vehicles and the unfortunate accident. Ill. 3000 w. Autocar—June 21, 1902. No. 49116 A.

Steam and Gasoline.

Automobilism (Ueber Selbstfahrwesen). Captain Engels. A paper before the Verein für Eisenbahnkunde giving illustrated descriptions of various styles of gasoline and steam vehicles, and advocating their use instead of light railways in Germany and her colonies; with discussion. 10000 w. Glasers Annalen—July 1, 1902. No. 49426 D.

Steam Vehicles.

Adams Express Company's Steam Wagon. Illustrated description of a 2-ton wagon which has had two years actual use. Also particulars of a heavier model recently designed. 1600 w. Ir Trd Rev—July 3, 1902. No. 49226.

English Gardner-Serpollet Steam Cars and the British Power Traction and Lighting Company's Works. Illustrated detailed description of the system, and of the York works. 5000 w. Auto Jour—June 28, 1902. Serial. 1st part. No. 49162 A.

The First Steam Carriage. Angus Sinclair. Reviews the early history of steam engineering, and gives the credit of the first steam carriage to Robert Trevithick. 1200 w. Auto Mag—July, 1902. No. 49-280 C.

Storage Batteries.

The Storage Battery and the Motor Car. Thomas A. Edison. An account of the writers' new battery and the tests it has undergone in its application to automobiles. 1300 w. N Am Rev—July, 1902. No. 49299 D.

Tractor.

The Tractor in Lumbering Operations. An illustrated description of a freighting engine in use in California, and the results accomplished. 900 w. Sci Am—June 28, 1902. No. 49092.

Trials.

Competitive Trials of Parts. Albert L. Clough. Suggests the testing of the various parts of motor vehicles, such as batteries, coils, spark plugs, sparking generators, radiators, lock-nuts, lamps, tires, etc. 1000 w. Horseless Age—July 9, 1902. No. 49-501.

The Motor Bicycle Endurance Contest. C C. Bramwell. An account of the run from Boston on July 4th to New York. Ill. 800 w. Horseless Age—July 9. 1902. No. 49502.

HYDRAULICS.

Alpine Water-Power.

The Utilization of the Water Power of the French Alps (L'Utilisation des Chutes D'Eau dans les Alpes Françaises) R. Tavernier. A review of the possibilities of the hydraulic power of the French Alps, comparing the progress made in Italy and Switzerland, and discussing the conditions of profitable exploitation. 15000 w. Mem d l Soc d Ing Civils de France—May, 1902. No. 49476 G.

Baths.

Public Baths at the Paris Exposition (Ueber Arbeiter und Volkbäder, Waschvorrichtungen und Aborte auf der Weltausstellung Paris 1900). Anton Schnabel. Abstract of an illustrated report to the Austrian Government on public baths and washing facilities shown at the Paris Exposition, and account of a large public bath at Brussels. 3 plates. 3000 w. Oesterr Wochenschr f d Oeffent Baudienst—June 7, 1902. No. 49430 B.

The Bathing Arrangements at the Austrian Government Salt Works (Ueber

Badeeinrichtungen bei den K. K. Salinen). Anton Schnabel. An illustrated description of the baths and washing arrangements for the workmen of the Austrian salt mines. 3 plates. 3000 w. Oesterr Wochenschr f d Oeffent Baudienst—June 28, 1902. No. 49434 B.

Drainage.

House Drainage. A. B. Raymond. Read before the Mich. Engng Soc. On the proper manner of constructing the drains and pipes. 2000 w. Munic Engng—July, 1902. No. 49285 C.

Mine Pumping.

The Advantages and Disadvantages of Different Mine-Pumping Systems (Vorzüge und Nachteile Verschiedener Wasserhaltungs-Systeme). F. Schulte. A comparative discussion of the costs of steam and electric pumping for mines. Tables. 1800 w. Glückauf—June 21, 1902. No. 49457 B.

Plumbing.

Plumbing Regulations Criticised. Extract from a paper by Paul Gerhard, read before the health officers at Burlington, Vt. 2000 w. Dom Engng—June 25, 1902. No. 49104 C.

Water Supply in the Carnegie Residence, New York. Illustrated description of the remarkably complete work in a 70x130 ft. 4-story residence. 3000 w. Eng Rec—July 5, 1902. No. 49197.

Pumping.

See Electrical Engineering, Power Applications.

Pumping Engine.

Duty Test of a 6,000,000-Gallon Pumping Engine, Haverhill, Mass. Reviews a test, made under service conditions, of a horizontal cross-compound flywheel pump. 1200 w. Eng Rec—July 12, 1902. No. 49319.

Water-Power.

The Concord, N. H., Water Power Plant. An illustrated description of the plant and an account of its service. 2800 w. Elec Wld & Engr—July 12, 1902. No. 49351.

The Hydraulic End of Power Transmissions. John S. Eastwood. Read before the Pacific Coast Elec. Trans. Assn. Considers the water storage works, the conduit, the pipe lines, the water wheels and tail race. 4000 w. Jour of Elec—June, 1902. No. 49508.

MACHINE WORKS AND FOUNDRIES.

Accounting.

A New Factory Cost Accounting System. Wilfred Bancroft. Describes a method devised to furnish the fullest possible information about every operation, on every piece, in a machine containing some 1,500 pieces. 3800 w. Am Mach—July 24, 1902. No. 49655.

Aluminothermy.

Aluminum as a Reducing and a Heat-Producing Agent. H. O. Hofman. Reviews the commercial application of aluminum as a reducing agent, describing the processes. 4000 w. Tech Qr—June, 1902. No. 49322 E.

The Goldschmidt Aluminothermic Process and Its Applications (Das Goldschmidt'sche Aluminothermische Verfahren zur Erzeugung Hoher Temperaturen und seine Technischen Anwendungen). An illustrated account of applications of the thermite process in which high temperatures are evolved by the combustion of aluminum, to welding and mending. 1500 w. Glasers Annalen—June 15, 1902. No. 49424 D.

Annealing.

A Handy Heating and Annealing Oven. Walter J. May. Illustrates and describes an arrangement which can be used for an oven from 4 ft. to 20 ft. in length, in which it is possible to heat regularly from end to end either tubes, bars, or other forms of wrought material. 1300 w. Prac Engr—July 11, 1902. No. 49527 A.

Belting.

A Diagram for the Solution of Problems in Belting. Frank A. Kleinhans. Diagram is given and applications shown. 350 w. Am Mach—July 10, 1902. No. 49515.

Bridge Works.

The New Pittsburg Plant of the American Bridge Company. Plan and description of new works now being constructed 2500 w. Ir Age—June 26, 1902. No. 49-075.

Brown, Boveri & Co.

The Electric Manufacturing Works of Brown, Boveri & Co. at Mannheim, Germany (Die Fabrikanlagen von Brown, Boveri & Cie. A. G. in Käferthal bei Mannheim). A well-illustrated description of works for the manufacture of electrical apparatus, where electric driving is employed 1200 w. Zeitschr d Ver Deutscher Ing—June 21, 1902. No. 49417 D.

Cams.

A Cam Cutting Attachment for the Milling Machine. Brief illustrated description. 400 w. Am Mach—July 10, 1902. No. 49-510.

Chains.

Chains and Their Manufacture. An illustrated article discussing the various types and their manufacture. 3600 w. Ir Age—July 3, 1902. No. 49136.

Making Fifty-Ton Anchor Chains. Brief illustrated description of the manufacture of these chains at Lebanon, Pa. 700 w. Sci Am Sup—July 12, 1902. No. 49399.

Channelling.

Oil-Way Channelling Machine. Illustration, with description, of a machine for cutting the oil channels in journal brasses. 700 w. Engng—July 4, 1902. No. 49366 A.

Cranes.

Notes on Crane Design. Concerning the advantages and disadvantages of wire rope and chains, and other points in crane machinery. 1000 w. Am Mach—July 17, 1902. No. 49599.

See Electrical Engineering, Power Applications.

Cutting-Off.

German Cold Saw Cutting-Off Machines. Illustrations with brief descriptions of three machines made in Würtemberg. 500 w. Am Mach—July 17, 1902. No. 49600.

Designs.

From a Designer's Note Book. Brief sketches describing nuts, clamps, pulleys, etc. 1200 w. Am Mach—June 26, 1902. No. 49089.

Dies.

A Bending and Forming Die. C. H. Rowe. Illustrated description of die and punch. 600 w. Am Mach—July 24, 1902. No. 49656.

A Combination Blanking Die. William Doran. Illustrated description. 600 w. Am Mach—July 10, 1902. No. 49512.

A Complete Set of Dies for the Manufacture of Sheet Metal Hinges. Joseph V. Woodworth. Illustrated description of dies used for manufacturing sheet metal hinges and latches for grape crates at a minimum cost. 1200 w. Am Mach—July 3, 1902. No. 49238.

A "Follow-Die" Which Draws, Pierces, End-Finishes, Cuts Off and Bends in One Operation. Joseph V. Woodworth. Illustrates and describes the die and its operation. 600 w. Am Mach—June 26, 1902. No. 49085.

A Set of Dies for Rectangular Tin Boxes. Joseph V. Woodworth. Description and illustrations of dies for the production of vaseline boxes and covers. 1800 w. Am Mach—July 17, 1902. No. 49601.

Drawings.

Shop Drawings. A full description of the system in use at the shops of Messrs. David Rowan and Co. 3000 w. Engng—July 27, 1902. No. 49174 A.

Electric Driving.

See Electrical Engineering, Power Applications.

Ellipse.

A Ready Construction of the Ellipse. W. S. Buvinger. Gives curves giving radii for all ellipses at angles of 15, 30 and 60 degrees, measured from the center line. The curves have been constructed from mathematical calculation and are sufficiently accurate for ordinary work. 300 w. Am Mach—June 26, 1902. No. 49087.

Engineering Works.

Royles Engineering Works, Irlam. Illustrated description of new works, covering about five acres, near Manchester, England. They consist of iron and brass foundries, pattern shop and stores, machine and erecting shop, offices, etc. 1500 w. Engr, Lond—July 4, 1902. No. 49377 A.

Forced Fits.

Forced and Shrink Fits. C. D. King. Describes methods and explains the action of the metals and why the rough surface holds stronger than the very smooth. 800 w. Sci Am—June 28, 1902. No. 49090.

Forging Steel.

The Imperative Conditions for Forging Steel. From a paper by H. F. J. Porter, before the Engine Builders' Assn at Pittsburg. Briefly describes the processes considered necessary to manufacture the grade of forgings used by engine builders. 1800 w. Am Mach—July 3, 1902. No. 49239.

Grinding.

Grinding Machines and Processes. Joseph Horner. Describes recent developments in machines and their operation, new processes, etc. Ill. 3500 w. Engng—July 4, 1902. Serial. 1st part. No. 49364 A.

Surface Grinding Attachment for a Universal Grinder. Illustrations, with description. 600 w. Am Mach—July 24, 1902. No. 49654.

Hardening.

Hardening Thin Cutters. E. R. Markham. Hints as to methods of heating and arrangement of plates for cooling the work. Ill. 1200 w. Am Mach—June 26, 1902. No. 49086.

Laboratory.

Physical and Chemical Laboratory of the J. I. Case Threshing Machine Co., Racine, Wis. Illustrated description of this laboratory and the important features of the work. 3800 w. Eng News—July 10, 1902. No. 49387.

Lathe.

Automatic Screw-Cutting Lathe. Illustrates and describes a lathe which will cut screws up to 2 in. in diameter. Its movements are automatic, and right or left threads may be cut. 2000 w. Engng—July 18, 1902. No. 49629 A.

Machine Tools.

Copper Stay-Making Machines. Illustrates and describes an ingenious automatic tool. 1200 w. Engr, Lond—July 4, 1902. No. 49375 A.

Machine Works.

The Jones and Lamson Machine Co.'s Plant and Methods. Illustrated detailed description of a plant at Springfield, Vt. 4500 w. Ir Trd Rev—July 3, 1902. No. 49225.

Manufacturing Plant.

Some Features of the Works of the Stanley Elec. Mfg. Co. Illustrated description of the general arrangement of an electric manufacturing plant and the details of the power plant. 2700 w. Eng Rec—July 5, 1902. No. 49193.

Paints.

Anti-Corrosive Paints; Their Qualities and Composition. Discusses the capabilities of many of the so-called anti-corrosive paints in use, and offers suggestions for the production of a perfect painting compound. 4000 w. Engng—June 27, 1902. No. 49-173 A.

Patterns.

Patterns with Branches. I. McKim Chase. Illustrates the application of geometry to practical pattern making. 1500 w. Mach, N Y—July, 1902. No. 49252.

Premium System.

See Industrial Economy.

Shafting.

Shafting Hints. Charles Herrman. Calls attention to difficulties arising in connection with shafting, and gives suggestions for overcoming them. Ill. 2000 w. Power —July, 1902. No. 49140 C.

Tool Steels.

New Tool Steels and Their Advantages. A review of special steels now made, with report of tests showing character, and information concerning their use. 6800 w. Ir & Coal Trds Rev—June 20, 1902. No. 49134 A.

Variable Speed.

A New Variable Speed Mechanism. Walter Ferris. Illustrates and describes a recently invented device called a cone pulley transformer. 900 w. Am Mach—July 3, 1902. No. 49240.

Works Management.

See Industrial Economy.

MATERIALS OF CONSTRUCTION.

Alloys.

Notes on the Practical Melting of Alloys. Percy Longmuir. Deals with practical methods of producing good examples of the alloys used in the industrial arts. 1800 w. Prac Engr—June 20, 1902. No. 49-119 A.,

The Constitution of Alloys (La Constitution des Alliages). Leon Guillet. A comprehensive study of alloys and their physical, chemical and electrical properties. Diagrams and tables. Serial. Part I. 3000 w. Genie Civil—June 28, 1902. No. 49486 D.

Upon the Structure of Metals and Binary Alloys. William Campbell. Discusses methods of obtaining a knowledge of the structure, the crystalline structure, the effects of strain and the effect of heat treatment. Ill. 2900 w. Jour Fr Inst—July, 1902. Serial. 1st part. No. 49291 D.

Emery.

A Speed Trial of Emery Wheels as to Strength. T. Dunkin Paret. Gives information from Prof. Grübler's preliminary report concerning tests made in Germany to arrive at some verified data as to the speed which solid emery wheels could safely endure. 1300 w. R. R. Gaz—July 11, 1902. No. 49353.

Steel.

The Selection of Steel for Various Articles. Begins a list of a series of articles, giving the carbon contents which have been found by experience to be the most suitable for the purpose to which the steel has been put. 1800 w. Serial. 1st part. Ir Age—July 10, 1902. No. 49279.

Stresses.

A Diagram for the Combination of Direct and Shearing Stresses. E. R. Douglas. Gives diagram and explanation of its use. 600 w. Am Mach—July 10, 1902. No. 49511.

An Investigation Into the Stresses on the Framework of a Destroyer's Engines. Jasper E. Cooper. The present article investigates the stresses caused by the dead weight of the cylinders, by the steam pressure on the cylinder covers, by the steam pressure on the piston valves, and by the steam pressure transmitted to the guides by the connecting rod. 2000 w. Prac Engr—June 27, 1902. Serial, 1st part. No. 49159 A.

Testing.

The Accuracy and Value of Testing Cast Iron. Dr. Richard Moldenke. A discussion of American practice in testing, showing the aim to be the determination of the true value of the material apart from any particular casting. 2000 w. Engineering Magazine—August, 1902. No. 49706 B.

Testing Machine.

Experience with a Simple Babbitt Testing Machine. E. S. Farwell. Read before the Am. Assn. for the Ad. of Science. Illustrates and describes the machine and the improvements made upon it. 1600 w. Am Mach—July 24, 1902. No. 49657.

Tin-Plate.

The Manufacture of Tin-Plate. W. H. Tregoning. A review of this industry and the uses made of the tin-plate, the raw materials, the manufacture, etc. 4000 w. Ir. & Coal Trds Rev—June 20, 1902. No. 49133 A.

Lubricants.

Valve Oil. Editorial discussion of some of its characteristics, rate of feed in lubricators, fire test, effects of thick oil, packing boxes, etc. Loc Engng—July, 1902. No. 49203 C.

MEASUREMENT.

Calorimeter.

A Simple Form of Fuel Calorimeter. Charles R. Darling. Illustrated description of an instrument for which is claimed the advantages of simplicity in working, a visible combustion completely under control, and considerable accuracy. 1600 w. Engng—June 20, 1902. No. 49127 A.

Dynamometer.

A Water Dynamometer. Illustrates and describes a machine originally designed by William Froude for use in experiments on the propulsion of ships, but since modified for use with stationary engines. 1400 w. Engr, Lond—June 20, 1902. No. 49126 A.

Indicators.

Notes on Indicator Cards from Air Cylinders. Ward Raymond. Gives the principal uses of an indicator on the air cylinder, the characteristics of the various lines, tables of pressures, etc. 2000 w. Compressed Air—July, 1902 No. 49671.

Novelties in Spring Steam Gauges, Indicators and Valves (Neuerungen an Federmanometern, Indikatoren und Ventilen). P. H. Rosenkranz. Paper before the Hanover Section of the Verein deutch. Ing., giving illustrated descriptions of instruments and apparatus made by Dreyer, Rosenkranz & Droop. 2200 w. Zeitschr d Ver Deutscher Ing—July 5, 1902. No. 49-422 D.

Metric System.

The Metric System of Weights and Measures. Report of committee with general discussion. 8500 w. Jour Fr Inst—June, 1902. No. 49143 D.

Microscopic Measurements.

A Method of Measuring Objects in the Microscope. Frederick E. Ives. Directions with illustrations. 400 w. Jour Fr Inst—July, 1902. No. 49294 D.

Planimeter.

An Improved Arrangement of the Hatchet Planimeter. Frank B. Kleinhans. Shows the method of using the instrument. Ill. 800 w. Am Mach—July 17, 1902. No. 49602.

POWER AND TRANSMISSION.

Belts.

Belt-Problems. Shows how to overcome the difficulties met in making calculations where belts are employed. 2500 w. Prac Engr—June 27, 1902. No. 49158 A.

The Elasticity of Belts Taken from Different Parts of a Hide (Die Elastizität der an Verschiedenen Stellen einer Haut Entnommenen Treibriemen). C. Bach. An account of tests of leather belts to determine the elasticity and elongation of different parts of a hide. Tables and curves. 1500 w. Zeitschr d Ver Deutscher Ing—July 5, 1902. No. 49421 D.

Compressed Air.

Air Compressors at the Düsseldorf Exposition (Der Bergbau auf der Düsseldorfer Ausstellung 1902. Die Luftkompressoren). Hr. Müller. An illustrated description of various kinds of air compressors, particularly of those used for mining purposes. 8 plates. 3500 w. Glückauf—June 21, 1902. No. 49455 B.

Raising Liquids from Shafts, Boreholes, etc., by Means of Compressed Air. Victor Petit, in *Petroleum Industrial and Technical Review.* Illustrated descriptions of methods used. 1500 w. Compressed Air—July, 1902. No. 49672.

The Harris System of Pumping by Compressed Air, as Applied at the Deloro Mine. J. P. Kirkgaard. Illustrates and describes the displacement method applied. 2500 w. Compressed Air—July, 1902. No. 49670.

Conveying.

Rapid Transit of Material. Day Allen Willey. Illustrated description of various processes of the Brown Hoist, explaining their merits. 2000 w. Sci Am—July 5, 1902. No. 49268.

Friction.

Investigations of Adhesion and Sliding Friction (Untersuchungen über Adhäsion und Gleitende Reibung). Dr. Johann Basta. A mathematical discussion of the laws of friction in the light of recent experiments. 5,000 w. Oesterr Wochenschr f d Oeffent Baudienst—July 5, 1902. No. 49 435 B.

Power Plant.

Power Plant of the Frick Building, Pittsburg. Illustrates and describes the plant of this mammoth office-building of interest for its size, cost, magnificent finish and many mechanical problems that had to be solved. 4500 w. Engr, U S A—July 1, 1902. No. 49287.

The Mechanical Plant of a New York Office Building. Illustrated description of the installation in a 15-story building for heating, lighting and elevator service. 1500 w. Eng Rec—July 26, 1902. No. 49642.

The Mechanical Plant in the Rogers-Peet Building, New York. Illustrated description of a plant in an 8-story clothing house where a number of machines are driven electrically, and which has rather unusual accessories to the heating plant.

2200 w. Eng Rec—July 12, 1902. No. 49-320.

The Mechanical Plant of the Chicago Tribune Building. Brief illustrated description of the building and its equipment, especially the mechanical features. 3600 w. Eng Rec—June 28, 1902. No. 49151.

The Mechanical Plant of the First National Bank, Uniontown, Pa. Illustrated description of the electric, heating, and elevator plant in an 11-story office structure, 10,100 sq. ft, in plan. 1700 w. Eng Rec—July 5, 1902. No. 49196.

Ropeways.

The Bleichert Aerial Ropeways. Illustrated detailed description of this system of wire ropeway and its working. 3000 w. Ir & Coal Trds Rev—July 11, 1902. No. 49535 A.

Variable-Speed.

The Delagneaux Extensible Pulley (La Poulie Extensible du M. Delagneaux). An illustrated description of a pulley whose diameter can be varied on the principle of the "Nuremberg shears" and so vary the speed transmitted. 600 w. Bull Soc d'Encouragement—June, 1902. No. 49478 G.

Worm Gearing.

Worm Gearing with High Efficiency (Schneckengetriebe mit Hohem Wirkungsgrade). N. Westberg. An illustrated description of worm gears made by the Oerlikon Company, principally for use with electrical machinery with account of tests showing high efficiency. 3000 w. Zeitschr d Ver Deutscher Ing—June 21, 1902. No. 49416 D.

SPECIAL MOTORS.

Alcohol Motors.

Competition and Exhibition of Alcohol Motors and Other Apparatus at Paris (Concours et Exposition de Moteurs et Appareils Utilisant l'Alcool Dénaturé). G. Coupan. Description of motors, automobiles and boats using alcohol, and account of competition held at Paris, 1902. Tables. 5000 w. Génie Civil—June 21, 1902. No. 49484 D.

Scientific Tests of Alcohol Motors. M. C. Krarup. Discusses the results of this year's tests in France, the necessity of guarding against corrosion, the defective combustion of all explosive motors, etc. 3300 w. Ir Age—July 24, 1902. No. 49592.

The International Competition of Alcohol Motors and Apparatus (Concours International des Moteurs et Appareils Utilisant l'Alcool Dénaturé). H. Guérin. An illustrated description of alcohol lamps and heaters, exhibited at Paris, 1902. 2400 w. Génie Civil—June 14, 1902. No. 49481 D.

The Status of Alcohol as a Power Source. Marius C. Krarup. Discusses the results of the trials in Germany and France, and the interest of the question in the United States. 3300 w. Ir Age—July 10, 1902. No. 49278.

See Mechanical Engineering, Special Motors.

Gas Engines.

Gas Engines at the Düsseldorf Exposition (Düsseldorfer Ausstellung 1902. Grosse Gasmotoren). C. Volk. Illustrated descriptions of large gas engines, particularly those for using blast-furnace gas. 2500 w. Oesterr Zeitschr f Berg u Hüttenwesen—June 28, 1902. No. 49466 B.

Gas Engines at the Düsseldorf Exposition (Die Industrie und Gewerbeausstellung in Düsseldorf 1902. Die Gasmaschinen). R. Schöttler. A general review. Serial. Part I. 2500 w. Zeitschr d Ver Deutscher Ing—June 14, 1902. No. 49-413 D.

Gas Engine Piston Rings. James F. Hobart. Discusses the forms of rings, and how to make a nice wearing ring. 2200 w. Am Elect'n—July, 1902. No. 49-255.

Gas Engines for Rolling Mill (Zur Frage der Gas-Walzenzugmaschine). An illustrated description of a 700-H. P. gas engine, using blast-furnace gases, for driving a train of rolls. 1500 w. Stahl u Eisen —July 15, 1902. No. 49451 D.

Large Gas Engines and the Gases Used by Them. Dugald Clerk. Read before the Gas Inst. (England.) Describes the construction and working of some large gas engines on the continent using blast furnace and other gases. Discussion follows. 10400 w. Gas Wld—June 14, 1902. No. 49-062 A.

On Gas-Engine Temperatures. H. E. Wimperis. Gives some interesting deductions made from figures given in the last report of the Gas Engine Research Committee, with an explanation of the variability of the temperature throughout the mass of the gas. 3500 w. Engng—June 27, 1902. No. 49172 A.

700 Horse-Power Blast Furnace Gas Engine. Illustrated description of a double acting two-cycle gas engine of the Korting type, exhibited at the Düsseldorf Exhibition. 1100 w. Engng—June 27, 1902. No. 49176 A.

See Electrical Engineering, Miscellany.

Gasoline Engine.

Test of an Otto Gasoline Engine. E. C. Oliver. An illustrated account of tests made to obtain as accurately as possible a heat account or heat balance for the engine, and the temperatures within the cylinder at various points in the cycle. 1800 w. Am Mach—June 26, 1902. No. 49084.

The Determination of the Temperatures in a Gasoline Engine Cylinder. E. C. Oliver. Gives calculations made, explaining the data on which they are based. 1200 w. Am Mach—July 10, 1902. No. 49513.

STEAM ENGINEERING.

Boilers.

A Four Hundred Horse-Power Horizontal Return Tubular Boiler. Illustrated detailed description. 1400 w. Power—July, 1902. No. 49138 C.

Boiler Bracing. W. H. Wakeman. Discusses methods of bracing, and the principle upon which the theory of bracing rests. 1200 w. Elec, N Y—July 16, 1902. Serial. 1st part. No. 49563.

Boiler with Three Large Fire Tubes (Der Dreiflammrohrkessel). Prof. L. Lewicki. An illustrated description of the Paucksch boiler, which has a third fire tube under the two main ones, with account of tests showing rapid heating and steam raising powers. 2500 w. Zeitschr d Ver Deutscher Ing—June 21, 1902. No. 49418 D.

Connecting Boilers to Steam Mains. W. E. Snyder. Gives sketches of a number of connections from boilers in actual service, with discussion of practice. 1700 w. Power—July, 1902. No. 49142 C.

Report of the Committee on Naval Boilers. Begins the publication of the report of the committee appointed by the Admiralty to investigate the subject of navy boilers. 4800 w. Engng—July 11, 1902. Serial. 1st part. No. 49540 A.

Stationary Boilers and their Accessories at the Paris Exposition of 1900 (Exposition Universelle de Paris 1900: Les Chaudieres à Vapeur Fixes et Leurs Accessoires). E. Masson. A general review. Serial. Part I. 1 plate. 6500 w. Rev Universelle des Mines—May, 1902. No. 49,694 H.

Steam Boilers at the Düsseldorf Exposition (Der Bergbau auf der Düsseldorfer Ausstellung 1902. Die Dampfkessel.) Illustrated descriptions of boilers and auxiliary apparatus, particularly those used for mining purposes. Serial. Part I. 1 plate. 1000 w. Glückauf—June 21, 1902. No. 49-456 B.

The Flaring of Boiler Tubes. Calls attention to precautions that should be taken and explains the best practice. 1200 w. Locomotive—May, 1902. No. 49135.

Chimneys.

Brick Factory Chimneys: Some Features of Their Construction. William Wallace Christie. Read at meeting of the New England Cotton Mfrs. Assn. Discusses points in design and construction, materials, etc. 2500 w. Engr, U S A—July 15, 1902. No. 49591.

Novel Method of Erecting a Steel Stack. Illustrates and describes a method employed in erecting a stack at West Albany, N. Y., by which the entire stack was raised at one time. 700 w. Ir Age—July 21, 1902. No. 49594.

Draft.

Mechanical Draft. F. R. Still. Discusses the factors that make the fan more economical than chimney draft, even when that is good. Ill. 11000 w. Jour W Soc of Engrs—June, 1902. No. 49296 D.

Ejector-Condenser.

The Theory of the Ejector-Condenser and Experiments with a New Type (Théorie des Ejecto-Condenseurs et Expériences sur un Nouveau Type de ces Appareils). A. Rateau. Illustrated discussion of the theory of the Morton ejecto-condenser for steam engines, and account of experiments with a type designed by the author. 8500 w. Rev d Mécanique—June, 1902. No. 49477 E+F.

Emergencies.

Emergencies in the Boiler Room. R. A. Douglas. Calls atention to various emergencies and suggests what should be done to remedy the troubles. 4400 w. Am Elec'n—July, 1902. No. 49256.

Engines.

Dynamics of Reciprocating Engines. M. E. Cooley. Considers the forces to which the crank-pin is subjected, showing graphically the effect of the angularity of the connecting-rod and of the acceleration of the reciprocating parts. The discussion is confined to horizontal engines. 5200 w. Technic—1902. No. 49687 D.

500 Horse-Power Horizontal Compound Tandem Engine. Illustrations and brief description of an engine at the Düsseldorf Exhibition. 500 w. Engng—June 27, 1902. No. 49175 A.

700 Horse-Power Engines. Illustrations and account of the leading points in three sets of Corliss engines built recently in England. 1500 w. Engng—July 11, 1902. No. 49539 A.

The Correct Type of Engine for Large Generating Stations. A. A. Day. Read before the Incor. Munic. Elec. Assn. at Islington, England. Favors the low-speed type of engine, a horizontal compound or triple-expansion engine with direct-coupled generator between cranks, stating its advantages. Discussion. 7700 w. Elec Engr, Lond—July 11, 1902. No. 49582 A.

Firing.

Practical Hints on Firing. William Kavanagh. Illustrated discussion of different methods. 1700 w. Power—July, 1902. No. 49141 C.

Liquid Fuel.

Liquid Fuel for Steam Purposes. J. S. S. Brame. Considers the various methods of burning liquid fuel, estimations of the calorific value of different liquid fuels, cost, etc. 2800 w. Nature—June 19, 1902. No. 49112 A.

Texas Oil as a Steam Boiler Fuel. Gives results of experience in the use of Beaumont oil. 5200 w. Steam Engng—July 10, 1902. No. 49552.

Packing.

Observations on Metallic Packing. C. G. Robbins. A comparative study of the theories of fibrous and metallic packings and the reasons for the efficiency of the latter. Ill. 2000 w.Marine Engng—July, 1902. No. 49247 C.

Piston Heads and Packing Rings. J. H. Dunbar. Practical comments on the design and operation of steam engine pistons. Ill. 3000 w. Mach, N Y—July, 1902. No. 49251.

Scale.

Boiler Scale. William S. Bremner. Read before the Glasgow Branch of the Marine Engng. Assn. The treatment of the subject is almost altogether chemical. 3200 w. Engrs' Gaz—July, 1902. Serial. 1st part. No. 49334 A.

Shops.

Steam Engineering Department Shops, N. Y. Navy Yard. Illustrated description of the new shops which the writer thinks are the best built and best equipped shops for the repair and building of marine steam engines in the United States, if not in the world. 4000 w. Mach, N Y—July, 1902. No. 49250.

Smoke Prevention.

Smoke Consuming Furnaces (La Fumivorité des Foyers). V. Belugou. An illustrated description of the Sabourain smoke-consuming furnace and account of experience with it at the shops of the pneumatic tube company of Paris. 1200 w. Génie Civil—June 14, 1902. No. 49482 D.

See Gas Works Engineering.

Speed Regulation.

Adjustment and Regulation of the Rites Governor. F. M. Rites. Directions regarding its adjustment and regulation. 3500 w. Power—July, 1902. No. 49139 C.

Engine Speeds for Direct-Connected Alternators. Edgar Knowlton. Discusses the influence of speed on the amount of flywheel effect required. 1300 w. Elec Wld & Engr—July 26, 1902. No. 49652.

Spring Governor (Leistungs-Federregler). J. Stumpf. An illustrated description of a steam engine governor with a wide range, which will act both as a regulator and as a safety device. 2000 w. Zeitschr d Ver Deutscher Ing—June 14, 1902. No. 49414 D.

The Weight of Flywheels for Alternating Current Units. J. Begtrup. Gives method of determining the weight, illustrating by examples, and giving displacement curves of various types of engine. 1800 w. Am Mach—July 10, 1902. No. 49514.

Steam.

Rapid Steam Raising. G. W. Worrall. Discusses the Rapid steam-raising qualities of a boiler, and the methods of heating, fuel, etc. 1800 w. Horseless Age—July 9, 1902. No. 49503.

Steam. A reply to an article published in this paper on May 30. States existing theories of the nature of steam and examines observed phenomena. 4200 w. Engr, Lond—June 20, 1902. No. 49125 A.

Steam Plant.

Power Plant of the Champion Coated Paper Co., Hamilton, O. Fred W. Ballard. Illustrates and describes a plant of about 4000 h. p., in which almost complete use will be made of the exhaust steam. 4200 w. Engr, U S A—July 15, 1902. No. 49589.

Steam Turbines.

Steam Turbines. S. E. Fedden. Read before the Incor. Munic. Elec. Assn. at Islington, England. Calls attention to some of the advantages of the steam turbine when running under the conditions for working in a power station, and gives information of interest. 2000 w. Elec Engr, Lond—July 11, 1902. No. 49581 A.

The Steam Turbine at Hartford. Illustrates and describes briefly this turbine, the largest yet installed in the United States. 1000 w. Power—July, 1902. No. 49137 C.

Stoking.

The Economy of Mechanical Stoking. W. W. Christie. The second and concluding paper gives actual comparisons between machine and hand firing gathered from numerous tests. 3000 w. Engineering Magazine—August, 1902. No. 49707 B.

Stopping Devices.

Engine Safety Stopping Devices. James F. Hobart. Illustrated description of various forms in use. 1300 w. Am Elect'n—July, 1902. No. 49257.

Valves.

A Style of Valve Difficult to Set. H. H. Kelley. Concerning the piston valve used for high pressures, giving illustrations of various types, and suggestions for their adjustment. 2000 w. Engr, U S A—June 16, 1902. No. 49073.

Water Level.

The Water Level in a Battery of Boilers. W. H. Wakeman. Concerning the proper arrangement of feed pipes. Ill. 1100 w. Steam Engng—July, 1902. No. 49553.

MISCELLANY.

Address.

Master Mechanics' Association. Extract from the able address of President Waitt, discussing recent motive power improvements, the handling of traffic, etc. 2000 w. Am Engr & R R Jour—July, 1902. No. 49241 C.

Aeronautics.

The "Mellin" Air Ship. Illustrations with brief description. 500 w. Auto Jour—July 10. 1902. No. 49623 A.

By-Products.

The Census Bulletin on the Utilization of Wastes and By-Products. Reviews certain features of a paper by Henry C. Kittredge, criticizing some of the statements. 2000 w. Eng News—July 24, 1902. No. 49660.

Economy.

Comparative Economy of Structures. Gives problems showing methods of determining the relative economy of different structures or machines for accomplishing the same ends. 2200 w. Technic—-1902. No. 49688 D.

Gyrostatic Action.

Gyrostatic Action and Its Bearing on Certain Points of Enginering Design. W. R. Kelsey. An investigation of the nature and magnitude of the forces called into action when the plane of rotation of a revolving mass is turned through any angle. Ill. 1200 w. Elec Engr, Lond—July 18, 1902. No. 49617 A.

Heating.

Central Station Heating (Fernheizungen). Prof. Rietschel. Paper before the Berlin Section of the Ver. deutsch. Ing. on long distance steam heating in general, with a particular description of the great Dresden plant. 6000 w. Zeitschr d Ver Deutscher Ing—June 28, 1902. No. 49-419 D.

Heating and Ventilating a Residence with Steam. Illustrated detailed description of the system used in a large four-story residence in Middletown, N. Y. It provides direct, semi-direct and indirect radiation, and the open fireplaces are arranged to create an outflow or exhaust current of air. 2500 w. Met Work—July 5, 1902. No. 49198.

Pipe Sizes for Hot Water Heating. Charles L. Hubbard. An illustrated article considering the conditions that determine the size, and the method of computing the effect of each. 2800 w. Engr, U S A—July 1, 1902. No. 49288.

Refrigeration.

An English Municipal Ice and Cold Storage Plant. Brief description of the plant of the corporation of Wolverhampton. 1000 w. Eng Rec—July 26, 1902. No. 49643.

Commercial Methods of Cooling. Henry H. Kelley. Illustrated descriptions of various methods of producing low temperatures. 1300 w. Engr, U S A—July 15, 1902. No. 49590.

How to Buy or Build an Ice-Making Tank. William Nottberg. An illustrated article giving the writer's idea of the different insulations used in the construction of such tanks. 2200 w. Engr, U S A—July 1, 1902. No. 49289.

The U. S. Refrigerating Plant at Manila, P. I. Illustrated description of a 2-story plant 245 ft. square, built by the War Department for cold storage and ice making. 3000 w. Eng Rec—July 5, 1902. No. 49191.

Ventilation.

Ventilating and Heating the Rochester Athenaeum and Mechanics' Institute. Illustrated description of a plant embracing both hot-blast warming and ventilation, and direct and indirect steam heating, the air supply being passed through moist coke as a filter. 2200 w. Eng Rec—July 19, 1902. No. 49561.

Wire Glass.

Wire Glass (Conférence sur le Verre Armé). L. Appert. A well illustrated account of the manufacture and applications of glass with an internal wire network, with abstracts of the principal patents. 10000 w. Bull Soc d'Encouragement—June, 1902. No. 49479 G.

MINING AND METALLURGY

COAL AND COKE.

Africa.

Coal Supply of the Rand. From the *African Review*. Shows the areas from which coal may be drawn for use in the mines. 1000 w. Ir & Coal Trds Rev—July 4, 1902. No. 49362 A.

Anthracite Mines.

Anthracite Coal Mines and Mining. Rosamond D. Rhone. An illustrated article describing the mines, their ventilation, mining accidents, etc., the methods of mining and preparing the coal for market are also considered and related matters of interest. 7000 w. Rev of Revs—July, 1902. No. 49327 C.

Anthracite Mining.

See Industrial Economy.

Briquetting.

The Briquetting of Brown Coal (Die Entstehung des Braunkohlenbriketts). C. Kegel. A discussion of the physical and chemical properties of brown coal and their influence on processes of briquetting. 2000 w. Glückauf—July 5, 1902. No. 49-461 B.

China.

The Kaiping Coal Mines and Coal Field, Chihle Province, North China. Herbert C. Hoover. Read before the Inst. of Min. & Met. Gives the location, history, geology, character of the coal, coking qualities, mines and methods, and general information. 2200 w. Col Guard—June 25, 1902. No. 49170 A.

Coal Cutting.

Experiments with Coal-Cutting Machinery in the Ruhr District, Germany (Versuche mit Schrämmaschinen im Ruhrkohlenbecken). Hr. Kier. A discussion of coal cutting by machinery and illustrated descriptions of various machines. 3 plates. 7500 w. Glückauf—July 5, 1902. No. 49460 B.

The Application of Coal-Cutting Machines to Deep Mining. W. E. Garforth. Read before the Midland Inst. of Min., Civ., and Mech. Engrs. An illustrated article claiming that the difficulties experienced in deep mining may be overcome, and the coal worked economically. 2800 w Col Guard—July 1, 1902. Serial. 1st part. No. 49361 A.

See Electrical Engineering, Power Applications.

Coal Trade.

United States Coal Trade. Frederick E. Saward. Gives information concerning the important coal-producing districts. 2200 w. Loc Engng—July, 1902. No. 49-201 C.

Coke.

Notes on the Industrial Use of Gas Works Coke. Alexander Lencouchez. Read at meeting of the Société Technique du Gaz en France. Discusses how to burn gas coke, the heating of water and raising of steam, making producer gas, etc., etc. Ill. 3500 w. Gas Wld—July 12, 1902. No. 49525 A.

Depreciation.

Depreciation of Coal and Coke by Shipment. Report submitted at the International Navigation Congress, Düsseldorf. 3500 w. Engng—July 18, 1902. No. 49630 A.

Disaster.

The Fernie Colliery Disaster. C. H. Gibbons. An account of a disastrous explosion at Coal Creek, British Columbia, costing 151 lives. Ill., 1800 w. B. C. Min Rec—July, 1902. No. 49520 B.

Düsseldorf Exposition.

Ore Concentration, Coal Preparation Briquetting and Coke Manufacture with the Winning of By-Products (Der Bergbau auf der Düsseldorfer Ausstellung, 1902. Aufbereitung, Brikettierung und Kokereibetrieb mit Einschluss der Gewinnung von Nebenprodukten). Hr. Wendt. A general illustrated review of the exhibits in these departments of mining and metallurgy. 8 plates. 12000 w. Glückauf—July 12, 1902. No. 49462 B.

Nova Scotia.

On the Possible Occurrence of a Coal Area Beneath the Neo-Carboniferous or Permian Strata of Pictou County, Nova Scotia. Dr. H. M. Ami. An illustrated explanation of the geology of the district and reasons for supposing a new coal-field may be found. 2500 w. Can Min Rev—June 30, 1902. No. 49223 B.

Peat Fuel.

The Manufacture of Peat Fuel by the Aid of Electricity. Illustrates and describes the process invented by P. Jebsen, of Norway, in which the electric current is used to carbonize the dried peat in retorts of special design. 1000 w. Engr, Lond—June 27, 1902. No. 49182 A.,

Queensland.

Queensland Coal Fields. Information from the *Imperial Institute Journal* concerning the output and working of the various districts. 2500 w. Col Guard—June 25, 1902. No. 49171 A.

Thick Seam.

A Method of Working. William Charlton. Read before the So. Staffordshire and E. Worcestershire Inst. of Min. Engrs., England. Illustrates and describes the method of working the thick coal seam in two sections, at the New Hawne Colliery, Staffordshire, England. 1500 w. Mines & Min—July, 1902. No. 49310 C.

COPPER.

Alaska.

The Copper Deposits of the White, Tanana, and Copper River Regions of Alaska. Alfred H. Brooks. From the reports of the U. S. Geol. Survey, describing these regions and giving maps, and general information. 1200 w. Eng & Min Jour—July 5, 1902. No. 49234.

British Columbia.

The Ore Deposits of the Boundary (Creek) District, B. C. R. W. Brock. Describes the geology of the region very briefly, discussing the low-grade copper-bearing sulphide deposits, the oxydized copper veins, and the small gold and silver bearing quartz veins. 5500 w. Can Min Rev—June 30, 1902. No. 49222 B.

Deposits.

Recent Development of Southern Copper Deposits. Walter Harvey Weed. Information concerning the Ducktown district, the Virginia copper belt, and the Gold Hill district. 2000 w. Eng & Min Jour—July 19, 1902. No. 49577.

Queensland.

Copper Deposits of the Mount Perry District. Allan Gibb. Notes on these copper-bearing lodes, describing their occurrence and working. Ill. 5500 w. Q Gov Min Jour—May 15, 1902. No. 49390 C.

GOLD AND SILVER.

Africa.

West African Gold Mining and the Concessions Industry. John Geo. Leigh. A review of conditions on the Gold Coast, giving the true state of affairs on this over-exploited region. 4000 w. Engineering Magazine—August, 1902. No. 49702 B.

Cupelling.

A New Form of Cupel. Joseph Voyle. Describes using a kaolin slab for the cupelling and estimation of minute beads of gold and silver. 900 w. Min & Sci Pr—July 19, 1902. No. 49675.

Drift Mine.

The Kimble Drift Mine, El Dorado County, Col. George W. Kimble. Describes the mine, mode of working, timbering, ventilation, milling, etc. 1700 w. Min & Sci Pr—July 12, 1902. No. 49562.

Dry Crushing.

The Dry Crushing of Ore. Abstract of an important paper by Philip Argall, read at London, before the Inst. of Min. & Met. Discusses sampling and dry crushing referring more especially to the treatment of the telluride ores of Cripple Creek, Colorado. 4200 w. Eng & Min Jour—July 5, 1902. Serial. 1st part. No. 49232.

Extraction.

Extraction of Gold by Chlorobromuration (C. Grollet's Process). The process consists in the simultaneous employment of chlorine and bromine, with the aid of pressure in certain conditions. 2300 w. Min & Sci Pr—July 19, 1902. Serial. 1st part. No. 49674.

Ironsands.

Auriferous Ironsands of New Zealand. Information concerning these deposits on the east and west coats. 4800 w. N. Z. Mines Rec—May 16, 1902. No. 49113 B.

Japan.

Telluride Ore in Japan. E. W. Nardin. A short illustrated account of the Nojiri mine where the writer discovered tellurides of gold. 1200 w. Aust Min Stand—May 22, 1902. No. 49566 B.

Oil Furnaces.

Notes on Oil Furnaces for Assaying and Melting. Charles Brent. Illustrated description of furnaces used in the assay office and melting room, which may be constructed at small cost, and are in many ways more convenient than furnaces of the old type burning solid fuel. 2000 w. Can Min Rev—June 30, 1902. No. 49221 B.

Oregon.

Bohemia Mining District of Western Oregon. James P. Kimball. Map, and account of this district with statement of values of veinings as shown by present developments. 2000w. Eng & Min Jour—June 28, 1902. No. 49106.

Production.

The World's Production of Gold and Silver During 1901. Joseph Struthers. Tables and diagrammatic charts of the output of each metal in the principal countries of the world, showing recent progress. Explanatory notes. 2000 w. Eng and Min Jour—July 5, 1902. No. 49233.

Recovery.

Saving Gold from Black Sand. Explains the difficulty met in solving this problem, and considers the cyanide process the solution, precipitating the gold by the use of a current of electricity. 1200 w. Min & Sci Pr—June 28, 1902. No. 49216.

Slimes.

A New Treatment of the Slime Problem in Cyaniding Talcose Ores. Morrill D. Stackpole. A detailed description of the method to be employed at the Sunshine Mill, Utah. Ill. 1500 w. Eng & Min Jour —July 12, 1902. No. 49392.

Smelters.

British Columbia Smelters. E. Jacobs. Shows the gradual increase in the treatment capacity, and reports the smelter betterments. 1500 w. Eng & Min Jour—July 5, 1902. No. 49235.

The New Plant of the American Smelting and Refining Company at Murray, Utah. Brief description. 1200 w. Eng & Min Jour—June 28, 1902. No. 49107.

Tests.

Tests for Gold and Silver in Shales from Western Kansas. Waldemar Lindgren. Abstract of a bulletin of the U. S. Geol. Survey. Gives an account of the investigations, methods of testing, results, etc. 3000 w. Eng & Min Jour—July 26, 1902. No. 49646.

Transvaal.

The Gold Mines of the Transvaal. Comments on the development of these mines in South Africa, the future outlook, their contribution to mining knowledge, etc. 1600 w. Eng & Min Jour—July 5, 1902. No. 49230.

Veins.

Origin and Relations of the Auriferous Veins of Algoma (Western Ontario). W. O. Crosby. The writer's observations in the Michipicoten District are presented, with a general summary of Dr. A. P. Coleman's observations and conclusions, and a comparison of the theories of vein formation as applied to this field. Ill. 6800 w. Tech Qr—June, 1902. No. 49324 E.

Washington.

Notes on the Republic District, Washington, with Special Reference to the Metallurgy of Its Ores. J. C. Ralston. An account of this region which has produced about $1,400,000 in gold and silver, the silver being a small percentage. Ill. 4800 w. Eng & Min Jour—July 19, 1902. No. 49576.

Western Australia.

Western Australia: Its Progress and Resources. H. W. Venn. Contains information concerning the gold industry, and other mineral resources. Also brief discussion. 10000 w. Jour Soc of Arts—June 20, 1902. No. 49111 A.

IRON AND STEEL.

Analysis.

Contributions to the Analysis of Iron (Beiträge zu der Analyse des Eisens). Felix Bischoff. A discussion of the best methods for securing uniformity in the analysis of iron and steel, with diagrams and tables. Serial. 2 parts. 1 plate. 8000 w. Stahl u Eisen—July 1, 15, 1902. No. 49450 each D.

Australia.

Iron in Australia. W. H. Harrison. Reviews the history of past attempts at iron manufacture in Australia, with the conclusion that the Australian ores can be reduced to fibrous or wrought iron more readily than to cast or pig iron. 1600 w. Aust Min Stand—May 29, 1902. No. 49-567 B.

Calcium and Magnesium.

Calcium and Magnesium in Iron (Ueber einen Gehalt des Eisens an Calcium und Magnesium). Prof. A. Ledebur. An account of experiments showing that calcium and magnesium can combine with iron only in the electric furnace and in the presence of silicon. 1500 w. Stahl u Eisen—July 1, 1902. No. 49449 D.

Concentration.

The "Humboldt" Company's Pavilion for Ore Treatment and Concentration at the Düsseldorf Exposition (Düsseldorfer Ausstellung, 1902. Pavillon für Erzaufbereitung der Maschinenbauanstalt "Humboldt" in Kalk). An illustrated description of ore-treating apparatus and particularly of magnetic separators for iron ore. 2 plates. 1200 w. Oesterr Zeitschr f Berg u Hüttenwesen—June 14, 1902. No. 49-463 B.

Gas Analysis.

See Gas Works Engineering.

Germany.

See Marine Engineering.

Gutehoffnungs Works.

The Gutehoffnungs Iron and Steel Works (Die Werke der Gutehoffnungshütte.) A very well illustrated historical and descriptive account of these old and great works at Oberhausen, in the Rhineland. Serial. Part I. 2000 w. Zeitschr d Ver Deutscher Ing—July 12, 1902. No. 49423 D.

Lake Superior.

The Lake Superior Iron Ore Mines. L. Douglass Anderson. A description of the important mines of this region, methods of mining, development, discovery, etc. Ill. 6000 w. Technic—1902. No. 44690 D.

Malleable Iron.

The Manufacturing of Malleable Iron. Joseph V. Woodworth. An account of methods employed at Hoosick Falls, N. Y., in a large shop for the manufacture of machine parts. 1500 w. Am Mach—July 17, 1902. No. 49598.

Manufacture.

Manufacture of Iron and Steel. R. R. Neild. Read before the Canadian Ry. Club. Gives a brief outline of this important industry. 2500 w. Can Engr—July, 1902. No. 49212.

Melting.

A Queer Phenomenon in Melting. G. P. Blackiston. Gives evidence supporting the statement that iron and steel melt from the inside, the outside being the last to be converted to a liquid state. Ill. 700 w. Ir Age—July 24, 1902. No. 49593.

New Zealand.

Iron Ores and Sands of New Zealand. Sir James Hector. Brief description of the ores and statement of where they are found. 1000 w. N Z Mines Rec—May 16, 1902. No. 49115 B.

Open-Hearth.

American Open-Hearth Steel Plants (Amerikanische Siemens-Martin-Anlagen). Hermann Jllies. A well illustrated account of the Carnegie plants at Homestead and Duquesne, the Pencoyd and the Sharon plants. Two parts. Three plates. 2000 w. Stahl u Eisen—June 15. July 1, 1902. No. 49445 each D.

A Special Open-Hearth Steel Process (Eine Besondere Art des Erzprocesses im Martinofen). W. Schmidhammer. A description, with tables and diagrams, of charges for open-hearth furnaces consisting principally of pig iron and ore with no scrap, as used in the Ural and elsewhere. 1500 w. Stahl u Eisen—June 15, 1902. No. 49446 D.

Rails.

The Structure and Finishing Temperature of Steel Rails. Albert Sauveur. Read at meeting of Am. Soc. for Testing Materials. Discussion of the treatment of steel, with description and criticism of the Kennedy-Morrison rail finishing process. 2200 w. Ir Trd Rev—June 19, 1902. No. 49097.

MINING.

Discipline.

Discipline and Danger in Mines. R. W. Raymond. A discussion of the reckless-ness and wastefulness of miners, especially coal miners, 2400 w. Eng & Min Jour—July 26, 1902. No. 49644.

Drilling.

Rock Drilling Contest at Idaho Springs, Colorado. An illustrated account of contest with air drills, giving tabulated record. 1200 w. Min Rept—July 17, 1902. No. 49584.

Electric Haulage.

See Electrical Engineering, Power Applications.

Explosives.

Mining Explosives. James Tonge, Jr. Gives the theory of an explosion, with a description and classification of the explosives used in the coal mines of Great Britain. 3500 w. Mines & Min—July, 1902. No. 49306 C.

Faults.

Certain Conditions in Veins and Faults in Butte, Mont. William Braden. Briefly outlines the geology of this district, noting some characteristic features of a region containing one of the most wonderful vein systems known. Ill. 2000 w. Can Min Rev—June 31, 1902. No. 49219 B.

Faults in Metal Mines. Prof. Arthur Lakes. Illustrated description of the different types and their various manifestations, showing their effect upon ore deposition. 1700 w. Mines & Min—July, 1902. No. 49307 C.

Firedamp.

The Relation Between Firedamp Explosions and the Height of the Barometer in the Dortmund District, Germany, in 1901 (Die Schlagwetterexplosionen in Oberbergamtsbezirk Dortmund mit Beziehung auf den Barometerstand im Jahre, 1901). A record of observations, with tables and curves, and discussion. 1 plate. 2000 w. Glückauf—June 28, 1902. No. 49459 B.

France.

Government Report on French Mines. Information from the official report on the working of mines in France since July 1, 1899. The present article deals with the general conditions of the industry. 1500 w. Col Guard—July 11, 1902. Serial. 1st part. No. 49536 A.

Mining in France. A résumé of information from a recent report of the Minister of Public Works regarding the coal, iron and other mining industries. 1700 w. U. S Cons Repts, No. 1386—July 8, 1902. No. 49190 D.

Geological Survey.

The Geological Survey and the Western Miner. T. A. Rickard. On the value of the work of the survey to the miner, and the practical value of the work done, urging that it be made more timely. 1400 w. Eng & Min Jour—July 5, 1902. No. 49231.

Haulage.

Compressed-Air Haulage. Robert Peele. A comparison of the several forms of motor haulage, stating the particular advantages of compressed air for mine work. 4000 w. Mines & Min—July 1, 1902. No. 49312 C.

Different Methods of Hauling Ore at Bingham, Utah. W. P. Hardesty. Brief illustrated descriptions of recent improvements in transporation from the mines to the railroad. 3000 w. Eng News—July 24, 1902. No. 49659.

Hoisting Machines.

See Electrical Engineering, Power Applications.

Hoisting Ropes.

Hoisting Wire Rope Statistics for the Breslau District, Silesia, in 1901 (Statistik der Schachtförderseile im Oberbergamtsbezirke Breslau im Jahre 1901). Abstract from official reports on round and flat, iron and steel wire ropes, their life and breakage. 800 w. Oesterr Zeitschr f Berg u Hüttenwesen—June 14, 1902. No. 49-465 B.

Methods.

Mining Methods in America and Europe. Impressions of Capt. G. A. Richard from a recent tour through Canada, America, Great Britain and the Continent in the interest of a gold-mining company. 2300 w. N Z Mines Rec—June 16, 1902. No. 49-524 B.

Mine Draining.

See Electrical Engineering, Power Applications.

Ore Handling.

New Ore Handling Machinery. Waldon Fawcett. Illustrates and describes new devices for use on docks and in blast furnaces. 1600 w. Am Mfr—July 17, 1902. No. 49569.

Organization.

Commercial Mine Organization. Charles V. Jenkins. Shows the advantages of a systematic organization of the mine and office force, giving suggestions for bookkeeping. 5000 w. Mines and Min—July, 1902. No. 49305 C.

Pumping.

See Electrical Engineering, Power Applications.

Safety Lamps.

Safety Lamps and Colliery Explosions. James Ashworth. Discusses the safety value of various lamps, giving illustrations. 3300 w. Can Min Rev—June 30, 1902. No. 49218 B.

Shaft Sinking.

Description of Primary Operations and Temporary Plant Required for a Sinking Pit. Harold T. Foster. Describes the order in which the operations of setting out and erecting the surface arrangements should be approached, and the progress of the undertaking. Ill. 1700 w. Ir & Coal Trds Rev—July 4, 1902. No. 49363 A.

Shaft Sinking (Schachtabteufen). A review of compressed air, freezing and other recent processes. 1200 w. Oesterr Zeitschr f Berg u Hüttenwesen—June 14, 1902. No. 49464 B.

Sinking a Deep Coal Shaft at Atchison, Kansas. William R. Crane. Describes the sinking plant, and method of sinking. 2000 w. Eng & Min Jour—July 26, 1902. No. 49-645.

The Pattberg Boring Process and Its Application to Shaft Sinking (Das Stossbohrverfahren von Pattberg und seine Anwendung beim Abteufen der Schächte der Zeche Rheinpreussen in Lockerem Gebirge). L. Hoffmann. An illustrated description of a method of sinking shafts in soft ground, in which a frame, armed with a boring edge, loosens the soil, water is forced in and the mud is removed by a pump. 1 plate. 2000 w. Glückauf, June 14, 1902. No. 49545 B.

Ventilation.

Mine Ventilation Apparatus at the Düsseldorf Exposition (Der Bergbau auf der Düsseldorfer Ausstellung, 1902. Wetterführung unter Besonderer Berücksichtigung der Ventilatoren). Hr. Stein. An illustrated description of blowers, sprayers and other ventilating apparatus. 3 plates. 2500. Glückauf—June 14, 1902. No. 49-453 B.

The Advantages of Small Fans for Mine Ventilation. Considers the tendency to ventilate workings by means of one or more small quick-running fans, showing the method to be efficient and economical. 2000 w. Col Guard—June 20, 1902. No. 49124 A.

Winding Engine.

Horizontal Twin-Tandem Winding Engine. Illustrated detailed description of a powerful engine exhibited at the Düsseldorf Exhibition. 1000 w. Engng—June 20, 1902. No. 49130 A.

MISCELLANY.

Asbestos.

Asbestos and Its Production in Canada. W. Mollmann. Information concerning the localities, quality, methods of mining or quarrying, and the importance to Canada of the industry. 2500 w. Can Min Rev—June 30, 1902. No. 49220 B.

Bosnia-Herzegovina.

Mining and Metallurgy in Bosnia and Herzegovina for 1901 (Das Berg- und Hüttenwesen in Bosnien und der Hercegovina im Jahre 1901). Statistics, with tables. 1500 w. Oesterr Zeitschr f Berg u Hüttenwesen—July 5, 1902. No. 49468 B.

Japan.

The Mineral Products of Japan. Information concerning gold, coal, iron, copper, etc. 1000 w. Jour Soc of Arts—July 18, 1902. No. 49616 A.

Joplin, Mo.

Zinc and Lead in the Joplin Field. Albert Phenis. On the development of this district, considering that many years will be required to develop the proved territory. 2200 w. Mfrs Rec—July 10, 1902. No. 49267.

Lithographic Stone.

The Lithographic Stone Deposits of Eastern Kentucky. E. O. Ulrich. Map, with description of the deposits and statement of their value. 1800 w. Eng & Min Jour—June 28, 1902. No. 49108.

Mica.

The Canadian Mica Industry (L'Industrie du Mica au Canada). A. Ladureau. A brief review of the mica industry in general and that of Canada in particular. 800 w. Génie Civil—June 14, 1902. No. 49483 D.

Petroleum.

The Geology of the Roumanian Oil Regions (Geologische Verhältnisse der Erdölzonen in Rumänien). Prof. Mrazek. Abstract of a government report. 2000 w. Oesterr Zeitschr f Berg u Hüttenwesen—July 5, 1902. No. 49467 B.

The Origin of Petroleum. Julius Ohly. Gives different theories which have been advanced and the circumstances for and against them. 3000 w. Mines & Min—July, 1902. No. 49304 C.

Platinum.

Micro-Crystalline Structure of Platinum. Thomas Andrews. Read before the Royal Soc. An interesting illustrated study. 1000 w. Engng—June 27, 1902. No. 49178 A.

Quarries.

The Granite Quarries of Yr Eifl. Illustrates and describes these interesting quarries in Wales. 2600 w. Quarry—July, 1902. No. 49332 A.

Salt Deposits.

The Formation and Geology of the Salt Deposits. F. O. Jones. An explanation of their formation and account of the causes that contributed. Ill. 2200 w. Sci Am—July 26, 1902. No. 49681.

Sapphires.

The Sapphire Fields of Anakie. B. Dunstan. Locates and describes these sapphire fields in Central Queensland. Ill. 11800 w. Q Gov Min Jour—May 15, 1902. Serial. 1st part. No. 49391 C.

Silesia.

Mining and Metallurgy in Upper Silesia for 1901 (Statistik der Oberschlesischen

Berg- und Hüttenwerke für das Jahr 1901). Statistics, with tables, of iron and steel, coal and coke, zinc, lead, silver and sulphur. Two parts. 2400 w. Oesterr Zeitschr f Berg u Hüttenwesen—July 5 and 12, 1902. No. 49470 each B.

Titanium.

Production of Titanium Ores. W. O. Snelling. Information concerning the deposits, their uses, methods of preparing titanium alloys, etc. 2600 w. Am Mfr—July 24, 1902. No. 49682.

Transvaal.

The Geology of the Transvaal, Particularly of the Ore Beds (Die Geologie der Südafrikanischen Republik Transvaal unter Besonderer Berücksichtigung der Lagerstätten). Karl A. Redlich. Review of an article by Molengraf in *Bulletin de la Société Géol. de France,* on the gold reefs and other geological features. 1400 w. Oesterr Zeitschr f Berg u Hüttenwesen. July 12, 1802. No. 49469 B.

Volcanoes.

Volcanoes. Prof. Arthur Lakes. An illustrated article considering the manner of their eruption, their effect upon the deposition of minerals, and their relation to the mining fields in Colorado. 3000 w. Mines & Min—July, 1902. No. 49309 C.

Zinc Smelting.

The Picard and Sulman Method of Zinc Smelting. Brief account of this method with comments. 1200 w. Eng & Min Jour—July 26, 1902. No. 49647.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

Railroad Accidents for the Last Quarter of 1901. A summary from the recently issued report of the Interstate Commerce Commission. 1700 w. R R Gaz—June 27, 1902. No. 49157.

Coal Carrying.

The Anthracite-Carrying Railways. H. T. Newcomb. A statement of the conditions connected with anthracite transportation, and the difficulties arising. 2000 w. Rev of Revs—July, 1902. No. 49-329 C.

Employees.

The Superintendent, the Conductor and the Engineman. B. B. Adams. Discusses the relation of these men to the collision record. 7000 w. R. R. Gaz—July 18, 1902. No. 49608.

Fast Runs.

New York to Chicago in Twenty Hours. Information concerning runs made by the new twenty-hour trains between New York and Chicago. Ill. 700 w. Ry Age—July 25, 1902. No. 49683.

Resistance.

Train Resistance. A. H. Armstrong. Considers the question of train friction, comparing the data from different tests. 2500 w. St Ry Jour—July 5, 1902. No. 49-262 D.

Train Resistance Formulæ. John Balch Blood. A discussion of the formulæ deduced by Mr. Davis, based on a series of tests on the Buffalo & Lockport Ry. 2000 w. St Ry Jour—July 5, 1902. No. 49263 D.

Train Speeds.

Train Speeds in Germany and America. Extracts from article by George C. Tunell, in the June number of the *Journal of Political Economy.* Discusses statements made in paper by W. Schulze, and the comparisons made. 2700 w. Ry Age—July 18, 1902. No. 49568.

MOTIVE POWER AND EQUIPMENT.

Car Lighting.

Car Lighting. L. T. Canfield. Topical discussion at the Mas. Car Bldrs. Assn. Discusses the Pintsch light, and the electric light principally. 2000 w. R R Gaz—July 11, 1902. No. 49354.

The Lighting of Railway Cars (L'Eclairage des Voitures de Chemins de Fer). J. Carlier. A comprehensive, illustrated review of all methods of lighting cars by candles, oil, gas, acetylene, electricity, etc. Serial. Part 1. 7000 w. Rev Universelles des Mines—May, 1902. No. 49695 H.

The Electric Lighting of Trains (Eclairage Electrique des Trains). M. Jacquin. A comprehensive illustrated account of the principal systems of car lighting by electricity. Two parts. 2000 w. Bull Soc Internationale des Electriciens—May and June, 1902. No. 49493 each E.

Cars.

Test of 100,000 Lbs. Capacity Steel Dump Cars for Colorado Fuel & Iron Co. Illustration, with report of loading tests. 600 w. Ry & Engng Rev—July 12, 1902. No. 49519.

Compressed Air.

Compressed Air Locomotives. Illustrated description of locomotives for yard service in the Invalides Station in Paris. 1200 w. Sci Am Sup—June 28, 1902. No. 49095.

Continental Practice.

Features of European Locomotive Construction. Charles R. King. Mr. King's concluding paper discusses the engines of Switzerland, Saxony, Russian and northern Europe generally. 4500 w. Engineering Magazine—August, 1902. No. 49703 B.

Economizer.

An Improved Fuel Economizer and Smoke Consumer. Illustrated detailed description, with results of tests of an improved device which is to be applied to all new passenger engines on the N. Y. C. & H. R. R. R. and also on other roads. 2000 w. Ry & Engng Rev—June 28, 1902. No. 49102.

Electric Traction.

Electric Problems of Main-Line Railway Traction. Charles T. Child. A thoughtful examination of the fundamental conditions of the problem, showing the limitations of modern electric motors for railway use. 2500 w. Engineering Magazine—August, 1902. No. 49704 B.

The Relative Efficiency of Electric and Steam Locomotives (Die Leistungsfähigkeit der durch den Elektrischen Strom und der durch Dampfkraft Betriebenen Lokomotiven). Hr. Beyer. A general discussion of electric vs. steam traction on standard railways. 1800 w. Glasers Annalen—July 1, 1902. No. 49427 D.

Electric Traction in Its Relation to Existing Railways. J. W. Jacomb-Hood. Read before the London & Southwestern Ry. Debating Soc. A discussion of the subject from the point of view of a practical railway operator. Considers the possible advantages of electricity over steam, service, etc. 3700 w. Transport—July 11, 1902. Serial. 1st part. No. 49523 A.

Feed-Water Heater.

M. N. Forney's Feed-Water Heater for Locomotives. Illustrated description from advance sheets of a pamphlet by Mr. Forney. 4700 w. R R Gaz—June 27, 1902. No. 49155.

Fire Prevention.

Railway Fire Prevention. Major Fox. Considers the most important points relating to fire dangers and fire appliances in their relation to railway companies. 2200 w. Transport—July 4, 1902. No. 49338 A.

Friction Tests.

Tests of the Friction of Side Bearings and Center Plates for Freight Cars. Abstract of a report of a special committee of the Mass. Car Bldrs. Assn., giving account of tests, with results and conclusions. 4000 w. Eng News—July 10, 1902. No. 49388.

Frozen Pipes.

Frozen Train Pipes, Their Cause and Prevention. Parts of the discussion of the second report presented at the Air-Brake Convention at Pittsburg. 3500 w. R R Gaz—July 18, 1902. No. 49611.

Locomotive Repairs.

Crosshead and Piston Rod Connection. Roger Atkinson. The causes of failures are discussed, and the methods of overcoming the difficulties. 1000 w. R R Gaz—July 18, 1902. No. 49609.

Locomotives.

Consolidation Freight Locomotive for the New York, Chicago and St. Louis Railroad. Illustrated description. 600 w. Ry Mas Mech—July, 1902. No. 49549.

Eight-Wheeled Six-Coupled Tank Engine. Illustrations with brief description of engines for the Bombay, Baroda and Central India Ry. to meet unusual conditions of service. 300 w. Engr, Lond—June 27, 1902. No. 49181 A.

European Railway Jottings. Charles Rous-Marten. Discusses the growing popularity of ten-wheel passenger engines, illustrating a new engine, and considering a decapod suburban engine and powerful French engines. 1600 w. Loc Engng—July, 1902. No. 49200 C.

Express Engine, Great Central Railway. Illustration, with description of an engine for through express passenger traffic. 800 w. Engr, Lond—July 4, 1902. No. 49379 A.

Four-Cylinder Compound Locomotives with Goelsdorf Steam Distribution System (Nouvelles Locomotives Compound à Quatre Cylindres à Dispositif de Démarrage Système Goelsdorf). Illustrated description of Atlantic type locomitives for the Austrian government railways. 2500 w. Génie Civil—July 12, 1902. No. 49489 D.

Goods Locomotive for the Southern Railway of France. Illustrated detailed description of a compound engine. 1700 w. Engng—July 18, 1902. No. 49628 A.

Helping Engines. F. F. Gaines. Read before the Saratoga Convention of the Mas. Mechs' Assn. Considers the conditions that determine the economy of using a helper, and the factors which determine the size. 2500 w. R R Gaz—June 27, 1902. No. 49154.

Locomotives for the Mexican Southern. General dimensions with illustrations, of a ten-wheel narrow-gauge engine, and a consolidation narrow-gauge engine. 500 w. Ry Mas Mech—July, 1902. No. 49550.

Mineral Locomotive, London and North Western Railway. Illustration with brief description. 350 w. Engr, Lond—July 18, 1902. No. 49633 A.

Modern Locomotive Engine Management. T. McHattie. Read before the Canadian Elec. Club. Comments on the improvements made in the locomotives of the last thirty years, and the modern safety methods and appliances, and the requirements for handling them. 1600 w. Can Engr—July, 1902. No. 49211.

The Construction of a First-Class French Locomotive. Describes the construction of a first-class four-cylinder compound express engine as carried out at the Belfort works. 3200 w. Engr, Lond—July 4, 1902. Serial. 1st part. No. 49374 A.

The Oldest-Working Locomotive in the World. Illustrates and describes an engine built by George Stephenson in 1822, still at work after 80 years of continuous service on the Hetton Railway. 800 w. Engr, Lond—July 18, 1902. No. 49631 A.

The Schmidt Locomotive. Illustrated description of interesting locomotives adapted for the use of superheated steam on the Schmidt system, with information concerning their performance. 2000 w. Engng—June 20, 1902. No. 49131 A.

Why Large Locomotives Lack Economical Efficiency. F. P. Roesch. Practical demonstration on the road, of theory enunciated by Prof. Goss. 2700 w. Loc Engng —July, 1902. No. 49202 C.

Motive Power.

The Situation With Motive Power. From the address of A. M. Waitt at the convention of the Am. Ry. Mas. Mechs' Assn. Reviews the developments of the last five years, considering locomotive design and construction, operating expenses and efficiency, shop practice, etc. 4000 w. Ry & Engng Rev—June 28, 1902. No. 49-103.

Oil Fuel.

Apparatus Used in Roumania for Burning Petroleum Residues in Locomotives (Des Dispositifs Employé en Roumanie pour Bruler les Résidus de Pétrole dans les Locomotives). Illustrated descriptions of the Urquhart, Holden and Körting oil burners. 600 w. Rev Technique—June 25, 1902. No. 49712 D.

The Use of Oil Fuel on the Southern Pacific. P. Sheedy. Drawings and description of the arrangements for burning fuel oil on the engines. 700 w. Am Engr & R R Jour—July, 1902. No. 49242 C.

Truck Springs.

Equalizing Apparatus for Bogie-Trucks (Rückstellvorrichtung für Drehgestelle bei Lokomotiven). M. Kuhn. An illustrated description of hydraulic, spring and lever apparatus for equalizing the turning and side-motions of locomotive bogie-trucks. 1800 w. Glasers Annalen—June 15, 1902. No. 49425 D.

Valve Gear.

Valve Gear for Four-Cylinder Balanced Compound Locomotives—Von Borries Patent. From an article in *Glasers Annalen für Gewerbe und Bauwesen*. Illustrated description. 600 w. R R Gaz—July 25, 1902. No. 49666.

Water Supply.

Modern Water Supply for Locomotives. F. M. Whyte. Extracts from a report to the Mas. Mechs' Assn. Showing the present "state of the art." Considers the sources, pumping power, reservoir tanks, water cranes, track tanks, etc. Followed by general discussion. 7000 w. R R Gaz—July 11, 1902. No. 49357.

NEW PROJECTS.

Abyssinia.

Railways in Abyssinia. A summary of the situation concerning railway communication and a discussion of the effect. 1700 w. Transport—July 18, 1902. No. 49614 A.

Africa.

Prospective Railway Development in British Equatorial Africa. C. Stewart Betton. Describes this region, discussing the difficulties to be met, etc. 3800 w. Jour Soc of Arts—July 4, 1902. No. 49-331 A.

The Cape to Cairo Railway. Information concerning railroad development in South Africa. 800 w. U S Cons Repts, No. 1393—July 16, 1902. No. 49389 D.

Bridgeport, Conn.

The Bridgeport Improvement on the New York, New Haven & Hartford. Illustrates and describes extensive improvements, including a viaduct which will eliminate some 25 grade-crossings, a large new station, etc. 2800 w. R R Gaz—July 25, 1902. No. 49664.

Mountain Ry.

The Alamogordo & Sacramento Mountain Ry. Illustrations with brief description of a road presenting unusual engineering problems. 500 w. Ry & Engng Rev—July 19, 1902. No. 49588.

The Famous Oroya Railroad of Peru, Which Climbs Higher Than Any Other on the Globe. E. C. Rost. A brief account of a road which is at one point 15,665 ft. above the starting point. Ill. 1300 w Sci Am—July 12, 1902. No. 49396.

Switzerland.

The Ricken Railway (Neue Schweizerische Eisenbahnprojekte. III. Die Rickenbahn). Robert Moser. A discussion of various routes for a projected railway in the Canton of St. Gall. Maps. Serial. 2 parts. 4500 w. Schweiz Bauzeitung—July 5 and 12, 1902. No. 49473 each B.

Tehuantepec Railroad.

The Tehuantepee Railroad vs. the Isthmian Canal. An illustrated account of the rebuilding of this interesting road, which, it is thought, will prove a serious competitor of the Isthmian canal. 2200 w. Sci Am—July 26, 1902. No. 49680.

PERMANENT WAY AND BUILDINGS.

Engine Sheds.

The Slades Green Engine Sheds and Electrical Equipment. An illustrated description of the applications of electricity at these sheds of the South-Eastern &

We supply copies of these articles. See page 975.

Chatham Ry., England. 1600 w. Transport—July 11, 1902. No. 49522 A.

Grade Crossings.

Railway Grade Crossing Protection in Texas. Gives the Texas Railroad Commission's requirements and recommendations for interlocking systems. 2000 w. Eng News—July 17, 1902. No. 49603.

Grades.

What is Meant by a Grade Stated in Per Cent? Carl Hering. An explanation. 800 w. St Ry Jour—July 19, 1902. No. 49580 D.

Grain Elevators.

Grain Elevators of the Grand Trunk Ry. at Portland, Me. Illustrates and describes the elevators and conveying system at Portland. The most recently completed elevator has a capacity of 1,500,000 bushels. Many interesting features are described. 1700 w. Ry & Engng Rev—July 12, 1902. No. 49518.

Rails.

Steel Rails: Relations between Structure and Durability. Robert Job. A report of investigations made to determine qualities which resulted in fractures, or in rapid wear in service, and to find the means of reducing these to a minimum. Plates. 3900 w. Jour Fr Inst—July, 1902. Serial. 1st part. No. 49292 D.

See Mining and Metallurgy, Iron and Steel.

Roundhouses.

Up-to-Date Roundhouses. A committee report of the Master Mechanics' Assn. in which Mr. Robert Quayle describes and discusses plans of terminals recently constructed; Mr. D. Van Alstine presents his ideas of an ideal plan; Mr. G. M. Basford considers the details of terminals, and Mr. V. B. Lang discusses the operation of locomotive terminals. Ill. 6000 w. R R Gaz—June 27, 1902. No. 49152.

Scotland.

"Boulder" Signalling and New Express Locomotives on the Caledonian Railway. Norman D. Macdonald. A description of the unique arrangements for safety over a road made dangerous by falling rocks. Also illustrated descriptions of the locomotives used. 1100 w. Ry Age—July 25, 1902. No. 49684.

Shops.

The Chicago and Alton Shops at Bloomington, Ill. An illustrated description of these extensively remodeled shops and their new equipment. 3200 w. R R Gaz—June 27, 1902. No. 49156.

Signals.

Automatic Train Order Signal, Hocking Valley Ry. An illustrated description of the De Wallace system, which gives automatically a warning to the engineer, and automatically stops the train. 1600 w. Ry & Engng Rev—July 19, 1902. No. 49587.

Signaling Fast Trains in Fog. Editorial discussion, with suggestion that the signal be sounded for "all right" instead of sounding for "stop" or "caution." 2500 w. R R Gaz—July 11, 1902. No. 49358.

The Electric Danger Signals on the Erie Railroad. Illustrated description of the auto-electric installation in the Bergen tunnel, Jersey City. 1400 w. Elec Rev, N Y—July 19, 1902. No. 49586.

TRAFFIC.

Interchange Rules.

Proposed Changes in the M. C. B. Code of Car Interchange Rules. The importance of stencilling "capacity" as well as weight on the outside of all cars. 500 w. Loc Engng—July, 1902. No. 49205 C.

Record Cards.

Recording Waybill Statistics by Machinery. Describes a method of auditing freight accounts and compiling statistics relating to freight-traffic. Illustrates machines used. 3500 w. R R Gaz—July 4, 1902. No. 49276.

MISCELLANY.

Belgium.

Statistics of the Belgian Railways for 1900 (Statistiques des Chemins de Fer de la Belgique pour l'Année 1900). Abstract from government reports, giving general statistics, with tables of state and private railways. 1500 w. Rev Gén d Chemins de Fer—June, 1902. No. 49697 H.

England.

Railways: Co-ordinate and Sub-ordinate. R. H. Scotter. A discussion of the railway question in England, especially as related to light railways. 2500 w. Tram & Ry Wld—June 12, 1902. No. 49187 B.

Nineteenth Century.

The World's Railways in the Nineteenth Century (Die Eisenbahnen der Erde im 19. Jahrhundert). Abstracted from the *Archiv für Eisenbahnwesen*. A historical and statistical review of the railways of the world, with tables. 2500 w. Stahl u Eisen—July 15, 1902. No. 49452 D.

Reminiscences.

Reminiscences of Half a Century. M. W. Forney. Interesting review of the writer's railroad career, giving many incidents and facts relating to this industry, describing early locomotives, equipment, etc. Ill. 15200 w. N Y R R Club—May 15, 1902. No. 49548.

Report.

Safety Appliances and Accident Reports. Extract from the 15th annual report of the Interstate Commerce Commission, with appendix showing the most common defects in car equipment. 14000 w. St. Louis Ry Club—June 13, 1902. No. 49-290.

Cardiff.

The Electric Tramway System of Cardiff Corporation. An illustrated account of this system, giving detailed description of the plants, equipment, rolling stock, etc. 7500 w. Tram & Ry Wld—June 12, 1902. No. 49183 B.

Car Equipment.

The Electrical Equipment of an Ordinary Street Car. A. B. Lambe, Jr. Read before the Canadian Elec. Assn. Discusses the principal parts comprising the modern electric car equipment. 8700 w. Can Elec News—July, 1902. No. 49583.

Car House.

The Car House of the Eastern Tramway Company of Paris, at Lilas (Note sur le Dépôt de la Compagnie des Tramways de l'Est Parisien aux Lilas). G. Lelarge. A well-illustrated description of large car sheds of an electric railway and their complete equipment. 6000 w. Rev Gén d Chemins de Fer—July, 1902. No. 49699 H.

Chatham and District.

Chatham and District Light Railways. An account of the opening of these lines in England on June 17, 1902, and illustrated description. 3800 w. Tram & Ry Wld. July 10, 1902. No. 49678 B.

City and Suburban.

Urban and Suburban Electric Traction (Traction Electrique Urbaine et Suburbaine). M. Monmerque. A paper before the French Association for the Advancement of Science, opening a general discussion on the subject of electric traction. 12000 w. Rev Gén de Chemins de Fer—July, 1902. No. 49498 H.

Conductance.

Notes on the Resistivity of Track and Collector Rails as Affected by the Chemical Composition, etc. Sydney Woodfield. Considers the constituents of ordinary rails and their effects, giving experimental investigations and information from other sources. 2200 w. Elec Rev, Lond—June 27, 1902. No. 49163 A.

Conductors.

The Design of Conductors for Electric Railways. Frank B. Lea. Abstract of a paper read before the Glasgow and West of Scotland Tech. Col. Sci. Soc. Considers the electric path, transmission or distribution circuit employed on electric railways. 3200 w. Tram & Ry Wld—June 12, 1902. No. 49189 B.

Development.

Street Railway Development in New York State. Map showing existing and projected roads, with comments on the growth and features of interest. 1800 w. St Ry Jour—June 28, 1902. No. 49100 D.

Dublin.

The Dublin United Tramways Company. An illustrated account of the tramways of this company, which may be considered as the pioneer electrical system in the United Kingdom. 4200 w. Tram & Ry Wld—July 10, 1902. No. 49677 B.

Earnings.

Street Railway Investments and Earnings. Alton D. Adams. Showing the effect of the change from horse to electric motive power, and the extensions of roads, upon returns on invested capital. 1200 w. St Ry Rev—July 20, 1902. No. 49668 C.

Electricity vs. Steam.

Competition Between Steam and Electric Railways in the United States. Daniel Royse. Comparing the advantages and disadvantages of the two classes of roads when they are competitors. 2200 w. Transport—July 4, 1902. No. 49337 A.

Electric Cars on Steam Railroads. E. A. Evans. Read before the Canadian Elec. Soc. Showing that steam trains and electric cars can be operated on the same track with advantage. 1200 w. St Ry Jour—June 28, 1902. No. 49099 D.

See Railway Engineering, Motive Power and Equipment.

Exhibition.

International Tramways Exhibition. An illustrated review of the exhibits, with comments on the novel features. 7000 w. Mech Engr—July 12, 1902. No. 49526 A.

The Tramways and Light Railways Exhibition. An illustrated account of the exhibition and exhibits. 4700 w. Elect'n, Lond—July 4, 1902. Serial. 1st part. No. 49349 A.

Fayet-Chamonix.

The Electric Railway from Fayet to Chamonix, France (Chemin de Fer à Traction Electrique du Fayet à Chamonix). Henry Martin. A very well illustrated description of a direct-current electric railway, 20 kilometers long, near Mount Blanc, its rolling stock and hydro-electric plants. Serial. 2 parts. 2 plates. 9000 w. Génie Civil—June 28, July 5, 1902. No. 49485 each D.

Foundations.

Reconstruction of the Underground Foundations for the Paris Metropolitan

Railway. From *La Nature*. Describes the preparation of the sub-soil in certain regions that the city line is to traverse, in which extend vast quarries, now abandoned. Ill. 1000 w. Sci Am Sup—July 12, 1902. No. 49500.

Heavy Traction.

Collectors for Heavy Traction. George T. Hanchett. Calls attention to points in third rail and shoe construction, stating the requirements, and problems to be met. 3400 w. St Ry Jour—July 5, 1902. No. 49260 D.

Important Decision.

Interchange of Freight Between Steam and Electric Roads. An important decision by the N. Y. Court of Appeals concerning the right of electric railways to compel steam railroads to make connections between roads and to interchange freight. Text of Judge Haight's opinion. 2500 w. St Ry Rev—July 20, 1902. No. 49669 C.

Interurban.

Grand Rapids, Grand Haven & Muskegon Railway. Illustrated detailed description of a recently opened interurban railway in Michigan, for passenger and freight business. 2400 w. St Ry Jour—July 5, 1902. No. 49259 D.

Liverpool.

New Equipment for the Liverpool Overhead Railway. Describes the new motors which have made possible a greatly increased acceleration. Ill. 1400 w. Elec Rev, Lond—July 4, 1902. No. 49348 A.

London.

The Great Northern & City Railway. Illustrated detailed description of a London underground electric railway nearing completion, and its construction. 4500 w. Tram & Ry Wld—July 10, 1902. No. 49676 B.

New Orleans.

New Orleans & Carrollton Railroad, Light & Power Co. An illustrated article describing the topography and climatic conditions, track and roadbed, construction, rolling stock, shops, method of accounting, etc. 8000 w. St Ry Rev—July 20, 1902. No. 49667 C.

Oldham.

The Electric Tramways of Oldham. An illustrated detailed description of the line, stations, rolling stock, etc. 5500 w. Tram & Ry Wld—June 12, 1902. No. 49184 B.

Paris-Versailles.

Construction Work on the Paris-Versailles Electric Railway (Note sur les Travaux de la Ligne d' Issy a Viroflay). M. Rabut. A well-illustrated account of construction work on this suburban branch of the Western Ry. of France, particularly the viaducts and the Meudon tunnel. 5 plates. 8000 w. Rev. Gén d Chemins de Fer—July, 1902. No. 49698 H.

Power Stations.

See Electrical Engineering, Generating Stations.

Rack-Railway.

Two Swiss Mountain Railways (Zwei-Westschweizerische Bergbahnen mit Abt'scher Zahnstange). K. A. Breüer. An illustrated description of electric railways partly adhesion and partly on the Abt rack system, one between Bex, Gryon and Villars and the other from Aigle to Leysin. Maps. Serial. 2 parts. 3500 w. Schweiz Bauzeitung—June 21, 28, 1902. No. 49471 each B.

The Electric Rack-Railway of Bex-Gryon—Villars, in Switzerland. From *Le Genie Civil*. Brief illustrated description of this new line. 800 w. Eng News—July 17, 1902. No. 49607

Suspended Railway.

The Langen High-Speed Railway (Note sur les Chemins de Fer à Trafic Rapide, Système Langen). Robert Zumach. An illustrated description of the suspended electric railway at Barmen-Elberfeld, Germany, and a project for a similar one between Brussels and Antwerp. 7500 w. Rev. Universelle des Mines—May, 1902. No. 49696 H.

Third Rail.

The Baltimore & Ohio Third Rail System. Illustrated description of the recent third-rail construction, taken from an account in the recently published "Book of the Royal Blue." 1600 w. Ry Age—July 25, 1902. No. 49685.

Three-Phase.

The Stansstadt-Engelberg Three-Phase Electric Railway. Illustrates and describes features of interest on this line. 700 w. Tram & Ry Wld—June 12. 1902. No. 49186 B.

Tracks.

Special Track Work for Manchester Corporation Tramways. An illustrated description of special work where the tracks were manufactured complete, including all curved and connecting rails, without cutting or bonding rails in the street. 1000 w. Tram & Ry Wld—June 12, 1902. No. 49185 B.

Tramway Motors.

Selection of Tramway Motors: Tractive Effort and Power Required. Harold C. King. Gives a diagram showing the power required for various weights of cars running at various speeds on certain gradients, and points to assist in proper selection. 1200 w. Tram & Ry Wld—June 12; 1902. No. 49188 B.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w,* a bi-weekly, *s-w,* a semi-weekly, *m,* a monthly, *b-m,* a bi-monthly, *t-m,* a tri-monthly, *qr,* a quarterly, *s-q,* semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Am. Manuf. and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
American Telephone Journal. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Armee und Marine. *w.* Berlin.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin Scientifique. *m.* Liege.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemist & Metallurgist. *m.* London.

Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineering. *w.* London.
Enginering and Mining Journal. *w.* New York.
Enginering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *w.* New York.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Straussenbahnen. *s-m.* Berlin.
Indian and Eastern Engineer. *m.* Calcutta.
Ingeneria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* Londo...
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallographist. *qr.* Boston.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Wurtt. Ver. f Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Power Quarterly. New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Procedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'Way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Digest. *w.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. ed Agr. *b-m.* Catania.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Steam Engineering. *m.* New York.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Telephony. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining. Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.