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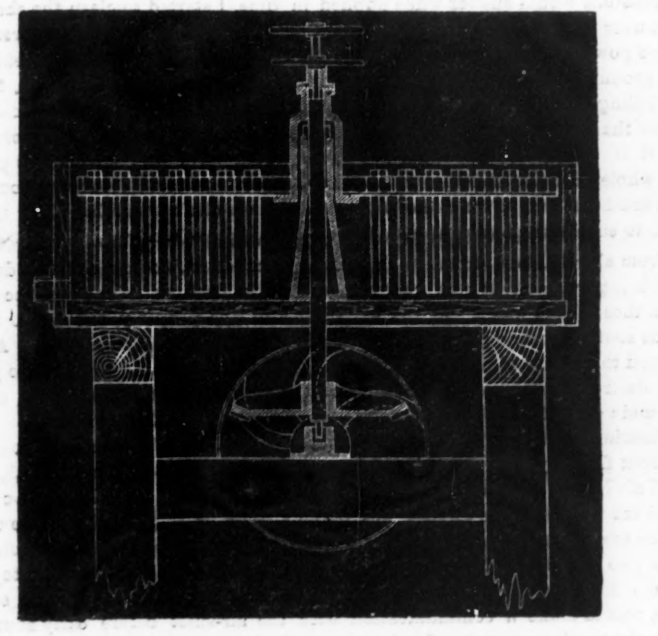
American Amalgamation—The Agitator.

The battery slimes after being amalgamated in the pan, and the amalgam collected in the settler, are run to a third receptacle, resembling the pan and settler but of larger dimensions, and with different working apparatus. Some kinds of amalgam—such as those containing copper or antimony—are friable, and on account of their fineness, cannot be recovered from the pulp while it is thick. It is therefore run into a circular tank or tub in which wooden stirrers revolve, a copious stream of water running constantly in at the top. Here the pulp is thoroughly beaten up and thinned, and while the lighter parts flow off with the current, the amalgam and floured mercury fall to the bottom, and collect there. This amalgam is always both poorer and less pure than that from the settler.

Our illustration shows one of Messrs. H. J. BOOTH & COMPANY'S (San Francisco)



agitators. It is formed of a round tub, the bottom and sides of which are made of wood. In the center a hollow cast iron cone is bolted, through which rises the the shaft, driven by a cog-wheel below. A cast iron cap, or carrier, rests on the top of the shaft, and from this project iron arms, in which are fastened the wood stirrers, hanging vertically and reaching down nearly to the bottom of the tub.

The Mid-Lothian Coal Mines.*

BY OSWALD J. HEINRICH, M. E., SUPERINTENDENT OF THE MID-LOTHIAN COMPANY.

In this paper I shall attempt a description of the successful extraction of coal from this property after it had been on fire for probably fifty years, or more, and after attempts, made at various times, which had still left considerable coal behind.

The Richmond coal-field has a well-founded bad reputation, arising from the circumstance that many of its collieries have had to be abandoned, from time to time, if not entirely, on account of fires, caused by spontaneous combustion, to which the character of the coal in this field renders them peculiarly liable.

While I fully assent to the opinion that this trouble lies in the nature of the coal, which is highly bituminous, and the seams of which are, moreover, divided by slaty bands, through which, as also in the coal, iron pyrites is more or less disseminated, often in microscopically small particles, I must, nevertheless, declare that many lamentable disasters, causing great loss of life and property, could have been avoided if a suitable system of mining had been pursued in all the collieries. If this could not have been done from the beginning of mining in this section of country (the history of which can be traced back to over one hundred years), at least experience enough existed upon this subject thirty and forty years ago to dictate the avoidance of the dangers to a considerable extent. It is therefore necessary here to refer first, in a few remarks, to the character of the coal deposits, particularly in this immediate neighborhood, the Mid-Lothian being one of the oldest and most extensive mines, and some of its coal being much subjected to spontaneous combustion. I must also refer to the history of former managements to explain more clearly the results which were arrived at.

The Mid-Lothian coal mine property, situated upon the eastern outcrop of the basin, about four miles south from James River, exhibits probably the largest development of coal in this basin. The seam here, except where pinched out to small leaders in troubled ground, is seldom less than thirty feet thick, and often attains thicknesses of sixty and seventy feet, from floor to roof. Although it is frequently considered to be but one seam, it is in reality divided into at least three, which can be recognized by the separating slates and bands, as well as by the character of the coal.

Beginning above the top seam (to show the character of roof), the following is a section fairly representing the deposit when in its undisturbed state, in that section of the property called Bailey's Hill, upon which the pits on fire were located:

Hard dark grey sandstone	3 ft. 7 in.
Hard bluish grey do.	4 ft.
Bluish grey clay slate	2 ft. 3 in.
Black slate	2 ft.
Grey argillaceous sandstone (jointed)	6 ft. 2 in.
Grey slate and indurated shale (very jointed)	4 ft. 10 in.
Top seam of coal	5 ft. to 6 ft. 4 in.
Top seam of slate, often interstratified with inferior bony coal	5 ft. to 6 ft. 4 in.
Clean good coal	3 ft. to 4 ft.
Dark slate	1 in. to 2 in.
Rich coal, highly bituminous	9 ft. 10 in. to 12 ft.
Sulphur band	1 in. to 7 in.
Coal	2 ft. 7 in.
Dark slate	1½ in.
Good clean coal (bottom coal of main seam)	5 ft. 7 in.
Light grey slate (gypsiferous)	9 in.
Coal	1 ft. 6 in.
Grey slate band	2 in.
Coal	6 ft.
Slate (grey)	1 ft. 6. in.
Coal 5 in. / Grey slate 4 in. / Hard grey sandstone (floor) 3 in.	1 ft.

From this it will appear that the coal-bearing strata attain a thickness of 45 to 50 feet, with a roof of 13 to 15 feet of a very inferior character as regards its strength to stand when the coal has been removed. The sandstones above are very strong, and stand even in large openings for a long time.

The pitch of the coal varies from 25° to even 75° (in the saddles), and even real faults, dislocating the coal almost vertically, are met with at disturbed points. Under these circumstances, it will appear at once that the regular square pillar system, largely used in districts like many English coal fields, with moderate and generally very regular dip and seams of medium thickness, cannot be adopted here, if the object is to gain the largest amount of coal. This was the system by which nearly all the pits in the coal-field were formerly laid out, although even the Staffordshire system of stalls and openings has been used, and, we may say, with even worse results, as could readily be expected. Very frequently no system at all was followed.

By the first-named method, after the pits were laid out in pillars, and work commenced homewards, the pillars could not bear the weight and were crushed from above, or at steep pitches and in troubled ground, where they were like wedges, lying with the thin edge upwards, and the larger face to the dip, they actually slipped off upon the inclined floor. A great deal of the coal was lost, and dangerous, unventilated ground, subject to accumulations of gas and the most dangerous rubbish to stimulate spontaneous combustion, was left behind. Ultimately, the heat accumulating from a constant grinding process upon the weak pillars, and not sufficient air being admitted to retard, by cooling, this process of slow combustion (it being considered most dangerous to admit suffi-

* A paper read before the American Institute of Mining Egineers, Boston, February 19, 1873.

cient air), the pits took fire, and, after vain and costly attempts, were abandoned.]

No better results were attained from the Staffordshire system. Openings 300 to 400 square yards in base, and 15 to 20 yards high, were frequently effected, entirely beyond the means of support by timber-work; often even more coal tumbled than the small capacity of the shafts permitted to be hoisted before the top broke down upon the remaining coal. It was impossible to clear the chambers of this dangerous rubbish, and it had to be left behind. Large breaks were formed in the top rock, often clear up to the surface, giving sufficient vent to increase the spontaneous combustion and preventing a regular system of ventilation on the one side to cool off the heating chambers, or an air-tight damming, on the other hand, to smother combustion.

These and a series of other errors, too numerous to be all recounted here, but all due to ignorance, want of system and false economy, have concentrated all the worst elements imaginable to prevent the continuous prosperity of these mines. Otherwise, under good management and improved systems of mining, the superiority of the coal, the large yield per acre, and the close proximity to home and foreign markets, ought to have placed them amongst the most prosperous and remunerative mines in the United States. The statement, so often made with regard to the irregularity of the seams, loses its force, if not its accuracy, under impartial investigation. Although the existence of such irregularities may be freely admitted, it could have been made comparatively harmless by proper records, surveys, maps, and timely explorations. It is not the irregularities, but our ignorance of them, that has worked trouble. Yet these important precautions have scarcely been observed at all.

Although a number of the mines in this section of country have paid handsomely at times, hardly any of them will do it now, in consequence of the above-mentioned causes. Even the Mid-Lothian pits, where a great deal of money has been made, were, in 1869, in the condition to be sold at public auction, after the outlay, during the previous two years, of $180,000, without any show of improvement. On the contrary, the property had been allowed to go to wreck and ruin.

It was under these conditions that I was placed in charge of this property, after the sale, with a lawsuit about some claims pending over it, which prevented complete possession. Houses, fences, machinery, roads, shafts, were all out of repair; no available pit of any consequence was in condition to raise coal; and, amongst other drawbacks, we were compelled to keep constantly going a 500 horse-power pumping engine to keep the water from drowning out the last vestige of available ground.

I shall now proceed to give a more detailed account of the opening and working of that portion of the Mid-Lothian property called Bailey's Hill, occupying a position at the eastern outcrop on the northeast portion of the property.

The tract of land included within the old pits, and where, therefore, coal could be supposed to be left behind, extended from the northeast to the southwest about 660 yards, and from the outcrop 176 yards west to the deepest shaft available on account of water. It contained in all about eighteen acres, of which fully one-third, near the outcrop, was a perfect honey-comb of old pits and slopes, and only partially accessible by temporary open workings. One acre of good ground from the adjoining property was added by lease, the coal being thrown by a saddle beyond the dip of the main shaft on its level course. Therefore, in all, about eighteen acres of ground were accessible from the main shaft, and formed the main workings.

Before the property was given under my charge it had already been proposed to run down a slope in the southeastern portion of this ground, to gain a body of coal said to have been left behind, and which had partially been explored by a shaft, 170 feet deep. Although the use of slopes for main working shafts in this broken and fiery ground was objectionable, it was still decided to make the experiment. After passing a very broken piece of ground, filled with loose coal and connected with a portion of ground already heating, the slope nevertheless was successfully driven to the bottom of the works, 280 feet on the incline, and a connection made for air, the slope forming naturally the up-cast. By that time it was already discovered that the loose piece of ground about 160 feet from the surface was on fire; and, after some unsuccessful attempts to remove the cause, the slope was, with difficulty, closed on the top. The smoke set so strongly up the slope that it was all we could do to save the men, our only retreat being by that route. Perceiving the impossibility of fighting the fire effectually and with safety to the men, so long as the slope remained the up-cast, we connected a fan with the hoisting engine at the mouth of the slope, and built also a cupola at the down-cast shaft, in order to reverse the natural air-course. After giving the fire some time to subside a little, I determined to make at least the effort to close the slope just above the part on fire, and to save the ground won above, if we should not be able to gain the lower part. After partially removing the dam at the mouth of the slope we followed downward the strong artificial current of air, effected as just described, and succeeded by strenuous efforts in putting in a strong clay dam just above the fire. Effecting now a communication with another old shaft, north of the slope, for a return air-course, we prepared to make the effort to safe the rest of the slope, by making it as far as possible air tight through the broken and burning ground, and maintaining it long enough to raise the coal below. For various reasons, but particularly on account of the great expense, the ground not justifying the use of such materials as iron or brick, I concluded to pack the timber work outside and between with moist clay, of the consistency of putty, keeping it in position by nailing planks in front of the timber sets. This operation was performed by opening the dam partially near the top, and substituting a temporary stopping of plank while the clay dam was constructed lower down, and in this manner was lowered from eight to eight feet, and always renewed firmly and as speedily as possible to shut off the lower works. Then the side-casing of clay was carried eight feet further down. In this attempt we succeeded completely in passing the point of fire, casing it, and once more gaining even access to the bottom of the slope. But during this time we had discovered that, after a certain lapse of time, the smoke (of burning wood) would always puff up with a great rush requiring the strictest attention to get the men out in time. This originated from the smoke filling some old and probably extensive works, and, when the maximum of expansive force was reached, forcing itself out at the lower part of the casing, which could not always be made immediately air-tight. Getting below the fire, we found that during the seven months it had taken to do all this work, including the time the slope had to be kept closed, much of the timbering had been burned out and the ground required some time to be retimbered. We had now closed tolerably firmly both sides and top of the slope; but the smoke burst through the floor, where we had never before experienced any breaks or leakage. This last accident was of so dangerous a nature (we being hardly able to get the men out) that it was—for economical reasons also— concluded to go no further down but to close the ground below and recover expenses at least from the coal left above.

This was successfully done, about 96,000 bushels of coal being raised, the casing below answering now as a long and substantial dam, being all filled up.

During this time, sufficient information at various points had been obtained to warrant the effort to open out a regular pit upon the ground to raise coal upon a larger scale. For this purpose, a shaft, called Rise Shaft, about 300 feet deep to water level, lying nearly in the center of the ground at its lowest available depth, had been selected, it being found by examination to be in good condition, but requiring to be retimbered and refitted at the surface. Having also satisfied myself that the clay-casing system, to make the sides air tight as much as possible, would answer when applied in time, I started to clean the shaft and re-timber it, providing for a good center brattice and putting up a twentyfive horse-power engine for hoisting purposes. Moreover, all breaks and openings in the ground at the surface were closed as far as it possibly could be done, to help in killing out the fire. The ground above having formerly been worked from more than a dozen shafts of various depths, from 100 to 400 feet, I made it a point if possible to prove that two shafts would have been sufficient to operate the whole ground. For this purpose another old shaft, 350 feet deep, about 200 feet southeast and to the rise of the former main shaft, was selected for the up-cast, to enable us to keep up always a strong supply of air.

From all reliable information that could be collected, no maps of any description being available, it was very certain that the best part of the coal accessible from those shafts was left at the extremities of the property, about 100 to 150 yards southwest, and from 70 to 100 yards northeast of the main shaft. All the ground to the rise of the main shaft was considered tolerably well torn to pieces and destroyed nearly to the bottom of the up-cast shaft, having been always the main seat of fire. This surmise I found afterwards fully confirmed.

Entering from the main shaft by a cross-cut east, we intersected the top seam at about fifteen yards. Having no communication yet with the air-shaft, bratticed air had to be used in the shafts and levels. Just where the cross-cut entered the top seam, the ground was found already heating and had to be closed on the east. Levels, north and south, were started at once in the top seam to have two sides well protected against fire, (the roof and water level at top and bottom forming natural protection.) The main object now, it being spring time, was to make a communication with the air-shaft before early summer; since the south-western winds almost invariably prevent ventilation in our pits, when bratticed air is used without the aid of a fan. The ground immediately between the main shaft and the desired up-cast being known to be on fire and broken ground, it was impossible to make a direct communication; but after driving fifty yards through heavy rock-tumbles, where every foot had to be forepaled* and powder was required to blast the large rocks encountered, a communication was ultimately effected, and the fiery ground south of the main shaft was successfully and securely flanked by casing through all the broken ground. This, being done *in time*, answered the purpose for nearly two years—long enough to remove the coal from both sections laid out south of the shafts at the respective shaft bottoms. The temperature at the south level during the time it required to make the connection, had increased from 78 deg. to 95 Fahr., and it was certainly a difficult undertaking to make men stand up to perform such work for weeks together. But afterwards we never suffered for want of air, and in colder days had to close the doors, some of the levels being too cold for the men. The levels cooled off splendidly; and the ground behind heated but very slowly, although it was of such extent and in such bad condition that we never succeeded in stopping the spontaneous combustion entirely.

The plan, determined upon from the beginning, to work this ground was to surround the fiery ground and make safe communication with the up-cast by as few levels as possible; thence, if solid or at least remunerative ground was encountered, always to open out and exploit the ground by two gangways upon

* That is, the work was protected by driving the timbers ahead, or keeping the working face closely timbered, and preventing sudden movements of rock masses.—Ed.

the same level, one at the roof, the other at the floor, and only for the sake of air to crosscnt between them, at distances of abont thirty-three yards. Pillars were thus left with a base 100 feet long, by 30 to 60 feet wide, and, in the beginning, 40 feet high perpendicular to the floors above. The base of the pillars, therefore, was upon a level instead of being on the pitch of the coal, as formerly. In consequence of the old works we had sometimes to deviate from this plan. Two levels either near the roof or near the floor, but from 30 to 60 feet apart upon the dip, had to be nsed. The object, then, was by working homewards to work out the pillars, according to the nature of ground, by crosscuts or by benches in the conrse of the coal, taking the dividing slates for a guide, and to fill up and sustain the ground so exhausted as much as possible, and, when necessary, to dam it up against the fires originating from connections with the old works. Of course, for this purpose a great deal of waste stuff had to be procured at the surface and sent below.

The pit was then laid out in four sections, two north and two south of the shafts, each two being about 16 yards apart vertically, and independent of each other, being only connected in the beginning at two points by winzes for the return air course and to discharge the coal from the upper sections to the main shaft level. Precaution was taken to secure points sufficiently solid, in case of necessity, to permit damming off the sections, and so securing the shafts. The connection through the south level has already been described.

The attempt to make the connection in a similar manner north of the main shaft, where most of the coal was anticipated, was less successful. A large old work or chamber, filled with fine, loose coal, was encountered, and took fire in front of ns while we were driving. I abandoned the work, after some severe but fruitless attempts to penetrate the chamber, using even double casing with a layer of clay between. It was then determined to run a rock tunnel in the course of the coal, but in the roof rock, from the main shaft, until I could intersect the coal at a safer point, of which we had some information. This was by estimate found to be the cheapest plan, and this we succeeded in, by driving seventy-seven yards along the roof; but although fifty feet from the coal, we still encountered the broken part of the roof opposite the big chamber mentioned above. This was now, however, easily closed by a rock-dam. But we had the gratification to reach a body of coal of a very solid character, being eighty-five feet thick from roof to floor, and the connection with the up cast was here effected in good ground by driving a winze up twenty-three yards to the main top level. Here we were compelled to use a small hand-fan, to supply the men with air.

Having now succeeded in flanking all the fiery ground and completely surrounding it, we were in the condition to exploit the rest of the ground in the manner described above. As it was, of course, necessary to defend the field, mnch work in conrse of time had to be done to dam off and protect the main levels. For this purpose, also, a line of water pipes was provided down the npcast shaft, connected with a cistern above and condncted through the main top levels. To these, hose could be attached, and, in the first beginnings of fires, they were of the greatest advantage. Sometimes considerable quantities of old rubbish on fire were actually excavated by the hydraulic process! In one instance, the main air course being threatened, and the timber being already on fire, a brick arch twenty-five yards long had to be run underneath the wooden casing on fire. Here the hose were freely used to pnt out the fire, to enable the bricklayers to go on; and the work was completed, and answered its purpose until the south sections had been all successfnlly robbed and a new air-shaft, a little north of the former, had been cleaned out, to be used for the north sections. Here much of the coal had yet to be won, and the old air course was too much in danger to be trusted for the length of time required to work homewards.

In loose coal, we succeeded in making dams out of old iron pipes and railroad iron, covered with old boiler plate nearest the coal, and then cutting ont the timber and packing the whole with clay, we conld stay the fire for a considerable time. I also experienced in snch broken gronnd that arched work was not as good as passages made with straight walls, the top covered with railroad iron and old boiler plates, with a heavy coating of rock on the top of that. These have answered until the heat was too great for men to pass underneath.

In this manner, we succeeded in working out thoroughly the two sonth sections and closing them off securely near the main shaft, and also exploiting the largest portion or the two north sections. But here we encountered in the top section a piece of most dangerous ground, connected with the bottom level throngh a big chamber. It took fire from bottom to top; and we never succeeded in getting all the coal ont, but were ultimately compelled to close it np entirely, at places left in the top seam for dams, in such an event. Those dams, 20 feet thick of clay and masonry, are now, after 8 months, still as hot as a bake-oven.

Dnring the time those four sections were working, we had discovered a saddle at the northwest corner of the north section, where the coal, althongh inferior and not very thick, took an eastern dip and therefore indicated a reversed dip beyond the saddle. Having satisfied myself that we could pass the saddle on the sonth end, a rock tunnel 44 yards long was driven to protect this new developed section from the old fires. But the new section proving good coal a little below the shaft bottom, we were compelled to keep the water at its lowest point, and in consequence of this, the fires from the former section fonnd a passage to the west end of this rock tunnel underneath. Having only bratticed air in that tunnel we could not fight the fire successfully. The smoke from the return, mixing with the fresh air, made the back workings as bad and dangerous as the places near the seat of fire. We had seventy men *hors de combat* in the conrse of fifteen honrs, through exhaustion and black damp and smoke; and we had to withdraw the force to save them from being suffocated. Being at the same time threatened right over the top in the old section, not then entirely cnt off, nothing was left us but to close all the works up and let the water rise for awhile. The existence of coal at the level of our present shaft, in the new section, conld not have been well anticipated, being only at that elevation in consequence of the saddle-shaped npheavel. It nevertheless offered a fine prospect; and it was therefore determined to carry ont my former plan, for economical reasons not yet execnted, namely, to drive another rock tunnel, 55 yards long, to shorten the line of transportation over 500 feet, getting a direct air-course with an independent return and a safe retreat for the men in case of fire breaking out again on our return. This was also successfully carried through, and the old air course was superseded by driving a winze np through the rock in the roof to the air-shaft. It was impossible to keep the old airconrse open on acconnt of fire, and we failed to obtain the air through the top seam coal by reason of breaking into the large old work partially known to us before.

This undertaking was the most trying work performed. Although 23 feet of rock was between the men and the old work below on fire, the heat of the floor increased to such an extent that shortly before the junction was effected it actually burnt the feet through the soles. From 5 to 10 minntes only could the men stop at the working face, at a temperature of 100° Fahr; and ultimately 8 men in the eight-honr shift were employed to break through. The black damp at that time prevented onr working down from the upper level also to meet the men. But, to the credit of the men be it said, they stood np like soldiers until the job was completed.

Having now fully secured the pit again, the new section was exploited until the coal thinned out so as not to pay for working, and, successfully working homewards, we have, after being three years and four months in this pit, still a few months' work to expect.

To snm up the extent of this forced enterprise, I will only say that 2,037,961 bnshels (29 bnshels=1 ton) have been raised so far from the whole tract, of which 1,448,862 bushels were obtained from the rise shaft workings alone. While the expenditures have been very large, amounting often to $1500—2,000 per month for fire service alone, almost the year round, besides heavy general expenses of an extensive enterprise so pecnliarly situated, with a large amount of water to be kept at bay, I can only say that after all the costs for opening the pits and repairing the property (houses, roads, and such machinery as was needed) have been paid, a profit as interest upon the capital invested in the late purchase will be left, over and above all remaining expenses.

I mention this simply to show what may be accomplished in this coal field by taking np *new* ground, free from the curse of former bad management.

There is no shadow of doubt that, under skillful management and by introducing late improvements in mining, even the deep mines in this coal field would pay handsomely, the advantage of freight to market giving them constantly an advantage in the competition with other coals.

I can not refrain at the close of this description from mentioning the fact that most of onr labor here is colored labor, although we have a few good white miners amongst us. The men have faced great danger and undergone much hardship bravely.

In the whole of this enterprise I have been most ably assisted by underground bosses of which three are still with me, WM. DICKINSON, GEORGE JEWITT and THOMAS CORNUE, also my assistant Mr. THOMAS JEWITT, all English miners, who have faithfully execnted the very trying tasks which I was compelled to ask of, and to share with them, in carrying out this work. Their experience in general and their knowledge of portions of the ground in particular, was often of the greatest service. I will add that in spite of all the dangerous work performed we have not to lament the loss of a single life nor even the material crippling of any man.

American Society of Civil Engineers.

A regular meeting of this society was held at its rooms in New York, January 15, 1873.

A paper by CASIMIR CONSTABLE, C. E., of New York, "On Retaining Walls, an attempt to reconcile Theory with Experiment," illustrated by a model, was read.

A retaining wall is stable when the moment of its weight about the point of rotation exceeds the moment of a certain triangular prism of material back of the wall about the same point—the intersection of the line of rupture of the wall, and the resultant thrust of the prism.

Many formulæ and tables for retaining walls are presented for use, without a factor of safety—since walls proportioned therewith, well built and carefully "back filled" have been permanent.

Experiments made on a small scale, in which the theoretic conditions were more nearly fulfilled than in practice, show that such walls are more than stable, and point out the reason why.

The problem having been thus solved, a factor of safety may be introduced in the formulas, which will allow for shocks, irregular workmanship and uncertain materials.

The problem may be considered under these several heads: the angle of rupture, the height of the prism of rupture, and the direction and point of application of the pressure of the prism.

Angle of rupture.—This was first supposed to be the angle of repose with the vertical—the thrust was assumed to be horizontal, and at two-thirds the height of the wall. BELIDOR assumed the angle at 45°, and that the earth moved in layers parallel to the line of rupture. COULOMB first considered the slope of earth, with the attendant physical conditions—his theory, as amplified by M. DE PRONY, is discussed by M. GAUTHEY, who gives a clear analysis of the angle of rupture.

Supposing the resistance of cohesion is proportional to the surface of rupture, and the friction to the normal pressure: the pressure against a retaining wall is that of the prism of earth, which would at once fall, if the wall were removed. The inclination of the plane of separation of this prism will vary with the cohesion and friction of different earths. If a series of planes be conceived less inclined than that of repose, and originating from the same point, one of them will have such a position that the separating prism will have need of a greater opposing force to its sliding motion than any other.

Upon this hypothesis it is proved, the prism of greatest pressure is given by the plane which bisects the angle of repose, and that:

$$P = \tfrac{1}{2}\, w,\ h^2 \tan^2 \frac{i}{2}$$

in which P= the horizontal force which sustains the prism; w, the weight per cubic foot; h, the height, and i the angle of repose, of the prism.

Lieut. HOPE found, with layers of colored sand, the average angle of rupture to be 24° and of repose 54°. This small difference in practice from theory, is probably due to the cohesion of particles, an element which, from lack of sufficient data, is generally disregarded.

Height of prism of rupture.—From the first it has been assumed that the wall turned over as a solid mass about the bed joint at its base. In practice it is not so—the line of rupture is a stepped line, in or near the natural slope—and leaving a part of the wall undisturbed.

For experiment, a box 16 in. high and wide, and 24 in. long, with glass sides, was made. A miniature wall of pine blocks or "bricks," 1 in. square, 2 in. and 3 in. long, with a bank of oats or peas instead of earth, in eight trials turned over as stated. When the wall began to move, the face bulged out, the center of the curve being at about one half the height, and would continue thus, until started forward by a jar. This, due to cohesion of the backing, doubtless adds materially to the stability of walls of long standing, which, it is often noticed, stand, although bulging outward. (This and subsequent statements were illustrated by experiments.)

A solid wall with a joint at the place of separation was more stable than one of "bricks," for although each began to move at the same time, the first did not continue to give way, and required to be continually started.

NAVIER seems first to have noticed that walls rupture in this manner. It is reasonable that the prism of pressure should start at a point above the foot of the wall, for, by rotation of the wall about the outer point in the base, the lowermost portion of the backing must be lifted.

Experiments made in the case of surcharged walls gave heights agreeing very closely with those calculated upon this basis; while assuming the prism of pressure to start from the foot of the wall, would give a height far below that sustained.

Direction of thrust.—If the weight of prism of greatest pressure be resolved into two components—one normal to the slope of rupture, and the other to the back of the wall—the first will resist by its friction the tendency to slip along the slope; the second is expressed by the formula given, and may be resolved into two other components; one inclined—the actual thrust against the wall; and one vertical—to overcome the friction along the wall; this latter, from the indefinite knowledge of the value of the co-efficient, is generally neglected. The point of application of thrust, at first assumed to be at one-third the height of the prism of pressure, which gave too great thickness to the wall has been shown by RANKINE and others to be at one-third the height from the foot. The height of the prism of pressure will be from 0.70 to 0.75 feet of height of wall. The conditions of the problem are now determined, from which follow these formulæ:

$$\frac{t}{p} = -\left(n + \frac{n^1}{2}\right) \pm \sqrt{\frac{2\tan^2 \frac{d}{2}}{7w}\left(w_1 + \frac{8p}{3}\right) + \frac{n^2}{3} - \frac{n^2}{12}}$$

in which t=thickness at top of wall, p=any weight per square foot of surface distributed over the bank,—n=batter per foot in height of outside. n^1 =same of inside of wall. d=angle of repose. w=weight per cubic foot of masonry, and w^1 =same of earth. If n and n^1 =O

$$\frac{t}{p} = \sqrt{w + \frac{8p}{3}}\ \tan \frac{a}{2}$$

and if p=o

$$\frac{t}{p} = 0.53 \tan \frac{a}{2} \sqrt{\frac{w^1}{w}}$$

This would have been 0.57 instead of 0.53 in case the prism was assumed to start from the foot of wall.

RANKINE's theory of earth pressures makes the thrust parallel to the surface of the bank—accepting this and there results $\frac{t}{p} = 0.57 \sin \frac{a}{2} \sqrt{\frac{w_1}{w}}$ differing from the usual formula in substituting sin. $\frac{a}{2}$ for tan. $\frac{a}{2}$.

This gave results very close to those obtained by experiment—and considerably less than those from the formula last given; which perhaps accounts for the general omission to employ a factor of safety.

Transformation of Profiles—VAUBAN's rule—that a rectangular wall may be transformed into one of equal stability with a batter on the face—having the same thickness at one-ninth the height is true within 1-120th when the batter exceeds one-sixth.

Now it is usual to give a less batter, and by taking the common thickness at one-tenth the height, the error is inconsiderable. [This was proved by experiment.]

In a surcharged wall, if the surcharge starts from the back of the wall

$$\frac{t}{h} = 0.38 \cos. a \sqrt{\frac{w_1}{w}}$$

And experiment verifies this.

Uniformly, when the experimental wall first gave way, the filling did not revolve, as stated by some writers, but settled suddenly, and then rested until another shock started it again. This seems to show the advisability of stepping the back of walls.

Much depends upon the manner in which the work is done after the profile has been fixed; inattention to the details of construction may jeopardize the safety of a structure well proportioned.

For several years pains have been taken to collect data of walls in existence, with a view to establish a coefficient safe under ordinary conditions, and which may be modified by the engineer to suit particular cases.

DISCUSSION.

Mr. J. DUTTON STEELE gave a practical rule, verified by his experience, for surcharged walls of dry masonry less than 18 feet high—namely, a width of three feet at top, a batter of one-sixth outside, and none inside. In one case, for a mortared wall, 18 feet high, he reduced the thickness at the top to 2½ feet, and gave a batter to both sides. Engineers, who from lack of room have been compelled to lay walls upon narrowed or stepped foundations, will be pleased to know, from Mr. CONSTABLE's experiments, that such conform to theory, and are safe in practice.

Mr. COLLINGWOOD inquired whether it was not best to step the back of a wall, rather than give it a batter.

Mr. CONSTABLE said, it was more a matter of practice than of theory; by thus stepping a wall; the back filling upon settlement did not act as a wedge.

Mr. STEELE said that generally now the back of a wall is not stepped, as formerly, but made vertical. Often in railway practice it is counter-sloped or under-cut, and the stability thereby increased. The back should have a "frost" batter at top, where the earth is likely to freeze, so that it may be lifted from the wall. Care should always be taken in back filling to slope the packed earth from the wall, rather than towards it.

Mr. COLMAN said that in filling behind the masonry of New York State canal locks, broken stone one foot in thickness had been placed between the wall and embankment.

A communication was submitted from a prominent Canadian engineer, in which he said: "In practice I have always made my walls heavier than theory demanded, on account of the severe operations of frost in this northern latitude, where it strikes from three to four feet into the ground, and yet without giving a slope or "frost" batter to the back of the wall where the frozen earth presses against it, our strongest walls could not stand. It has been my rule to make the base of the wall equal to 2-5ths its height, but this is for first-class masonry, laid in hydraulic cement."

Mr. CONSTABLE, by experiment with the model, demonstrated that two walls of same area of section—one rectangular, and the other with batter on the face of 22-100th, were equally stable; and also, that the saving in material by giving much batter, is but little. A wall battered on the back less than on the face evidently is less economical than if all the batter was on the face.

Attention was called to the difference in resistance to crushing per square inch of section of stones 1" and 1½" cube, as stated in Mr. C. B. RICHARDS' paper recording "Experiments on the Resistance of Stones to Crushing," read before the Society January 8th last. Thus, white marble gave a mean resistance in the first of 5812, and in the second of 8294 pounds per square inch of section. The question was raised, what relation was there between the size and the resistance of specimens, and whether tests upon blocks proportioned like those used in any particular work, would better enable the engineer to determine how much the latter could withstand.

Tests of the strength of any material are of greatest value when conducted under conditions most like those governing actual use. The difficulty of making such large specimens was pointed out, and a brief comparative account of testing machines was given.

It was proposed to take up the latter, as a subject of discussion, at a future meeting of the Society.

THE COAL TRADE.

NEW YORK, March 18, 1873.

Business is looking up and promises to be very lively from the opening of the Spring trade. All the companies are reported to have calls for coal far in excess of their ability to meet. Contracts for the season "at a price" are reported, and it is the general expectation that prices will be firm, though a rise is not expected for April. The price is now more than a dollar over the rates of a year ago, and though the demand shows that the market will fully sustain the present rate, it is thought that the companies will rest satisfied with returns that yield a good profit and which can be sustained without risk of a reverse. Part of the advance is divided with the transportation companies which have raised their rates, but nevertheless the trade is certain to present a very different spectacle this year from that of a year ago.

Soft coals are somewhat easier, the price in New York being nine dollars a ton. It is thought that the canals will open in about two weeks, when coal can be delivered at Baltimore for $4 75 instead of $5 as at present. The condition of the gas coal trade is anomalous. The Baltimore and Ohio road has raised its tolls, and refused the usual drawback, and West Virginia coal is quoted in Baltimore at $7, free on board. This price it is almost needless to say, is one which makes the supply of the New York market from the West Virginia region almost impossible. What the purpose of Mr. Garrett, of the Baltimore and Ohio road, can be in shutting out the large amount of gas coal which passes, or rather which ought to pass over his road, it is difficult to imagine. The Pennsylvania road deals better by its customers and Penn gas coal has been sold for $7 free on board at Philadelphia. The comparison of these two prices, with the known superiority of the Pennsylvania coal over the West Virginia article, is sufficient to show why the latter has no chance in the market. Later in the season the Baltimore and Ohio road will be wanting coal and will perhaps be ready to make terms for its customers but then the season will be too far gone for regular work.

Anthracite Coal Trade for 1872 and 1873.

The following table exhibits the quantity of Anthracite Coal passing over the following routes of transportation for the week ending March 8, 1873, compared with the week ending March 9, 1872.

COMPANIES.	1872.		1873.	
	WEEK.	TOTAL.	WEEK.	TOTAL.
*Phila & Reading R.R†	63,219	738,461	86,242	821,265
*Schuylkill Canal	....	13,356	....	6,594
*Lehigh Valley R. R.	44,064	715,894	63,395	692,378
Lehigh & Sus. R. R.	33,837	228,184	24,192	316,184
" "				
Scranton North	11,168	124,587	11,070	117,535
" South	35,108	367,318	40,783	346,238
Penn. Coal Co., rail	14,952	168,186	11,419	131,356
" " canal	....	....	....	....
Del. & Hud. Canal Co.	....	....	....	....
" " East	10,531	103,599	9,859	59,586
" " West	6,387	74,047	6,765	78,260
" " South	5,493	64,052	5,159	59,332
Shamokin	9,132	69,173	8,862	88,631
Trevorton	....	....	....	....
Lykens Valley Coal Co.	....	....	....	....
Wyoming North	....	....	....	....
Wyoming South	....	....	....	....
P. N. Y. C. & R. R. Co.	10,240	131,571	9,205	142,737
Williamstown Col'y	....	....	....	....
Big Lick Col.	....	....	....	....
Total	244,081	2,807,436	276,951	2,859,994
1870			244,081	2,807,436
Increase			32,870	52,558
Decrease				

* These figures are for the week and fiscal period commencing Nov. 30.
† Less coal transported for Company's use and Bituminous coal.

Bituminous Coal Trade, 1872 and 1873.

The following table exhibits the quantity of Bituminous Coal passing over the following routes of Transportation for the week ending March 8, 1873, compared with week ending March 9, 1872.

COMPANIES.	1872.		1873	
	Week.	Year.	Week.	Year.
C. & O. Canal	220	220	....	....
B. & O. R. R.	19,729	180,796	27,902	207,125
Penn. S. Line	....	......	2,028	17,399
H. & B. T. R. R.	5,994	47,608	7,641	72,834
*Harrisburg & D.	6,395	107,492	4,596	69,549
*L. V. R. R.	7 1	7,684	922	6,676
P. & N.Y.C & R. Co.	5,444	75,476	6,135	56,718
Cumberl'd Branch Canal	....	....	....	....
" Railroad	290	290	2,699	21,014
Total	38,7 3	419,566	51,963	451,316
			38,793	419,566
Decrease				
Increase			13,170	31,750

Pennsylvania Coal Company.

Shipments of Pittston Coal for the week ending March 8, 1872.

	1873.		1872.	
	WEEK.	YEAR.	WEEK.	YEAR.
By Railway	11,419 11	131,356 04	14,931 14	168,185 15
" Canal	....	....	....	....
Total	11,419 11	131,356 04	14,931 14	168,185 15
Decrease 1873	36,829 11			

Philadelphia & Reading Railroad and Branches.

COAL TONNAGE

For the Week ending Saturday, March 8, 1873.

BY RAILROAD.—ANTHRACITE.

PASSING OVER MAIN LINE AND LEB. VAL. BRANCH.

	Tons. Cwt.
From St. Clair	25,476 05
" Port Carbon	5,553 04
" Pottsville	3,455 05
" Schuylkill Haven	22,375 19
" Pine Grove	3,493 06
" Tamaqua	3,493 06
" Harrisburg	1,2e0 00
" Dauphin	
Total	71,092 11

FOR SHIPMENT BY CANAL.

Passing Frackville Scales	
" Mill Creek "	
" Schuylkill Valley Scales	
" Mt. Carbon "	
" Cressona "	
" Pine Grove "	
" Tamaqua "	
Total	

SHIPPED WESTWARD VIA CATAWISSA AND WILLIAMSPORT BRANCH AND NORTHERN CENTRAL RAILROAD.

Via Catawissa & Williamsport Br.	387 06
" N. C. R. R. passing Locust Gap	911 12
" " " Shamokin	3,553 05
" " " Herndon	....
Total	4,852 03

SHIPPED WEST OR SOUTH FROM PINE GROVE.

Via Schuylkill & Susquehanna R. R.	1,408 18
" Lebanon & Pine Grove Branch	548 04
Total	1,857 02

CONSUMED ON LATERALS.

From Frackville Scales	459 16
" Mill Creek "	515 17
" Schuylkill Valley Scales	1,028 00
" Mt. Carbon "	879 13
" Cressona "	436 08
" Pine Grove "	59 05
" Tamaqua "	328 19
Total	3,707 18

LEHIGH AND WYOMING COAL.

Received via Silverbrook Junction, Sent East	2,266 00
" " Cat. & Wpt. Br. Sent West	21 02
" " Rupert, Cat. & Wpt. Br.	15 12
" " Allentown, E. Penn'a Br.	158 17
" " Alburtis	....
" " Oreland, G. & N. Br.	1,609 03
" " Connecting R. R.	....
" " Willow Street R. R.	661 18
Total	4,732 12

BITUMINOUS.

From Harrisburg	4,585 12
" Connecting R. R., G. & N. Br.	
" Junction R. R.	10 00
Total	4,595 12

COAL FOR COMPANY'S USE.

Anthracite	7,826 04
Bituminous	204 13
Total	8,030 17

RECAPITULATION.

	Total for Week.	Corres-p'g week last year.		Increase and Decrease.
Passing over Main Line and Leh. Val. Branch	71,092 11	52,296 09	i	18,796 02
For Shipment by Canal		350 12	d	350 12
Shipped Westward via Northern Central R. R.	4,852 03	5,057 08	d	205 05
Shipped West or South from Pine Grove	1,867 02	1,427 01	i	430 01
Consumed on Laterals	3,707 18	3,062 18	i	645 00
Lehigh and Wyoming Coal	4,732 12	1,024 19	i	3,707 13
Total Anthracite paying freig't	86,242 06	63,219 07	i	23,022 19
Bituminous	4,595 12	6,394 14	d	1,799 02
Total of all kinds paying freig't	90,837 18	69,614 01	i	21,233 17
Coal for Company's use	8,030 17	3,556 10	i	4,474 07
Total Tonnage for Week	98,868 15	73,170 11	i	25,698 04
Previously this year	904,792 13	901,925 04	i	2,867 09
Total to date	1003651 08	975,095 15	i	28,565 13

SHIPPED BY CANAL.

From Schuylkill Haven				
" Port Clinton				
Total Tonnage per Week				
Previously this year				
Total to date	6,594 00	13,355 16	d	6,761 16

Northern Central Railway, Shamokin Division.

Below is the return of Coal sent over the Shamokin Division of the N. C. R. W., for the 7 days ending March 7, 1873.

		Tons. Cwt.
East	......	
West	8,861 11	
		8,861 11
Same time last year		9,131 18
Increase		......
Decrease		270 07
Total amount shipped to date		88,631 00
Same time last year		68,177 19
Increase		20,543 01
Decrease		....

Delaware Lackawanna & Western Rail Road Company.

Coal transported on the Delaware, Lackawanna, & Western Railroad for the week ending Saturday, March 8, 1873

	WEEK. Tons. Cwt.	YEAR. Tons. Cwt.
Shipped North	11,069 17	117,585 03
Shipped South	40,782 11	346,237 13
Total	51,852 08	463,772 16
For the Corresponding time last Year :		
Shipped North	11,167 12	124,586 12
Shipped South	35,108 08	367,318 00
Total	46,278 00	491,905 00
Increase	5,574 08	
Decrease	......	28 132 04

Penn. and N. Y. R. R.—Coxton, Pa.

Coal tonnage for week ending March 8, 1872.

	Week. Tons. Cwt.	Total. Tons. Cwt.
Anthracite received :		
From Lehigh Valley R. R.	5,382 00	83,070 13
" Lack. & B. R. R.	549 03	7,000 07
" Pleasant Valley R. R.	2,966 04	38,311 08
" Sul. & Erie R. R.	307 16	9,355 00
Total	9,205 03	142,737 08
Same time last year	10,240 11	131,570 11
Increase	1,035 08	11,166 17
Decrease		
Distributed :		
To Lehigh Valley R. R.	87 10	9,557 01
To Lack. & B. R. R.	16 02	252 11
To S. Central R. R.	1,637 14	30,553 01
To Ithaca & A. R. R.	2,445 10	22,216 17
To Erie R. W. Pockets for shipm't.	2,670 14	40,896 00
To individuals on line of road	522 11	13,223 19
To points at & above Coxton for use of Co.	566 18	7,226 02
To points between Waverley and Elmira	1,258 09	18,811 17
Total	9,258 09	142,737 08
Bituminous received from BARCLAY R. R.		
Shipped north from Towanda	6,072 01	56,376 10
Shipped south from Towanda	63 04	341 07
Northern Central R. R.	....	......
Total	6,135 05	56,717 17
Same time last year	5,443 15	75,476 08
Increase		
Decrease	691 10	18,758 11
Distributed :		
To Erie Railway	4,987 13	46,963 06
To So. Central R. R.	1,048 08	9,206 19
To Ithaca Valley R. R.	....	71 08
Lehigh Valley, R. R.	57 04	225 10
To individuals on line of Railroad.	6 00	109 02
To points on line of road for use of Company		41 12
Total	6,135 05	56,717 17
Grand totals transported		
Anthracite	9,205 03	142,737 08
Bituminous	6,135 05	56,717 17
Total	15,340 08	199,455 05
Same time last year	15,684 06	207,048 19
Increase	343 18	7,591 14
Decrease		

Report of Coal Transported over Lehigh Valley Railroad

Report of coal tonnage for the week ending March 6, 1873, with totals to date, compared with same time last year.

WHERE SHIPPED FROM.	WEEK. Tons. Cwt.	TOTAL Tons. Cwt.
Total Wyoming	10,256 10	164,487 05
" Hazleton	38,681 06	416,898 04
" Upper Lehigh	182 04	1,215 01
" Beaver Meadow	13,892 19	157,633 14
" Mahanoy	9,848 14	82,978 18
" Mauch Chunk	230 05	1,106 02
Total	73,091 18	824,319 04
Same time last year	54,253 15	825,652 07
Increase	18,838 03	
Decrease		1 333 03
Forwarded East from Mauch Chunk by rail	63,394 18	692,377 17
Same time last year	44,064 08	715,894 06
Increase	19,330 10	
Decrease		23,516 09
DISTRIBUTED AS FOLLOWS.		
Forwarded East from Mauch Chunk by rail	62,553 05	678,095 10
do East for use L. V. R. R.	838 13	14,282 07
Delivered at and above Mauch Chunk for use of L. V. R. R.	1,470 04	18,250 08
To P. & N. Y. R. R.	5,382 05	88,070 18
To N. C. R. R., at Mount Carmel	902 03	2,691 02
To D. H. & W. R. R.	1,077 14	11,341 17
To L. & S. R. R. at Packerton for rail	493 00	3,949 18
Delivered at M'h Chunk	102 00	1,256 06
Delivered on line of road above Mauch Chunk	240 05	4,775 04
To L. & S. R. R., at Penn Hav., for railroad		1,541 10
Do. for canal		
To Lehigh Canal Mauch Chunk		
To Catawissa Railroad		35 00
To L. & B. R.R. at Lack. Junc.	29 09	29 09
Total	73,091 18	824,319 04

Statement of Coal Transported over Cumberland and Pennsylvania Railroad

During the week ending Saturday March 8, and during the year 1873, compared with the corresponding period of 1872.

WEEK.

	C. & O. C'l Tons. Cwt	B. & O. R. R. Tons. Cwt.	Pa. S. Line Tons. Cwt.	Total. Tons. Cwt.
1873	—	27,902 00	2,028 03	29,930 03
1872	220 10	19,729 05	....	19,949 15
Increase		8,172 15	2,028 03	9,980 08
Decrease	220 10	......	....	

YEAR.

	C. & O. C'l Tons. Cwt	B. & O. R. R. Tons. Cwt.	Pa. S. Line Tons. Cwt.	Total. Tons. Cwt.
1873	—	207,125 00	17,398 12	224,523 12
1872	220 10	180,795 16	....	181,016 06
Increase	....	26,329 04	17,398 12	43,507 06
Decrease	220 10	....	....	....

Cumberland Branch R. R.

WEEK.

	To C. & O. Canal. Tons. Cwt.	To B. & O. R. R. Co Tons. Cwt.	Total. Tons. Cwt.
1873	—	2,699 04	2,699 04
1872	—	......	......
Increase	—	2,699 04	2,699 04
Decrease	......	......	......

YEAR.

	To C. & O. Canal. Tons. Cwt.	To B. & O. R. R. Co Tons. Cwt.	Total. Tons. Cwt.
1873		21,013 13	21,013 13
1872		290 10	290 10
Increase		20,723 03	20,723 03
Decrease			

Report of Coal Transported over Central R.R. of N. J. (Lehigh and Susq. Div.)

Week ending March 8—Compared with same time last year.

WHERE SHIPPED FROM	TIDE. tons ct.	LOCAL. tons ct.	TL WEEK tons cwt.	TL. DATE. tons cwt.
Wyoming Region	16396 12	11083 17	27479 09	268886 13
Upper Lehigh Region		3841 08	3841 08	37093 07
Beaver Meadow Region	1151 07	1108 03	2262 10	30078 14
Hazleton Region		280 19	280 19	2808 17
Mauch Chunk Region	4677 11	4438 06	9115 17	67400 13
Trescow Region				
Mahanoy Region				
Total	22228 10	20751 13	42980 03	406270 04
Previously reported	181103 18	182186 03	363290 01	
Total to date	203332 08	202937 16	406270 04	
Same time last year	162041 17	131989 15	294032 12	
Increase	41290 11	70948 01	112238 12	
Decrease				
DISTRIBUTION.	WEEK 1873.	WEEK 1872.	YEAR 1873.	YEAR 1872.
Forwarded East by Rail to Tidal points	22228 10	22347 12	203332 08	162041 17
Forwarded East by Rail to Local points	10166 13	9242 18	93931 00	60689 18
Forwarded East by Rail use Central Division	1478 15	2084 01	16405 19	13799 06
Forwarded East by Rail use L. & S.	321 01	182 11	2412 11	1642 10
Delivered at and above Mauch Chunk	1493 14	1467 09	16044 09	10809 08
Deliver'd at Coalport & Hazard for Canal	661 17	817 19	10666 19	4041 11
Delivered to L. V. R.R. at Packerton	930 12	411 08	8735 18	3097 19
Delivered to L. V. R. R. at Sugar Notch	1434 18		14723 07	
Delivered to L. & B. R. R. at Plymouth Bridge	4275 03	3847 17	40017 13	38399 03
Total	4298 03	40351 10	406270 04	294031 12
Increase for week				2,698 13
Increase for year				112,248 12

Delaware and Hudson Canal Company.

Coal mined and forwarded by the Delaware and Hudson Canal Company for the week ending Saturday, March 8, 1873.

	WEEK.	SEASON.
North	50,216 18	431,983 19
South	5,158 17	59,331 08
Total 1873	55,375 15	491,315 07
Corresponding time in 1872 :		
North	43,131 18	455,477 06
South	5,493 03	64,052 05
Total	48,625 01	519,529 11
Increase North		
Decrease North		
Increase South		
Decrease South		
Increase	6,750 14	
Decrease		28,214 04

Delaware and Hudson Canal Company.

Coal mined and forwarded by the Delaware and Hudson Canal Company for the week ending Saturday, March 8, 1873.

	WEEK.	SEASON.
By Delaware and Hudson Canal	....	....
By Railroad, East	9,859	59,586
" West	6,765	78,260
" South	5,159	59,332
Total 1873	21,783	197,178
Corresponding time in 1872 :		
By Delaware and Hudson Canal	....	118,599
By Railroad, East	10,831	14.047
" West	6,357	64,052
" South	5,493	
Total	22,381	241,698
Decrease	44,520	

Prices of Coal by the Cargo.

[CORRECTED WEEKLY.]

AT NEW YORK. March 13. SCHUYLKILL.	R. A.	W. A.	AT PHILADELPHIA. March 13. R. A.	W. A.
Lump	$- —	$5 25	- —	4 00
Steamer	- —	5 35	- —	4 00
Broken,	5 60	5 85	4 25	4 00
Egg	5 75	5 50	4 40	4 15
Stove,	5 95	5 65	4 80	4 30
Chestnut,	5 10	5 35	3 75	3 50
Pea	- —	- —	- —	- —
LEHIGH. Freight to New York 50 cents.			- —	- —
Lump, (on board)	- —	5 00	- —	—
Broken	- —	5 20	- —	- —
Egg	- —	5 20	- —	—
Stove	- —	5 50	- —	- —
Chestnut	- —	4 60	- —	—
Pea	- —	- —		
SPECIAL COALS.*			- —	- —
Honey Brook, Le'h W.A.		4 60@5 50	- —	- —
Spring Mountain " "		- —@- —	- —	- —
Sugar Loaf.... " "		- —@- —	- —	- —
Old Compy's... " "		4 60@5 50	- —	- —
Room Run.... " "		4 60@5 50	- —	- —
Hill & Harris.. " "		4 60@5 50	- —	- —
Shamokin..... " "		4 60@5 50	- —	- —
Lykens Valley. " "		4 75@6 00	- —	- —
Broad Top..... " "		6 50@- 00	5 25	- —

Company Coals.

March, 1873.

	L.	Str.	Grs.	Eg.	Sto.	Chest
*Scranton at E. Port	4 25	4 25	4 45	4 65	5 50	4 25
Pittston at Weehawken	4 70	4 70	4 70	4 90	5 40	4 60
*Lackawana at Weehawken	4 60	4 70	4 80	5 05	5 50	4 60
Wilk'b're at Hoboken	4 45	4 53	4 65	4 65	5 35	4 45
Old Co. Lehigh at Pt. John'n	5 25	—	4 85	4 90	5 15	4 15
Lehigh at Eliz. Port	5 00	—	4 75	4 75	5 10	4 15

For freights to different points see "Freights.

*To contractors only.

Prices at Baltimore—March, 1873.

Wholesale Prices to Trade.

Wilkesbarre, by cargo or car load	$5 75@6 00
Pittston and Plymouth, do.	5 75@....
Shamokin Red or White Ash, do.	6 00@6 25
Lykens Valley Red Ash, do.	@6 50
By retail, all kinds per ton of 2,240 lbs	7 50@8 50
George's Creek and Cumberland f. o. b. at Locust Point for cargoes	@5 00
Fairmount and Clarksburg gas f. o. b. at L. Point	6 40
Kanawha Cannel, coarse	@12 00
BITUMINOUS COALS.	
Kittaning Coal Co.'s Phœnix Vein, f. o. b. at Phila	$
Lemon " " "	
Cumberland Vein Coal	....
Consolidation Coal Co.'s on board at Baltimore	....
Maryland Coal Co. "	....

Prices at Georgetown, D.C., and Alexandria, Va.

March, 1873.

George's Creek and Cumberland f. o. b. for shipping$....@.... [nominally.

No coal before spring.

Prices at Havre de Grace, Md.

March, 1873.

Wilkesbarre and other White Ash for Cargoes	$ @4 75
Lykens Valley	@5 75
Shamokin Red or White Ash	5 00

Bituminous Coals (Cumberland).

Georgetown, F.o.b.	$
Baltimore	
New York	

Prices of Foreign Coals.

March, 1873.

Duty 75 c. per ton.

Corrected weekly by ALFRED PARMELE, No. 52 Pine street, N. Y.

Liverpool Gas Caking	Nominal.
" " Cannel	15 00@16 50
" House "	22 00@23 00
" Orrel.	17 00@18 00

Per ton 2,240 lbs., ex-ship.

PRICES FROM YARD.

Liverpool House Orrel, screened	$20 00@22 00
" Cannel, "	23 00@25 00

Per ton 2,000 lbs. delivered.

Prices of Gas Coals.

March, 1873.

PROVINCIAL.

Corrected weekly by Louis J. Belloni, Jr., 41-43 Pine st., N.Y

	Coarse	Slack.
Block House	$2 00	$1 00
Gowrie	1 75	— 80

Corrected by Bird, Perkins & Job, 27 South street.

	Coarse.	Culm of Coal.
Pictou.................nett	$2 25	1 25
Sydney	2 25	- 80
Lingan	1 75	- 80
Caledonia	1 75	- 80

A discount from the prices of the coarse Coal on purchase of 5000 tons and upwards. Duty on all slack coal or Culm: 40c. per ton of 28 bushels, 80 pounds to the bushel. On all bituminous coal or shale: 75 cents per ton of 28 bushels.

AMERICAN.	Nominal quo. Currency.
Westmoreland	$7 10 @- —
Fairmount Gas Coal Co. of N. Y.	7 00 @- —
Despard Coal Co.	7 00 @- —
Penn.	7 10 @- —
Newburg Orrel Gas	- — @- —
West Fairmount Gas Coal	7 00 @- —
Redbank Cannel, Penn.	- — @- —
AT PHILADELPHIA.	
Westmoreland	7 00 @- —

Rates of Transportation to Tide Water.

BY RAILROAD.

TO PORT RICHMOND, PHILADELPHIA.

Philadelphia and Reading Railroad, from Schuylkill Haven Lump and St., net, $1 60; Br., Egg and Ch., $1 65; Stove, $1 75 Shipping at Pt. R., 20c., for use at Phil., $2 18 from Pt. Carbon.

MAUCH CHUNK TO ELIZABETHPORT.	
L. V. Railroad from Mauch Chunk to Phillipsburgh	$0 72
C. R.R., N. J., Phillipsburgh to Elizabethport	1 06
Shipping expenses at Elizabethport	25
Wharfage	10
Total	$2 23
MAUCH CHUNK TO PORT JOHNSTON.	
L. V. R.R., or L. & S. R.R. from M. C. to Phillipsb'g	$0 72
C. R.R., of N. J., Phillipsburgh to Pt. Johnson	1 06
Shipping expenses	25
Wharfage	10
Total	$2 23
TO HOBOKEN	
L. V. R.R., Mauch Chunk to Phillipsburgh	72
Morris & Essex R. R. Phillipsburgh to Hoboken,	1 06
Shipping expenses	25
Wharfage	10
Total	$2 23
TO SOUTH AMBOY.	
L. V. R. R.	72
B. & D. R. R. } Cam. & Am. R. R. }	}1 06
Shipping Expenses,	25
Total	$2 23
PENN HAVEN TO ELIZABETHPORT.	
L. V. R R. Penn Haven to Phillipsburgh	0 84
C. RR. of N. J. Phillipsburgh to Elizabethport	1 06
Shipping expenses	15
Wharfage	20
Total	$2 35

Foreign and Provincial Freight

March, 1873.

Foreign.

Newcastle and Ports on Tyne, per keel of 21 1-
Liverpool, 5 per cent primage

TO NEW YORK.

Provincial.	
Sydney	$3 60
Lingan	3 50
Cow Bay	3 75
Port Caledonia	3 10
Little Glace Bay	3 00
TO BOSTON.	
Sydney	3 00
Lingan	3 00
Cow Bay	3 00
Port Caledonia	3 00
Little Glace Bay	2 90

Freights.—March, 1873.

TO EASTERN PORTS.	Cumberland. From Georgetown.	From Baltimore.	Anthracite. From Philadel'a.	From Eliz. Port, Port Johnston, and Hoboken.	From Newburgh.	From Rondout...
Amesbury						
Bangor						
Bath						
Boston	3 10	4 00		3 00		
Bridgeport	2 75	3 25		1 00		
Bristol				1 80		
Cohasset Nar'ows	2 25					
Derby				1 25		
Dighton	2 85					
East Cambridge				3 15		
Fall River	2 75	3 50		1 80		
Hackensack						
Hartford						
Hoboken	2 10			50		
Jersey City	2 10			50		
Lynn						
Middletown						
Mystic						
New Bedford	3 00			1 80		
Newburyport	3 10			3 20		
New Haven	2 75	3 25		1 00		
New London	2 75	3 50		1 40		
Newport	2 80			1 80		
New York	2 25	2 75		50		
Norwalk	2 50	3 50		1 00		
Norwich				1 50		
Pawtucket				1 85		
Portland	3 25	4 00		3 00		
Portsmouth, N.H		4 00		3 10		
Providence	2 75	3 50		1 80		
Rockport						
Saco						
Sag Harbor				1 40		
Salem	2 70			3 00		
Stamford				1 00		
Stonington				1 50		
Taunton						
Warren				1 80		
TO RIVER PORTS						
Albany						
Catskill						
Cocksackie						
Coeyman's						
Cold Spring	2 80					
Fishkill						
Haverstraw						
Hudson	3 25					
New York						
Nyack	2 25					
Poughkeepsie	2 50					
Rhinebeck						
Rondout						
Sangerties						
Sing Sing						
Stuyvesant						
Tarrytown						
Troy	3 00					
West Point						
Yonkers						

St. Thomas	$5 00 Gold.
Martinique	5 00
Demerara	6 00
New Orleans	6 00 "
Mobile	6 00 "

MARKET REVIEW.

NEW YORK, March 13, 1873.

IRON.—Scotch Pig is very quiet. There are a few lots arriving, most of which are by steamer and laid down here above present market rates. Stocks here are not large, and importers are asking full rates. There have been no sales except of a jobbing character. No. 1 brands of American Pig are in good inquiry, the stock of which, though ample for all immediate demand, is not large; No. 2 and Gray Forge are in large stock, with less inquiry than for No. 1; a sale of 500 tons No. 2 has been made on terms withheld. New English Rails are dull and without sales; may be quoted nominally $70a$72 gold. American have been in considerable inquiry, and during the past ten or twelve days about 10,000 tons have been taken for April, May and June delivery, part at $85 currency. Old English are in fair inquiry, and we note sales of 100 tons D. H. from ship at $58, and 118 do. T. $55. Scrap is steady at about $58a60 from yard, with sales of 100 tons from dock, on private terms. Manufactured is strong at the advance noted in our last, which, on some descriptions, was considerable.

From a late Liverpool paper:—We learn from Wolverhampton that at 20s. a ton advance upon last week's rates Finished Iron was difficult to get, and though consumers are ready to give the rise of 2s. per ton on slack as well as large coals, portions of works are standing for want of fuel. Masters are becoming greatly annoyed at the indolence of the men, and many will not accept orders at any price, so that, if necessary, they may close their works. Circulars from best Sheet makers withdraw all previous quotations, and marine Iron work is advanced 40s. per ton.

COPPER.—New Sheathing is steady at 43 cents, and Bolts and Braziers 45, Bronze and Yellow Metal Sheathing 27, and Y.M. Bolts 32 net cash. Ingot is very quiet buyers not stocking beyond the wants of the moment; the supply of Domestic however is very moderate and under good control, and prices are supported; English is dull, and the large contracts for Lake, noted in our last, will probably have a tendency to check shipments thence, while present prices are maintained in England;

sales have been made of 50,000 lb. Lake at 34½ cents, cash, and 70a80 tons English 29½a30, 30 days.

LEAD.—Foreign Pig, though quiet, is steady; there have been considerable receipts, but part of the imports was sold and reported previously; 225 tons Spanish sold within a few days on private terms; we quote Ordinary Foreign 6½ cents gold. Manufactured is steady at previous quotations.

SPELTER.—Remains firm, though there has been less business. Small sales Silesian have been made at 7½a7¾ cents gold. Domestic 9 cents currency.

STEEL.—There is no new feature to note, stocks being light, and prices firm.

TIN.—Since the large business in Pig [noted in our last] the market has been quiet, and we hear of no sales; prices are nominally firm as then quoted; say Straits 32½ cents, English 31½a32, and Banca 37½, all gold. Singapore Cables quote Tin $30 per picul. Plates are not active, but holders are very firm, and prices still gradually harden; sales have been made of 1,500 bxs. Charcoal Tin, in lots, at $12; and 1,500 do. Charcoal Terne, $11 gold.

ZINC.—Mosselman Sheet is firm at previous quotations. Manganese black oxide 3½ do. Gray 5½

METALS.

NEW YORK, March 13, 1873.

IRON.—Duty: Bars, 1 to 1¼ cents ℔ lb; Railroad, 70 cents ℔ 100 lbs.; Boiler and Plate, 1¼ cents ℔ lb; Sheet, Band, Hoop, and Scroll, 1¼ to 1¾ cents ℔ lb; Pig, $7 ℔ ton; Polished Sheet, 3 cts. ℔ lb; Galvanized 2¾; Scrap Cast, $6; Scrap Wrought, $8 per ton. All less 10 per cent. No Bar Iron to pay a less duty than 35 per cent. ad val.

	Store Prices.
Pig, Scotch—Coltness ℔ ton	63 50@65 00
Gartsherrie	— —@60 00
Glengarnock	56 00@58 —
Eglinton	55 00@56 00
Pig, American, No. 1	50 00@51 00
Pig, American, No. 2	45 —@48 00
Pig, American, Forge	40 00@44 00
Bar Refined, English and American	— —@110 00
Bar Swedes, assorted sizes (gold	120 00@130 00
	Store Prices, Cash.
Bar, Swedes, 1¼ to 5 x ⅜ & ⅞ 2 sq. & 6 to 12 x ⅜ & ⅝	150 00@160 00
Bar, Refined, ¼ to 2 in. rd. & sq. 1 to 6 in. x ⅜ to 1 in.	107 50@ — —
Bar, Refined, 1⅛ to 6 by ⅜	— —@112 50
Bar, Refined, 2⅛ to 2⅞ round 1 & 1¼ by ¼ & 5:16	115 00@ — —
Large Rounds	115 50@127 50
Scroll	130 00@160 00
Ovals and half-round	132 50@152 50
Band	— —@125 00
Horse Shoe	— —@127 50
Rods, ⅝ to 3-16 inch	112 50@155 00
Hoop	155 00@180 00
Nailrod	@ 9¼
Sheet, Russia, as to assortment (gold)	16 @ 16½
Sheet, Singles, D. and T. Common	—6¾@— 7½
Sheet, D. and T. Charcoal	—7¾@— 8½
Sheet, Galv'd, list 5 per cent, discount	—@ — —
Rails, English (gold), ℔ ton	70 00@ 72 00
Rails, American, at Works in Pennsylvania, currency	83 00@ 85 00

COPPER.—Duty: Pig, Bar, and Ingot, 5; old Copper 4 cents ℔ lb; Manufactured, 45 per cent. ad val.

	All Cash.
Copper, New Sheathing, ℔ lb	— @— 43
Copper Bolts	— @— 45
Copper Braziers, 16oz. and over	— @— 45
Copper Nails	— @— 45
Copper, Old Sheathing, &c. mixed lots	28 @— 30
Copper, Old, for chemical purposes, 14@16 oz.	— @— —
Copper, American Ingot	34½@— —
Copper English Pig	28½@—
Yellow Metal, New Sheathing & Bronze	27 @— 00
Yellow Metal Bolts	— @— 32
Yellow Metal Nails	27 @— 30

LEAD.—Duty: Pig, $2 ℔ 100 lbs.; old Lead, 1¼ cents ℔ lb. Pipe and Sheet, 2¼ cents ℔ lb.

Galena, ℔ 100 lbs	$— — @— —
Spanish (gold)	6 45 @6 50
German, do.	6 45 @6 50
English do.	6 50 @7 00
Bar (net)	9 25 @ —
Pipe (net)	— — @10 50
Sheet	— — @10 50

STEEL.—Duty: Bars and Ingots, valued at 7 cents ℔ lb or under, 2¼ cents; over 7 cents and not above 11, 3 cents ℔ lb; over 11 cents, 3½ cents ℔ lb, and 10 ℔ cent ad val. (Store prices.

English Cast (2d and 1st quality) ℔ lb	— 18 @— 22
English Spring (2d and 1st quality)	— 9¼@— 10½
English Blister (2d and 1st quality)	— 11½@— 16
English Machinery	— 11½@— 14
English German (2d and 1st quality)	— 11½@— 12
American Blister "Black Diamond"	— — @— 11½
American, Cast, Tool do.	— — @— 17
American, Spring, do.	— — @— 11
American Machinery do.	— — @— 11½
American German, do	— 9 @— —

TIN.—Duty: Pig, Bars, and Blocks, 15 ℔ cent. ad val.; Plate and Sheets and Terne Plates, 25 ℔ cent.; Roofing 25, ad val.

	Gold ℔ lb.
Banca	37½@—
Straits	32 @37½
English	31½@—

PLATES.

Fair to Good Brands.	Gold.	Currency
I. C. Charcoal, ℔ box	$12 00 @12 25	$14 12½@14 37½
I. C. Coke	10 50 @10 75	12 50 @12 75
Coke Terne	8 75 @ 9 75	10 50 @11 50
Charcoal Terne	10 75 @11 25	12 75 @13 37½

SPELTER—Duty: In Pigs, Bars & Plates, $1.50 p. 100lbs.

Plates, Foreign (gold) p. 100 lb.	7 37½@ 750
Plates, Domestic p. lb.	8¾@— 10½

ZINC—Duty: Pig or Block, $1.50 per 100 lb.; Sheet 2½c. per Sheet per lb.—10½@11 lb

LONDON METAL MARKET.

LONDON, Feb. 21, 1873.

COPPER—English steady; Tough Cake and Ingot £92 10s., best Selected £95, and Sheathing £101. Foreign—A fair business, and Chili Bars £85a£87.

IRON—Firm. Weardale Steel Rails (Bessemer) £17, Plates £23, Pigs £3 15s. No 1, £8 5s. Nos. 3 and 4, cash, Tudhoe Bars £15 10s., Hoops £16 10s., Plates £18 10., all f. o. b. on Tyne. Rails—American market quiet; nominal price £11a£11 10s. f. o. b. in Wales, 6 mos. Scotch Pig—Gartsherrie and Coltness 162s. 6d., Glengarnock 150s., Eglinton 139s., all No. 1, net, f. o. b. Glasgow.

LEAD—Firm. W. B. Pig £23 10s.; other good brands £22 10s.@£23.

QUICKSILVER—Steady at £13 ℔ bottle.

Spelter—Firm at £24 10s.@£25.

TIN—English steady; Blocks and Ingots 147s., Bars 143s., and Refined 149s, Foreign—Straits in moderate demand at 142s. 6d. on the spot. Banca 146s.

BARING BROTHERS & Co.

Vivian Younger & Bond, under date of the 20th, write as follows:

The Metal Trade continues for the most part dull, and the influence of the some causes which of late have combined to create so much uncertainty, is still in operation.

COPPER—There has been no general or steady demand, even on a moderate scale, during the past week, and prices have given way 20s.@30s. per ton all round on Foreign descriptions, though at the close there is a trifle more steadiness.

TIN—There has been rather an inactive market for Foreign sorts, and prices latterly have ruled rather easier, but the statistical position would still appear to be unassailable. Of straits 75 tons on spot sold at from 145s. to 143s., with five tons at the close at 142s. 6d.; 15 tons, March delivery, and 10 tons February steamer, 143s.; 15 tons Billiton, 142s., and 140s. 6d. ex ship; and 20 tons Billiton, all June, 138s. Small sales of Banca at 145s.@145s. 6d. English has been in better demand, with fair sales at 145s. for Ingots.

TIN PLATES—There is more inquiry for shipment (chiefly for America) Makers are very firm at quotations.

IRON—The position is unchanged. Many makers ask protective prices.

SPELTER—Still with small stocks values grow dearer.

LEAD—In better demand. Makers look for a further advance of 5s.@10s.

Petroleum.

ANNUAL STATEMENT OF THE PRODUCTION STOCKS, &c.

The production of America in 1872 and previous years compare as follows:

Total product of Penn., Oil region, 1872....	bbls.6,539,000
Do. West Virginia, Ohio and Kentucky	325,000
Do. Canada	530,000
Total product in 1872	bbls.7,394,000

1871	bbls.6,638,000	1869	bbls. 3,965,000
1870	6,535,000	1868	3,941,388

The daily average product in America in 1872 was 20,271 bbls., against 18,100 in 1871, and 17,900 in 1870. In Canada the yield is estimated at 530,000 bbls. for the year. In West Virginia and Ohio the product is given at 325,000 bbls.

Shipments in—	1872.	1871.	1870.
To New York....bbls.	1,957,254	1,537,652	1,324,922
Cleveland	1,174,513	1,727,833	1,828,831
Boston	197,180	179,678	169,363
Philadelphia	742,455	476,119	425,142
Pittsburgh	1,177,424	1,128,953	1,132,834
Other Points	460,918	409,975	337,837
Total.......bbls.	5,712,365	5,460,210	5,219,129

1869	bbls.3,944,388	1867	bbls.2,963,366
1868	3,893,252	1866	2,800,000

Average daily product of the Pennsylvania Oil district during the months indicated:

	1869.	1870.	1871.	1872.
January.......bbls.	10,192	12,624	15,477	16,286
February	9 967	11,917	14,391	16 013
March	9,871	12,385	13,457	15,506
April	11,067	12,974	13,308	16,308
May	10,153	14,165	13 987	18,345
June	11,334	14,817	14 806	17,749
July	11,697	16,989	17,261	18513
August	12,157	17,777	18,161	18,816
September	12,645	19,489	17 648	16 561
October	13,071	20,158	16,068	14,309
November	13,317	18,012	16,651	23,275
December	12,844	15,214	16,703	22,054

The annexed table gives the production of Pennsylvania each year since 1859:

1859	bbls.87,000	1867	bbls.3,3470,000
1860	500,000	1868	3,715,000
1861	2,118,000	1869	4,215,000
1862	3,056,000	1870	5,659,000
1863	2,632,000	1871	5,795,0 0
1864	2,116,000	1872	6,539 000
1865	2,497,000		
1866	3,597,000	Total	bbls.15,840,000

The greatly increased production of the year was so much in excess of the consumption that there was a large increase in stock. In Pennsylvania, the increase was steady from January to June 1st, when the total was over 1,000,000 bbls. In July and the four following months there was a decrease, but in November and December there was a rapid increase, and the stock January 1, 1873, reached over 1,000,000 bbls.

Average monthly prices of Crude on the Creek of barrels of forty-three gallons; January $4.05, February $3.85, March $3.67½, April $3.55, May $3.95, June $4.10, July $3.75, August $3.42½, September $3.25, October $4.25, November $4.50, and December $3.62½. The average price in 1873 was $3,75, against $4.50 for the previous year.—*Titusville Herald.*

San Francisco Stock Market

BY TELEGRAPH.

NEW YORK, March 12th, 1873.

We have advices from the San Francisco Stock Board dated the 11th inst. The market still continues its downward course, not an item on the list forming an exception to the unusual decline.

		March 11.	
Savage	—	47¾	—
Crown Point	—	90	—
Yellow Jacket	—	57	—
Kentuck, "New Issue"	—	8	—
Chollar Potosi	—	36	—
Gould & Curry "New Issue"	—	6¾	—
Belcher "New Issue"	—	64	—
Imperial	—	5¾	—
Raymond & Ely	—	73	—
Meadow Valley	—	10¾	—

American Institute of Mining Engineers.

OFFICIAL BULLETIN.

Announcements to Members and Associates.

I. All members and Associates who pay their dues ($10,) for each current year, strictly in advance, will have sent to their address, regularly and weekly, the ENGINEERING AND MINING JOURNAL, which is the organ of the Institute, and will contain the proceedings and transactions, and all important papers read before the Institute and all notices of meetings. Back numbers cannot, as a general rule, be sent.

Those members and associates who have not paid their dues for the current year, are requested to do so at once. Money may be sent in postal orders, checks or bank bills, to the Secretary, THOMAS M. DROWN, 1123 Girard street, Philadelphia, Pa.

II. It is expected that the more important papers, read before the Institute, and the debates thereon, will be published in annual or occasional volumes to which those Members and Associates will be entitled who have paid their dues.

III. All authors of papers are requested to notify the Secretary in advance of the meetings, giving the subject and length of their papers. Attention is also called, in this connection, to Rules 12 and 13.

IV. The ninth rule has been amended, so that there will be hereafter three meetings a year, in February, May and October.

THOMAS M. DROWN, Secretary.
1123 Girard street, Philadelphia, Pa.

Iron-Making in America.

When hobbyists persist in constantly inflicting upon us their peculiar views, it is not unfair to bring up their predictions at times when the course of events has turned the tables completely against them. For the amusement of our readers, we print the following extract from Kohn's Iron and Steel Manufactory in Great Britain in 1867 and 1868:

The United States of America are turning from importation of iron to the manufacture of this material. This is a somewhat premature step, unnaturally stimulated by an unreasonable tariff of import duties. A country like America has more profitable channels for the development of its natural resources than the sinking of that large amount of accumulated capital required for iron mining, and the slow returns which characterize this steady and conservative branch of industry. To cripple the whole effective power of that great nation whose characteristic element and mainspring of existence is rapidity of industrial progress—to increase, and even to double the price of iron and steel in such a country by artificial means—must be considered the height of political insanity. The protective tariff will create a parasitic industry in localities unsuited for its development; it will create a vested interest in these sickly glass-house plants which cannot now, and which will not in future, maintain themselves unprotected and in a natural state of affairs; and the end of it will sooner or later be such a commercial and industrial calamity as will astonish even our strong-nerved cousins across the Atlantic.

The condition of England to-day, where overstrained production and abnormally low wages have wrought their proper effects upon the iron industry of that country, is a criticism upon these views, the strength of which we cannot increase by any words. But there is one mistake which Mr. Kohn made, in common with many others who write in that strain. He overlooked the fact that the manufacture of iron is a necessity to every great nation. Whether we have war or peace, the production of our own iron is a vital necessity of life, for that metal now enters into nearly all forms of modern existence. The encouragement of iron smelting is a principle which is in some respects apart from all considerations of free trade. It is due to the nation as an industry necessary to national life.

But, in other respects, the condition of the iron manufacture in Great Britain to-day is a sufficient proof of the fallacy of these extreme views. Were the whole world, or even all America only, dependent upon that country for its iron, where would prices be now? It cannot be doubted that, instead of selling at 160 shillings and upward, as it did last fall in England, the advance would have been much greater, and the British people would have been common sufferers with Americans. Iron rose in both continents, but the two and a half million tons made here, and the facilities afforded by an established business for rapid increase of make, acted like a brake upon the headlong course of quotations. The iron business of the United States, so much maligned by our British cousins, has at length stood them in good stead. Without it, the world would very probably have witnessed that frightful calamity which Mr. Kohn predicted as a consequence of it.

Increase of Iron Works in 1872.

The increase in furnaces is divided among the States as follows:

State.	Furnaces Built.	Furnaces Projected.	R. Mills Built.	R. Mills Projected.	Total New Works.
Pennsylvania	48	11	15	5	79
Ohio	13	6	7	4	30
West Virginia	1	..	1	..	2
Indiana	4	1	2	1	8
Illinois	3	..	4	..	7
Missouri	6	2	1	..	9
Tennessee	5	2	1	..	8
Wisconsin	8	..	..	1	9
Michigan	6	5	1	..	12
Massachusetts	1	..	1	..	2
New York	4	1	2	..	7
Vermont	..	..	1	..	1
Connecticut	2	..	..	..	2
New Jersey	1	..	..	..	1
Georgia	2	7	..	..	9
Alabama	2	..	..	1	3
North Carolina	1	4	..	..	5
Total	107	39	36	12	194

The Danks Puddler in England.

An English company, wishing to try the Danks puddler, without going to the expense of a full plant, put up the furnace without the squeezer, though in ordinary operations the latter forms a necessary part of the plant. The ball is cut into small pieces as soon as it is puddled, and shingled under an ordinary steam hammer. As ten cwts. per heat can be worked, and seven or eight heats per day may be got, the rapidity of turning out the iron affords a great gain, seeing that the machine only requires the same number of men to work it as does the ordinary hand-puddling furnace. Besides the increase in the output, there is also a considerable saving in the quantity of coal used, and the puddled iron is said to be more free from phosphorus than when the iron is manipulated by hand. Contrary to their usual custom, the workmen will not oppose the introduction of this invention, but seem to approve of it, as by its use their labor will be so much lightened.

But not all of the mechanical puddling in England is so successful. Messrs. Bolckow, Vaughan & Co, of Middlesborough, Eng., who use the Danks puddler and employ one man and a boy to each machine, make, on the average, twenty-seven hundred weight of puddled iron to each furnace. The same firm have recently been experimenting with a machine, the "Menelaus," constructed somewhat on the Danks principle, but it only made twenty-six cwt. in five heats, with eight hands employed.

Silver-Lead Works near St. Louis.

One of the best establishments in the East for the treatment of lead and silver ores is that of the St. Louis Smelting and Refining Company at Cheltenham, near St. Louis. The ores are brought from Utah, Colorado and other districts by rail, without transhipment. Their average yield is about 75 ozs. silver, 40 per cent. lead, 23 silica, 10 moisture and 8 carbonic acid, the remainder being principally lime and iron oxide. This is charged with mill cinder in a shaft furnace and smelted with coke. The furnace treats about twenty tons daily. It is 15 feet high from the tuyeres to the charging door and 3½ feet in diameter. There are three tuyeres of 1½ inch diameter, air being furnished by a Sturtevant fan at about ¼ pound pressure. The engine is of 25 horse power. A roasting furnace, and another for fusion, are under construction, which, when finished, will about double the capacity of the works. In the treatment for silver the rich lead is cupelled at once. Poor lead is desilvered by zinc in a battery of three 12½ ton kettles, the zinc being added in three charges. Fractional extraction, by which any gold present is concentrated in the first scum taken off, is used whenever the lead contains that metal. After melting down the zinc the bath is stirred for one half hour, and then rests about three hours. The poor lead is drawn off by a tap in the bottom of each kettle, and runs to a reverberatory furnace, where it is refined.

Effect of Magnetisation on the Dimensions of Iron and Steel Bars.

Dr. Mayer, of the Stevens Institute, has made experiments on the change in dimensions of bars of steel and iron by magnetisation. These experiments were performed with great care, by the aid of apparatus capable of detecting and measuring with precision a variation in length of one two-hundred-thousandth of an inch. By means of this apparatus, he found that iron bars were elongated when a current of electricity was passed around them; when the current was interrupted, the bar shortened somewhat, but never again regained its original length. With annealed steel bars the result was the same; but with tempered steel, the results were altogether different. On passing the current around these they contracted, and on interrupting the current they contracted still further. He also made some experiments to determine whether there was any change in volume in a hollow cylinder of iron when it was magnetised. For this purpose a hollow cylinder, closed water-tight with the exception of an opening in the upper cup, into which a glass tube with a fine bore was fixed, was filled with water so that the water stood in the glass tube some distance above the top of the cap. On passing a current of electricity around the cylinder, the water sunk in the tube, showing that the capacity of the cylinder was increased. Other experiments showed that when a bar of iron was magnetised, an increase of temperature took place. This was beautifully shown by the above experiment, when contact was made and broken a number of times: the water in the cylinder was so heated that it overflowed the top of the glass tube.

An Instructive Story.

Not very long ago a small lot (half a car-load) of copper matte, containing gold and silver, was sent to this city from one of the western mining districts, and offered at first to Mr. Robertson, the New York agent of the Royal Prussian and Saxon Smelting Works, for shipment abroad. But the owner of the matte was dissatisfied with the regular tariff of those establishments, and, being sure that he could do much better at Swansea, shipped the lot to that place. We have not had the pleasure of inspecting this gentleman's balance-sheet; but it will interest him to learn that his matte was treated in Germany after all, being shipped thither by the Swansea Works, in accordance with what is at present their regular "method of treatment" for such materials. As the tariffs of the German works are official and impartial to all comers, it is not easy to see what is gained by sending cargoes to Hamburg *via* Swansea.

The safety catch of M. Libotte, which has found a wide application at the collieries of Belgium and the North of France, has lately again proved its value at the colliery of "Conception," near Mont-sur-Marchienne, when the pit rope broke when drawing up the cage loaded with four tubs of coal. The catch or parachute acted instantly, and forced its claws in the guiding beams 1·5 centimetres deep, and after sliding downwards ½ metre, brought the cage to a standstill, and kept suspended a weight of 5,410 kilogrammes, or 5½ tons, viz., the cage 1,700 kilogrammes, 4 loaded tubs 1,960 kilogrammes, and 250 metres of wire rope 1,750 kilogrammes. This apparatus merits its reputation and acts well, when the rope breaks winding up, but is not reliable when going down.

A suit for damages that involves some $200,000 has been commenced by one of the most prominent Pennsylvania iron firms against the proprietors of an iron mine, for breach of contract. The plaintiffs aver and allege that the defendants have violated the provisions of the contract, alleging that the ore is not equal in yield to the best No. 1 Lake Superior specular ore (Jackson Iron Company's ore excepted), whereby the complainants allege they have sustained a loss of $211,327.50. They also allege that 2,253 tons of the ore has not yet been delivered, showing a further loss of $14,087, or an aggregate injury in dollars and cents of $225,411.50.

THE ENGINEERING AND MINING JOURNAL.

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CONTENTS FOR THIS WEEK.

The American Institute of Mining Engineers.

We omit this week the instalment of the detailed report of the Boston meeting. The papers we publish are sufficient for one week. Meanwhile we call attention to the following note from Professor SILLIMAN making some important corrections:

"In the rendering of my remarks at the Boston meeting given in the Journal of March 11th, I find that in the discussion following the paper of Mr. ENGELMANN, I am made to say (p. 148, top of second column) I collected a *large* number of fossils and submitted them to Mr. DAWSON and Professor TENNEY, whereas I obtained a *small* number of supposed zoophites and submitted them to Mr. DAWSON and Professor DANA.

"Again, on p. 152, my remarks should apply to the *Ophir District, East Canyon*, and not to *Little Cottonwood*, as quoted.

THE ore report of the Utah Central railroad, the line which connects Salt Lake City with the Union Pacific, was for January: Import, 70 tons ore; export, 1,049 tons ore; 330 tons refined lead and 290 tons "bullion"—a total of 1,669 tons taken from the Territory. The report for February is as follows. Import, bullion 50 tons; export, ore 318½ tons, lead 50 tons, bullion 159 tons. Little is doing and business is quite stagnant.

WE commend to our readers the paper of Mr. HEINRICH on the Mid-Lothian colliery, read at the Boston meeting of the Institute, and published this week in our columns. The simplicity and boldness of the methods employed in this three years' hand-to hand under-ground fight with fire will attract the attention of mining engineers; and the details of the struggle cannot fail to arouse even through the business-like narrative of Mr. HEINRICH, a thrill of excitement in the most callous breast. The romance of the story need not, however, obscure its great professional interest or its commercial importance. The Richmond coal-fields, so long cursed with spontaneous fires, may, it is evident, be worked successfully in spite of all difficulties, and this is a fact worth knowing.

MR. HENRY ENGELMANN, whose valuable paper on the Utah mines we published last week, has been experimenting with the Wyoming coal, and finds that a good coke can be produced from it. His furnace, which was merely experimental, took a half ton charge and the product was of good quality. Financially, we believe, the results were not very favorable, though they were not at all indicative of the inability of Utah to provide her own shaft furnace fuel. On the contrary, with a larger plant the results might easily be very favorable, for the cost of the Utah made coke is a little less than that of the article brought from the east. The interesting point in these trials is the successful coking of a fuel that is looked upon as an undoubted lignite, though a lignite of high grade. We trust that Mr. ENGELMANN will publish such particulars of his experiments as will make these interesting trials conduce to our knowledge of western fuels. To the west the production of good coke from its fuel, even in an experimental way, is a fact fraught with the greatest possibilities.

MR. E. STEIGER of 22 Frankfort street, New York, proposes to print a catalogue of original American publications on all subjects, for foreign distribution; the intention being to place in the hands of foreign libraries, collectors and booksellers, a complete catalogue of American publications, including translations, but excluding reprints. Mr. STEIGER is a book publisher, and, of course, does this as a commercial undertaking, but his task is one that has in it a higher element than mere commercial profit. It will undoubtedly be of great benefit both to American authors and to foreigners, and this benefit will increase with the growth of investigation and original research in all branches of study, in this country. He asks authors and publishers to assist him by forwarding lists of their works. From these he will form a descriptive catalogue. He has already distinguished himself by publishing, for distribution here, lists of foreign works in all departments, and, whoever desires to pursue any study whatever, can obtain from him excellent guides to the existing literature upon that study.

John Torrey.

The National Academy of Sciences, so recently called to mourn the loss of Professor COFFIN, now suffers, in the death of Professor JOHN TORREY, another loss, not less profound. In this case, also, as in the former case, it is not a narrow, professional circle only which feels the blow, but a wide and sympathetic public of co-laborers, pupils, friends and admirers. The maxim, *De mortuis nil nisi bonum*, loses its significance when applied to one, of whom nothing but good was spoken while he lived. Professor TORREY's death will make audible, but it cannot make more favorable, the judgment of him which all who knew him entertained, and those most profoundly who knew him best. No doubt such early and constant friends as GRAY and HENRY will speak worthily of his virtues and his fame. But we venture nevertheless our humbler tribute, in recognition of his public and scientific career, and in expression of our personal esteem and love.

Professor JOHN TORREY, M. D., LL. D., was born in this city in 1798, and after leaving school attended the lectures of the New York College of Physicians and Surgeons, receiving his medical diploma in 1818. In 1824 he was appointed Professor of Chemistry, Geology and Mineralogy in the Military Academy of West Point. In 1827 the College of Physicians and Surgeons in this city induced him to accept their Professorship of Chemistry and Botany, which chair he occupied with great success until 1855. In 1830 he also became Professor of Chemistry and Natural History in the College of New Jersey at Princeton, and only relinquished it in 1853 when he was appointed by the Government Chief Assayer in the United States Assay Office at New York. To the duties of this position he added those of Professor and Trustee in Columbia College. His first work was a catalogue of the plants to be found in a radius of thirty miles around New York published in 1819. The following is a list of his later works: *Flora of the Northern and Middle States*, 1824. Compendium of the foregoing work, 1826. *Cyperaceae of North America*, 1836. *Flora of the State of New York*, 2 vols. 1843-44. *Botanical Reports of the Various Land Exploring Expeditions of the United States from* 1822 *to* 1858. *Appendix to Dr. John Lindley's Introduction to Botany*, 1831. He also edited, with Dr. Asa Gray, the *Flora of North America*. In 1860 Prof. TORREY presented to Columbia College, of which institution he had long been a trustee, his extensive and valuable herbarium and his entire botanical library. Although of advanced age, Prof. TORREY was up to within a few weeks of his death, quite active, and, in addition to his many duties as a scientific man, added those of Treasurer to the New York Society of the Cincinnati.

Such is the brief summary of his long and busy, though quiet life. If we add that he died on Monday evening, March 10, of pneumonia, we complete the record. The published works we have enumerated are so many monuments of his fame, recognized throughout the scientific world. His name and that of his colleague, Dr. GRAY, rise into view, like the twin peaks of the Rocky Mountains that bear witness to the eminence of these most illustrious of American botanists. But as one who views from afar the distant heights of TORREY's Peak against the sky, gains no conception, from that view, of the flowers, running streams, cool shadowy glades and sweet surprises of beauty that cluster below the sublime summit, so the celebrity of the *scientist* is an incomplete and barren aspect, without the nearer knowledge of the honor, gentleness, enthusiasm, unaffected piety, that blossomed and were musical in the *man*.

His books retain for us the fruits of his study and research. The pure and noble example of his life is an additional volume—and the best of all.

Legitimate Mining.

We have before us a pamphlet,* containing a good deal of interesting information about Colorado, conveyed in a pleasant style, and arranged in convenient form for reference. The descriptive list of mines comprises brief notices of the leading veins in the different districts. There is a noteworthy absence of such records of actual cost of working, etc., as would permit exact estimates of profit; and we notice in Mr. OLD's prophecies a considerable tint of rose. The book shows the marks, however, of a conscientious endeavor to avoid exaggeration. Its weakest point is its "science." The author's experience as a mining captain is known; his ignorance of geology and mineralogy need not have been known if he had not laboriously exposed it in these pages. On page 11, he sets down as the first pre-requisite to successful mining, "that the prevailing geological formation of the district or mountain where the mine or mines to be opened are situated should be plutonic, and of the class of rocks known by geologists as mineral-bearing." The last of these requirements is not very severe; any class of rocks that bears "mineral" is known to geologists as mineral-bearing; and there is scarcely any formation that has not somewhere been found productive in useful minerals, from the latest alluvium back to the oldest gneiss. What is necessary as a basis for legitimate mining is not a formation known in general to geologists as this or that, but one known in particular to mining engineers as carrying valuable deposits in the special locality under examination. As to the demand that the prevailing formation shall be plutonic, it is fortunate for Mr. OLD's investments, however it may be for his reputation as a geologist, that he does not know what he is talking about. The so-called granite of Colorado is not plutonic, but sedimentary—not an igneous granite, but a stratified gneiss. The deposits of Utah are mainly in limestone; the magnificent veins of Pioche district, Nevada, which produced last year more treasure than the whole Territory of Colorado, are in stratified quartzite; the California gold mines are in slates. Against these instances, Mr. OLD may put the Comstock, in Nevada, which has plutonic rock on one wall at least. But the Comstock has no companion in its peculiar vein-structure, any more than in extent and value.

But the second pre-requisite of successful mining is declared to be "that the outcrop should unmistakably indicate the near existence of a lode, and be so strong, the quartz being more or less stained with metallic oxyds, as to give unquestioned evidence of strength with depth." This kind of evidence is well named. It is good only while it is unquestioned. The minute you question it, it disappears, and you get a much better kind of evidence, namely, the results of exploration. Mr. OLD is not wrong in attributing some significance to the size and appearance of an outcrop; but he is quite wrong in asserting that these indications are necessary to successful mining, or that they have anything to do with mining proper. They serve merely to guide explorations, before mining really begins. The absence of an explicit declaration that mining operations on a comprehensive plan should never be commenced until thorough exploration has exposed actual reserves of ore, is a curious feature of this discussion. The author only stipulates for a plutonic, mineral-bearing formation, a well-stained outcrop and a location sufficiently accessible, and says: "After being satisfied that the three requirements noted have been complied with, it will have to be determined what the plan of opening with a view to extensive future working shall be." Hereupon follow wise directions about surveys, maps and other preparations. Colorado companies know this road by heart; it is called the road to ruin. All Mr. OLD's elaborate disquisition would not secure a mining enterprise against complete disaster. The essential point is barely hinted in a single paragraph, where it is declared "gratifying as well as necessary, to be assured" of twenty things in the way of gouges, slickensides, feeders, northeast and southwest courses, not one of which is essential to successful mining, "and lastly, that the ore mined (besides possessing other requisite characteristics) is not of so low a grade as to be profitless for working." This is just what people are always ascertaining *lastly*, and what they ought to find out first.

Now the object of our criticism is not to ridicule Mr. OLD, whom we esteem personally, as one who knows better than he writes. But we fear that the intention of such statements as he has made is to assist the sale in England of undeveloped properties—the payment of large sums for mines without known and measured reserves. This we have always discouraged, and always shall discourage. The more harm we can do to that kind of business, the better it will be for Colorado. If Mr. OLD wishes to demonstrate his knowledge of the Territory and his desire to be perfectly fair in presenting its claims upon capitalists, let him leave out of his otherwise excellent pamphlet the ridiculous chapter on "legitimate mining," and insert in its place the following perfectly simple, true and easily proved propositions—not more applicable to Colorado than to every other district west of the Missouri River:

1. No property should be called "developed" that does not present measured (not estimated) reserves of ore, of reasonably ascertained value.

2. A property not developed has merely a speculative value, and the purchase of it is a mere speculation, justified only when the risk is small. A thousand dollars, for instance, representing good wages for a summer's work on the part of the prospector, is enough to pay for a "highly-charged" outcrop in the most plutonic of formations.

3. A developed property should be valued in this way. The mine, buildings, machinery, and floating capital, taken together, may be considered as worth three times the annual net profits. In other words, the enterprise should pay at least 33⅓ per cent. annually on its whole capitalized value. This is a low estimate. In the San Francisco stock market, a stock is usually required to pay from 40 to 50 per cent., in order to maintain itself at par. The reason is three-fold. First, the risk of mining is great, at the best. Secondly, a mine is steadily consuming its own resources, and must therefore pay an interest sufficient to extinguish the capital. Thirdly, the rate of interest paid by savings-banks is twelve per cent., and three or four times as much from mining investments is to be naturally expected, in accordance with the universal practice in financial communities of all countries. It is true that English investors get three and four per cent. only, at home, from the safest investments; but it is what money brings in the West that determines the price to be paid for mines. The stockholders of the Emma, who were so much pleased at the promise of 1½ per cent. monthly, did not reflect that they could have loaned money at that rate in Salt Lake City or in San Francisco, on ample security.

These warnings we have repeatedly given, and shall continue to give. If English investors continue to disregard them, and to pay out huge sums for properties, franchises, processes, and what not, which, even if they were all that they are represented to be, would not be worth the money that is given for them, it must be for one of two reasons. Either in all cases, as, to our knowledge in some cases, the promoters of English companies are personally so interested in the purchase that they cannot afford to be enlightened, or else, it is necessary that our warnings should be repeated by English lips, that the suspicion of interested motives should be removed from them. If that is the trouble, we appeal to Mr. OLD to speak out on the subject, and to tell what he knows. It will not hurt Colorado to stop the wild-cat business. That territory has good mines enough; and there is no difficulty in finding such as will be sold on reasonable terms—by which we mean, a small payment down, and plenty of time to work the mine before consummating the purchase. After a few more heavy schemes for sales at huge figures have tumbled to pieces, the real miners of Colorado, who would like some help in actual mining operations, and who are not for ever dreaming of selling out and leaving the territory, will have their turn. Meanwhile, to persons who think of investing there, we would say, take Mr. OLD, or some other intelligent and perfectly disinterested expert, acquainted with the country, and spend a month or two in a personal examination of the territory. If possible, live there a whole season, and "get the hang" of things. We feel sure you will invest before you leave, and we know that if you do, you will get more for your money than if you took stock in a big concern. Of every State and Territory on the Pacific slope, we might with equal sincerity, say the same thing. Colorado has served as a text; the sermon is for all sinners. And the worst of the lot, just now, are not in Colorado, but in Utah.

* COLORADO, *United States, America: Its Mineral and other Resources. Including a Descriptive List of a Large Number of the Principal Mines; Advantages of Soil and Climate; Railway System; Journey from England, etc., etc.* By R. O. OLD. London: Published under the Auspices of the British and Colorado Mining Bureau, 1872.

The Monnier Process for Copper.

EVAPORATION AND CRYSTALLIZATION.

(Concluded.)

THE liquor from the lixiviators now contains all the metals of the ore, which are capable of forming soluble sulphates, except a portion of the iron: that is to say, the sulphate of copper is now in solution; also the sulphate of soda (which was mixed with the ore before calcining). The liquor is now run into brick crystallizers, where it is left for a few days, during which time most of the sulphate of soda crystallizes. The mother liquor is then drawn off, the sulphate of soda, obtained by crystallization, containing about 56 per cent. of water, is removed, and by exposure to the air loses its water of crystallization, thus greatly reducing the amount of water to be evaporated by heat. The sulphate of soda thus recovered is used over again in the calcination of fresh ore.

It is impossible, by crystallization, to obtain a complete separation of the sulphate of soda from the sulphate of copper; so the crystallization is arrested by the removal of the mother liquor before the crystallization of the mixture of the two sulphates commences. The mother liquor now containing the remaining soda, and all the sulphate of copper, is diminished in volume 30 per cent. by the crystallization of the soda in the previous operation. To obtain the salts, the liquor is evaporated in a reverberatory furnace, in the hearth of which rests a wooden trough, 50 feet long, 7 feet wide, and 1½ feet deep, lined with lead, having a thickness equivalent to 10 lbs. of metal to each square foot. The two long sides are inclosed by an eight-inch brick wall to the level of the trough, or pan, from which springs a low brick arch, well braced. The ends of the trough are inclined from the bottom outward at an angle of 35 deg. The arch is perforated with three working doors, also inclined, and the projecting ends and openings in the arch are closed by movable covers. At one end, and on the side of the trough is the fire box, communicating by a large flue with the free space over the trough, and thus by the exhaust pan with the smoke stack. The products of combustion from this fire box, and also the hot gases from the calcining and reducing furnaces (these furnaces being connected by a flue with the fire box), pass over the liquor in the pan, which is kept full to protect the lead from fusion, and also to compel the hot air to travel as closely to the surface of the liquor as possible.*

As the evaporation proceeds, the sulphate of copper precipitates, and also the remainder of the soda, as anhydrous sulphate of soda; thus by keeping a stream of liquor constantly running into the evaporator, a corresponding quantity of sulphates precipitates at the bottom of the trough, and is easily removed through the inclined ends and openings in the side of the arch.†

We shall now proceed to the succeeding step for the reduction of the copper and its separation from the sulphate of soda.

REDUCTION.

The sulphates of copper and soda are mixed with about an equal volume of charcoal, or stonecoal, and heated gradually in a reverberatory furnace. At first a small quantity of the mixture is introduced into the furnace; when it commences to dry, another quantity is added, and so on until the hearth or sole of the furnace is covered to the depth of about 8 inches.

By small additions at a time, of the mixture, the sulphates are prevented from running out of the furnace, which will infallibly take place if the whole is introduced at once, on account of the property these sulphates possess of melting in their own waters of crystallization when first heated.

As soon as the fluidity commences, sulphurous acid is evolved, and increases in amount as the mixture is gradually heated to redness, at which temperature it is kept until the sulphurous acid ceases to evolve. When all the sulphate of copper is decomposed, the sulphate of soda remains undecomposed. To ascertain if all the sulphate of copper is decomposed, a small quantity of the heated mixture is agitated in a cup with fresh water, and the liquor tested for copper. If copper is found, the heating must be continued till, by testing, it is found that no more copper is soluble in water. Then the charge is taken out of the furnace, and another charge introduced, and heated in the same manner as above.

The calcined mixture, when cold, is put on a sieve immersed in a water tank; after a few hours rest the sieve is gently moved up and down, the copper (a mixture of red oxide and metallic copper, according as the flame was more or less reducing) readily separates from the coal, to which it adhered, and falls to the bottom of the tank. The sulphate of soda, which has not been affected by this calcination, dissolves in the water; the solution, after the copper has settled, is run into the crystallizers. As the soda in this represents that part remaining of the first quantity used for the calcination of the ore, it follows that, except a trifling loss, the full amount of soda is recovered, and used again and again for the calcination of ores.

The charcoal, or stonecoal, remains on the sieve, and is used again, with a small addition of fresh coal, for a new reduction of sulphate of copper.

* When a *fat* clay can be obtained, the evaporator can be constructed with a mixture of clay and lime, with walls of stone or brick, like the furnaces used for the concentration of alum-liquor in England. This material will be much less costly.

† A still further saving of fuel can be made by utilizing the heat of the hot gas and steam escaping from the elevator, to warm the liquor before entering the evaporator. This is accomplished in Europe very extensively for a similar purpose, by the use of a narrow and shallow, but very long trough (of 50 to 60 feet in length), in which several lead pipes are disposed, slightly inclined from one end toward the other. The higher end of the pipes (where the hot gas and steam enters) project out of the trough, and are connected with the flue from the evaporator. At the other end, the pipes pass out through the side of the trough, and into a small chamber, having at its bottom a small opening for the exit of the water condensed from the steam, and at the top a large opening, connecting by an iron pipe with the suction pan. The trough is filled with the cold mother liquor from the crystallizers, which is introduced at the end next to the pan, gradually traveling to the other end, where the pipes rise above the trough, and from this end it is run, heated, into the evaporator. The hot gas and steam traveling through the lead pipes in the inverse direction to the liquor (finding the liquor colder as it advances), gradually lose their heat; the steam condenses in the lead pipes and runs out, while the gas, entirely evolved, is, by a suction pan, exhausted and forced into the stack.

Economy of fuel is the great desideratum, and more particularly in industries where large amounts of water are to be evaporated. We have first to look to a perfect combustion, and secondly to the utilization of all the heat lost to create draft. The loss of heat necessary to create draft only being estimated at one-fourth of the quantity of fuel used, it results that a steam engine of 80 horse-power consuming 400 lbs. of coal per hour, loses 100 lbs. coal, equal to 10 horse-power. The power required to drive a suction fan (the gas being cooled by passing through pipes immersed in water) for the combustion of 400 lbs. coal per hour, is only 2½ horse power.

The copper remaining in the tank is well washed with fresh water. The washing liquor is used in the lixiviation of calcined ore. The copper is then pressed into blocks to prevent its being carried away by the draft, or by the blast of the smelting furnace, and is ready for smelting into ingots. The smelting into ingots is made in the usual way, either in the reverberatory furnace or in the blast furnace.

The cost of treating 50 tons (1 ton=2,352 lbs.) of sulphuret ore, containing five per cent. copper, per week in one furnace, is given in the following table:

LABOR.

1 man at crusher.
8 men at muffle furnace.
2 men for lixiviation.
2 men for evaporation and crystallization.
2 men for reduction.
1 man as roller.

16 men×6 days..............96
Sunday work..................11

	107 days at	$1	$107		
Engineer	7 "	3	21		
Foreman	7 "	3 50	24 50	$152 50

FUEL.

Engine	11		
Calcination and evaporation	9½		
Reduction	4	—24½ cords wood at $2	49 00
Wear and tear and sundries, at $1 per ton of ore			50 00
			$251 50
Smelting into ingot—5,500 lbs. ingot copper at 1 cent per lb			55 00
Product—5,500 lbs. copper=total cost of extraction			$306 50

NOTE.—In this table a loss of 110 lbs. of copper to the ton of ore is allowed, or 6 per cent.; whereas, in actual working on a large scale, the loss has been found to be about 3 per cent. only (see letter of Messrs. WATSON & CLARK).

The melting process is the same as in the Lake Superior region, where one cent per pound of ingot copper is charged at the furnace for smelting, leaving a margin for profit to the smelters. Compared with this method, the treatment of 3 per cent. ore requires 12 days' labor, and 2½ cords of wood less per week; whereas, 10 per cent. ore requires 24 days' labor, and 6½ cords of wood more per week than the 5 per cent. ore, as estimated above.

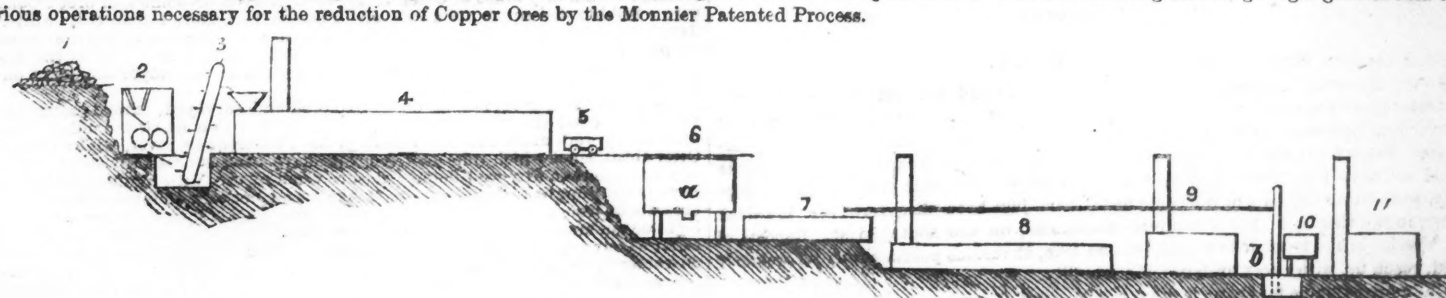
Table, giving the cost per pound of copper and per ton of ore, for the treatment of 3, 5 and 10 per cent. copper ore, by the Monnier Process, based on the figures given in the above table.

	3 per cent. Copper Ore, yielding 66 lbs. per ton.		5 per cent. Copper Ore, yielding 110 lbs. per ton.		10 per cent. Copper Ore, yielding 220 lbs. per ton.	
	Cost per ton ore.	Cost per pound Copper.	Cost per ton ore.	Cost per pound Copper.	Cost per ton ore.	Cost per pound Copper.
Labor	$ 2.81	$ .0425	$ 3.05	$ .0277	$ 3.53	$ .0160
Fuel	0.88	0133	0.98	.0089	1.24	.0056
Wear and tear	1.00	0151	1.00	.0091	1.00	.0045
	$4.69	$ .079	$5.03	$ .0457	$5 77	$ .0261
Smelting	0.66	.01	1.10	.01	2 20	.01
Total in ingot	$5.35	$ .089	$6.13	$ .0557	$7 97	$ .0361

The following extract, from a letter written by Messrs. WATSON & CLARK, of Philadelphia, shows how cheap and thorough the treatment is:

"The ore calcined in the calcining furnace, 80 feet long by 17 feet wide,

To assist the reader in appreciating the regular progress of the ore through the successive operations, we add the following sketch, giving a general idea of the various operations necessary for the reduction of Copper Ores by the Monnier Patented Process.



1. Lump Ore, from Mine.
2. Rock Breaker and Crusher.
3. Elevator for charging Calciner with Crushed Ore and Soda.
4. Calciner.
5. Iron Car to convey roasted Ore to Lixiviators, from Calciner.
6. Lixiviators.
   a. Opening for Discharge of Residue.
7. Crystallizer.
8. Evaporator.
9. Reducing Furnace.
10. Tank for Washing Copper from Soda and Charcoal, after Reduction.
   b. Reservoir and Pump to convey the remaining Soda in Solution (from the washing of Copper) to Crystallizers 7.
11. Smelting Furnace for ingot Copper.

requires the labor of three men by day and three men by night, and consumes 800 lbs. of coal in twenty-four hours in winter and 600 lbs. in summer.

"All the sulphur in the ore is gained, each pound of sulphur producing 2.98 to 3 lbs. of oil of vitriol. The copper ore contained 3.59 per cent. of metallic copper, or in each mining ton 84.5-10 lbs. of copper, of which was actually obtained 82.4-10 of metallic copper.

"We are satisfied that ultimately all the manufacturers of sulphuric acid will be compelled to adopt said Monnier's Process.

"The daily systematic observations and records are most satisfactory, and render superintendence easy."

AMALGAMATION.

The removal of the copper and a part of the iron by solution leaves a residue which, in the case of a gold ore, is in a condition especially fitted for amalgamation. In the first place it is richer than the original ore by the proportion of soluble salts removed; second, it has lost ALL its sulphur, for what did not pass off as sulphurous acid from the furnace has been removed as a sulphate by the water. The risk of flouring the mercury in amalgamating is, therefore, much lessened. These, and other considerations, indicate that there is a brilliant future for the metallurgy of gold as an auxiliary process in the wet treatment of its ores for copper, whenever that is possible.

The description of the process presented above has been drawn from the practice of those who have applied it to the treatment of many thousand tons iores.

Mr. MONNIER claims for his process a number of advantages which are of great importance. 1. No skilled labor is required. The operations are so simple that any superintendent of average intelligence can conduct them all successfully.

2. Saving of fuel. The amount required, as shown by the above table, being only 20 to 30 per cent. of the amount which is used in the ordinary treatment by fusion.

3. The use of iron is avoided by the patented method of reducing the sulphate of copper obtained from the ore. This corresponds to a saving of some cents per pound of metal. The materials used in this and other parts of the treatment are so cheap that they add but little to the expense, especially as the sulphate of soda employed in roasting, is revived and used over again with but very little loss.

4. The wear and tear of furnaces and other plant is small, on account of the low temperature used. Furnaces have been in actual use for years with a minimum expense for repairs.

5. The process enables all the metals in the ore to be extracted, while the sulphur can be converted into sulphuric acid.

6. Concentration of poor ores is unnecessary, and *paying ore* includes much lower grades of mineral than are permissible in the dry treatment. This is in many cases the most important advantage presented by this method. Mr. MONNIER calculates the saving in this respect, in a special case, as follows: One mining ton (2,352 lbs.) of 5 per cent. ore contains 117.6 lbs. metallic copper. One ton of concentrated ore of 15 per cent. copper requires 3¾ tons of 5 per cent. ore, which contains 441 lbs. metallic copper, but yields, when ready for the smelting furnace, only 352.8 lbs. copper, showing a loss of 20 per cent. of metal, all of which would be treated in the furnace and saved by the Monnier Process.

3¾ tons of ore of 5 per cent	441 lbs. copper.
Loss 20 per cent in concentration	88-20
Product 1 ton 15 per cent. concentrated ore	352.80 lbs.

Saved by the Monnier Process in one ton dressed ore, copper 88.20 lb., at (say profit) 15c	$13 23
Cost of mining ¾ ton wasted=88.20 lbs. copper at $3 per ton	2 25
Cost of dressing 1 ton 15 per cent. ore, from 3¾ tons of 5 per cent	6 00
Total saved in 3¾ tons mined ore	$21 48

or about $5.75 per ton mined, equal to a reduction in cost of working of 5 cents per pound copper (117 lbs. per ton at 5c.=$5.85).

MINING SUMMARY.

Lake Superior.

DISCOVERY OF TIN ORE.

From the *Iron World and Manufacturer* of March 7:

To the discovery of mineral deposits on the shores and beneath the bed of Lake Superior there seems to be no end. The extraordinarily rich mines of native copper of that region have attracted the attention of the world, while its mountains of unsurpassed iron ore are nearly as widely known. More recently exceedingly rich deposits of silver have been found and profitably worked on the north shore, near Thunder Bay, while other deposits of the same metal have just been discovered on the Iron river, in the vicinity of the Porcupine mountains, on the south coast. Reports of discoveries in the immediate vicinity of the lake, at various points about its westerly end, reach us, with every evidence of credibility.

But more valuable far than all these is the recent discovery of tin ore in the same prolific quantities and richness that characterize all the deposits of that wonderful country. This discovery, the latest and as yet the least developed of any of the mineral discoveries of the region, promises to be the most important and valuable, because of the scarcity of the metal on this continent and its universal use in this age of the world. There have been several slight traces of tin ore found in various localities in the United States and Mexico, but none of them have developed the metal in sufficient quantities to repay the cost of mining. Some years ago the United States government, realizing the value and importance of this metal, offered a reward of $100,000 for its discovery in quantities sufficient to justify its mining, and the Canadian authorities also offered a liberal reward for the same object. Both of these offers, after standing open for years without accomplishing the desired purpose, were subsequently withdrawn. Now American enterprise and energy have brought to light what these large rewards failed to disclose. The deposits which have been so recently discovered are virtually inexhaustible, and according to the analyses of the ores that have been made, they are, like the other metallic deposits of the Lake Superior region, of unexampled richness.

A few years ago a vein of virgin silver was discovered on a nearly submerged islet, just off the entrance to Thunder Bay, on the north shore of the Lake. This discovery was followed by the formation of a company, with ample capital, that is now working at that point one of the most successful silver mines in the world. This discovery stimulated the zeal of explorers, with whom the whole north shore was soon covered. These enterprising searchers after hidden wealth soon unearthed other beds of silver along the coast in the vicinity of Thunder Bay and 100 miles back in the interior, in the region of Shebandowan Lake, and brought to light promising beds of quartz, richly studded with gold. This discovery has remained in abeyance until the present time, it is alleged, because a dispute arose between the Provinces of Ontario and Manitoba, as to the ownership of the soil, and the consequent inability of the discoverers to obtain patents for the land. But the adventurous exploring parties that pushed out in other directions from Thunder Bay, were equally successful in their discoveries, and more so in their ability to secure title to the lands. One of these parties, following the coast down to the southeastward, in the vicinity of Otter Head, on the main land, north of Michipicoten Island, came upon a series of well defined veins of mineral deposits, cutting through the lofty cliffs that line that coast, and losing themselves in the fathomless depths of the lake. These veins yielded an exceedingly hard, dark and heavy ore that was unknown to the explorers, but was supposed to be iron. Specimens were secured for assay, but when tested for iron failed to yield that metal. Traces, more or less, of copper and silver were found in some of the specimens, and some did yield a fair show of iron, but not a sufficient percentage to account for the high specific gravity of the ore. The assayers to whom the specimens were submitted, were either wholly unacquainted with tin, or else, because that metal was so completely unknown on this continent, they failed to suspect its presence, and therefore made no tests for it; and so the value of the discovery was for a long time unknown. Some assays that were made of the product of these veins did produce a white metal which, as silver was the metal sought, was taken for silver without much scrutiny. But later and more thorough and more scientific analyses, made by Professor Williams, of the Missouri School of Mines, at Rolla, Mo.; by Dr. Aug. F. Jennings, chemist and assayer of the Detroit Mineralogical Mining and Assaying Association, and by Dr. Torrey, of the United States Assay office in this city, establish the presence of tin in prolific quantities. Dr. Torrey says:

"The ore is a true tin stone or cassiterite, mixed with quartz; some of it is massive, but a considerable portion of the specimen examined is in the form of small, translucent quadrangular prisms some of which are perfectly terminated. The average of the samples yielded 33 3 per cent. of metallic tin. It would be easy to concentrate the pulverized mineral to a considerably higher percentage of metal."

Dr. Jennings analyzed a great number of specimens, producing an aggregate average yield of 28. 7 per cent. of metallic tin. Some of his specimens yielded as high as 57. 7. In reporting his analysis, he says:

The ores examined are free from any injurious minerals, and especially wolframite, which is often associated with tin ores, and whenever present, always depreciates the value of the mining property and product. The specific gravity of wolframite so closely approximates that oxide of tin that any amount of mechanical washing cannot separate the two satisfactorily. The result of my investigations has convinced me that the metal produced from these ores cannot be excelled as regards its purity nor in the cost of working.

The location of this wonderful and most timely discovery, as already intimated, is on the north shore of the lake in the province of Ontario. The precise point is about midway between the Sault St. Mary Canal and Thunder Bay, immediately opposite Michipicoten Island. The coast in this locality is high, rocky and barren. Cliffs of solid granite rise from the bosom of the lake to an altitude of 1,000 feet, their tops covered with a sparse growth of fir and cedar. This rock-bound coast is broken by an occasional ravine, through which some wild mountain streams find a precipitous course to the grand receiving reservoir. The mouths of these streams are usually broad and deep, furnishing secure and beautiful harbors, with sufficient borders of lowland for commercial purposes. Those lowlands are covered with evergreens and white birch. A few stray Chippewa Indians wander through the forests back of the lake in that vicinity, and subsist by trapping otter and beaver, the furs of which they sell to occasional traders along the coast. Bears, wolves and deer abound also in the woods, and abundance of water fowl and fish of the finest quality are always to be found in the lake and estuaries. The region is really a wilderness, presenting all the features of natural grandeur, beauty and solitude that struck the attention of the original discoverers of this continent. There is not a single civilized human being residing within fifty miles of Otter Head, though a venturesome half breed Canadian, with a full blooded squaw for a wife, and a buxom lass, more Indian than white, their daughter, have established themselves at the head of the harbor at Otter Head and propose to remain there this winter to trade with the Indians. This is the first settlement of what is destined to be the most considerable and important point on Lake Superior.

The tin producing region, so far as explored and surveyed, extends along the lake shore from Otter Head southeasterly for a distance of about twelve miles. The first discoveries were made near the mouth of the Puckersquaw river, eight miles below Otter Head, since which time new deposits have been successfully discovered, until now not less than fifty well defined fissure veins of ore, with multitudes of feeders, have been brought to light, spreading like a vast network of mineral over the whole area about from a point three miles below the Puckersquaw to the Rideau river, eight or ten miles above, and running back from the lake across the lofty cliffs inland as far as any explorations have been made. The exceedingly rugged and precipitous character of the country renders inland travel almost an impossibility, so that explorations have been mainly confined to the coast proper, though some of the larger veins have been traced several miles inland, while the Indians report even richer lodes at a still greater distance from the lake. Some of the veins are found to be from six to twelve feet in thickness, as clearly shown by the action of time and the elements in wearing them away where exposed to atmospheric influences, leaving the granite walls on either side like a well cut roadway, to mark their presence and course. These veins can be traced with the naked eye from cliff to cliff, across the rugged highlands and beneath the transparent waters of the lake until they are lost in its great depth.

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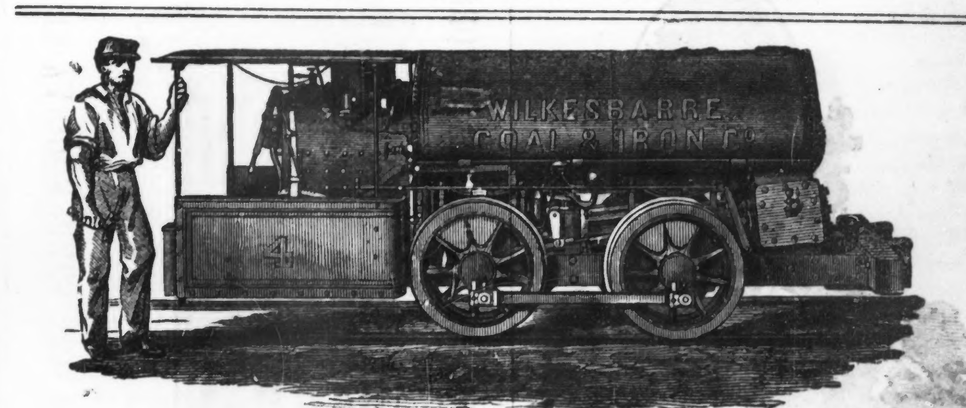

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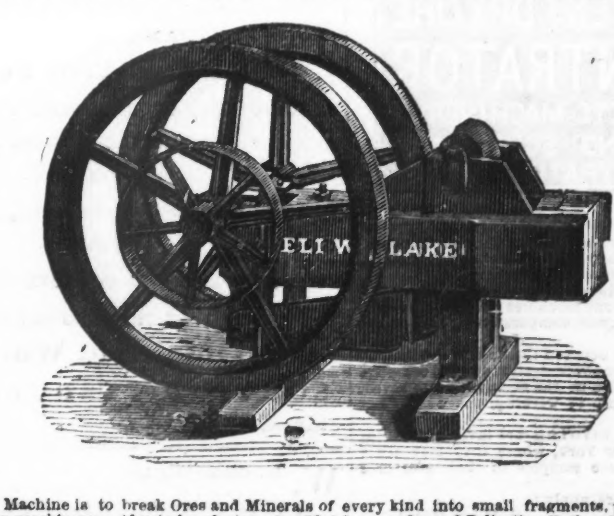

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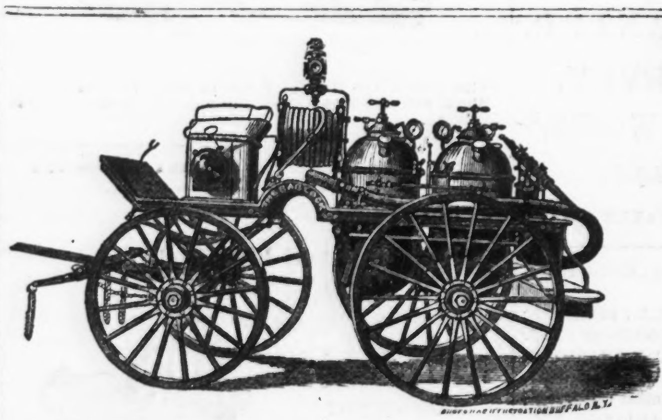

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