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Vol. XIV.—No 5 | 1895—OTTAWA, MAY—1895 | Vol. XIV.—No. 5.

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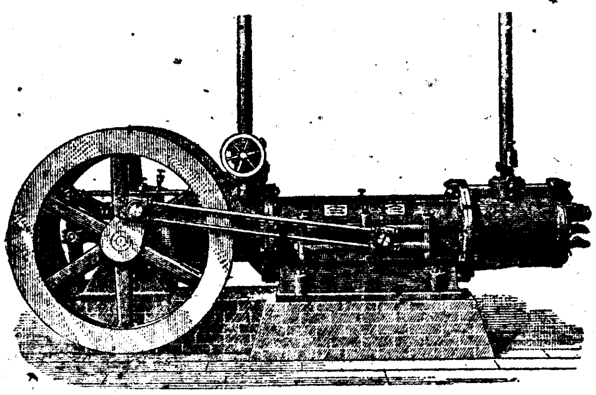

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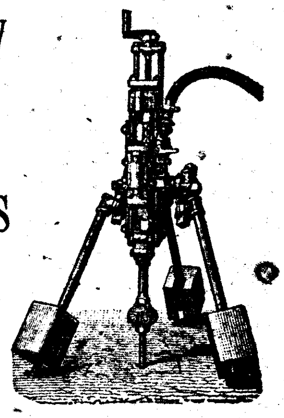

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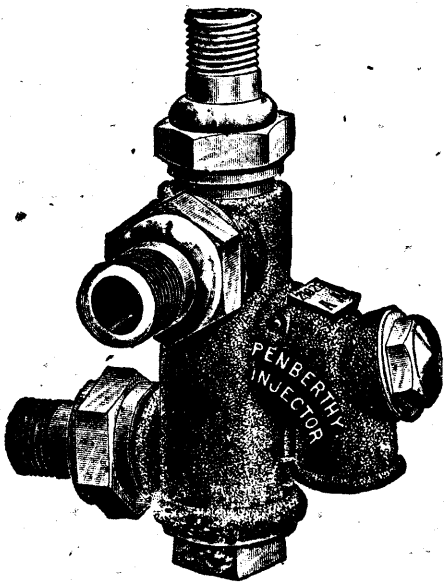

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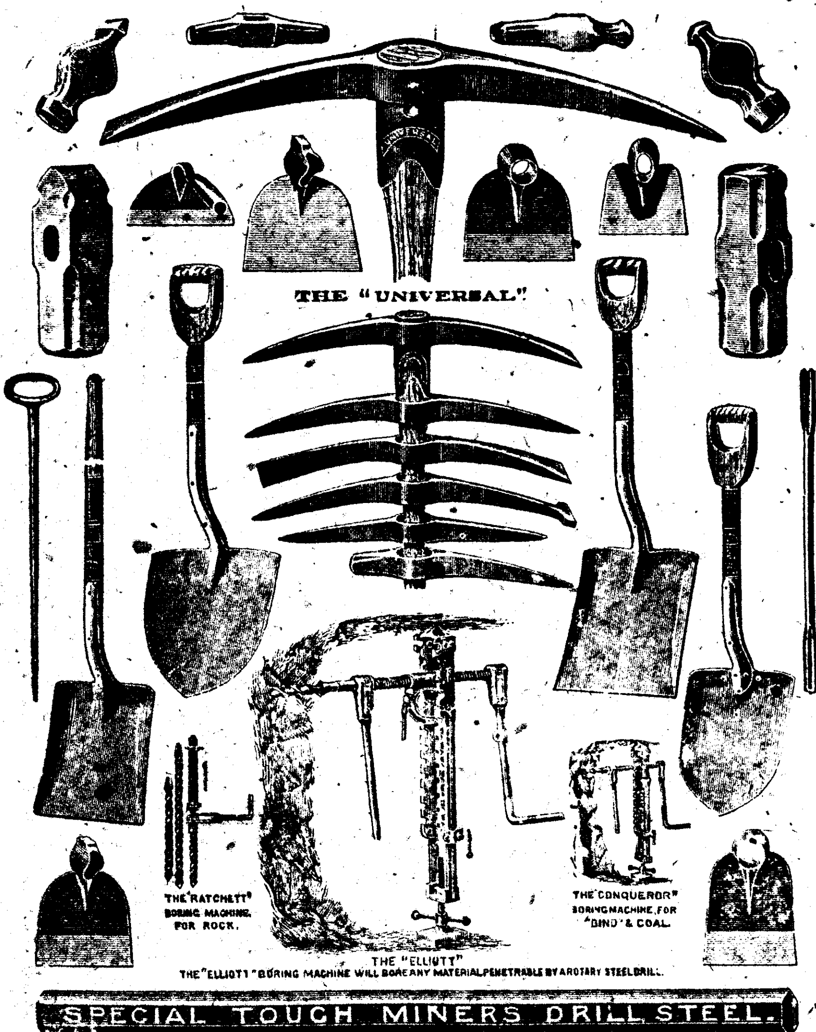

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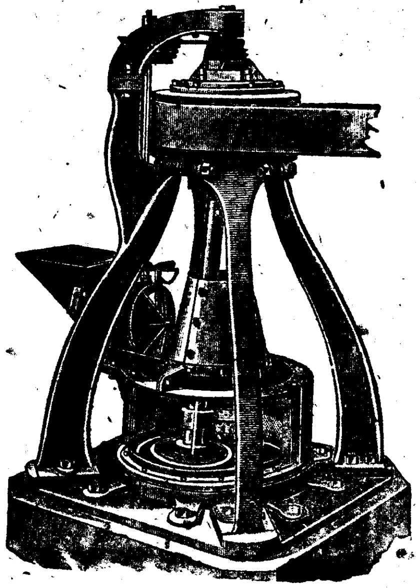

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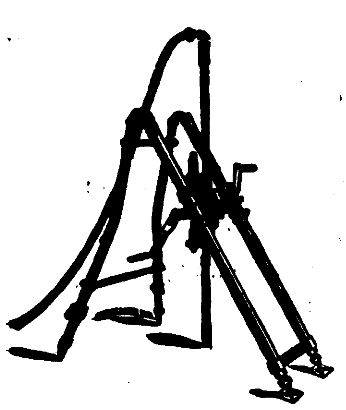

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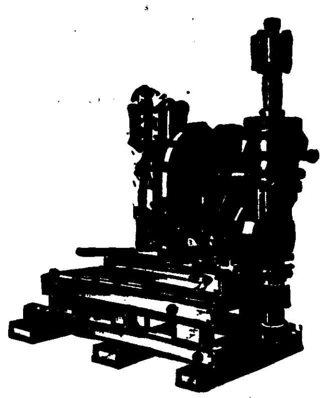

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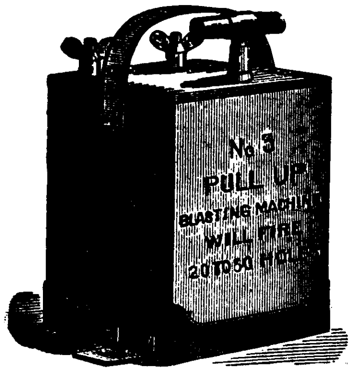

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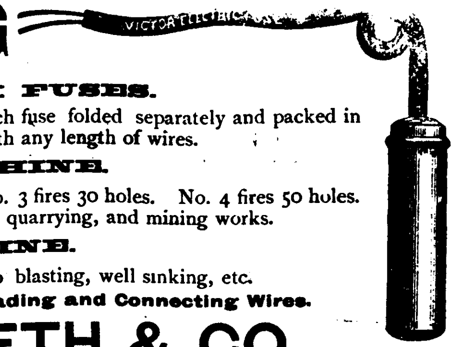

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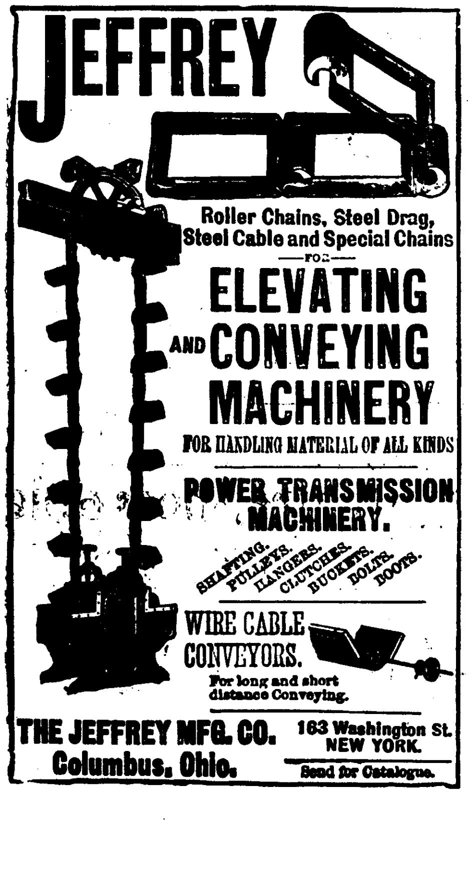

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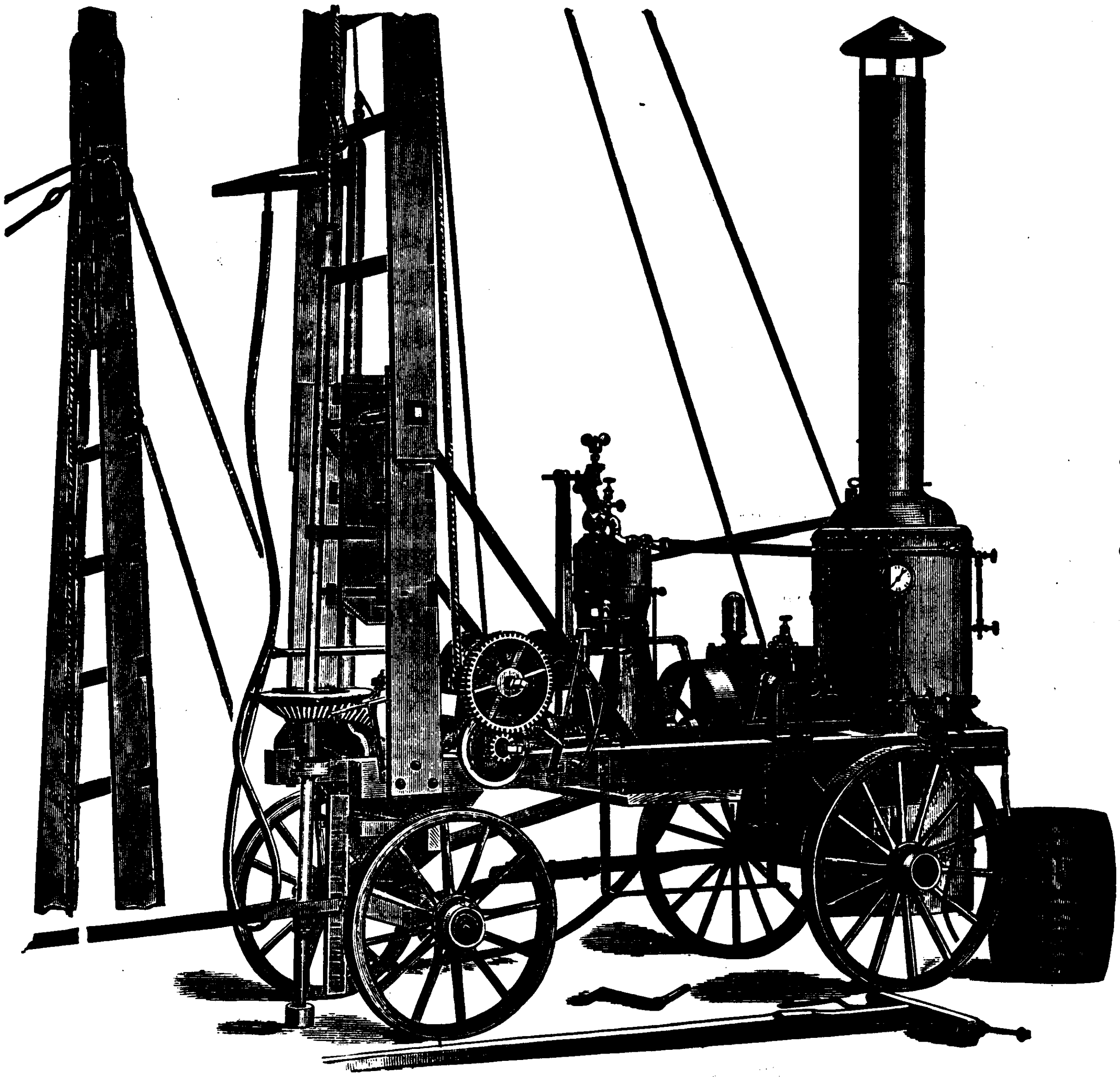

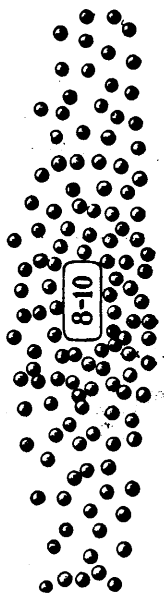

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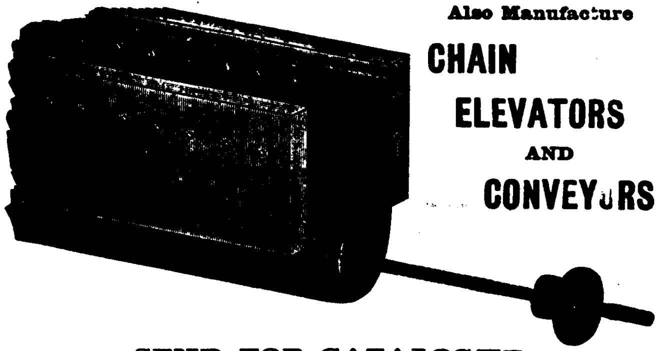

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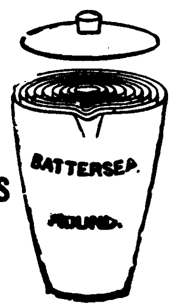

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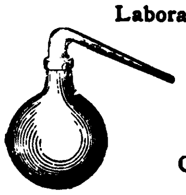

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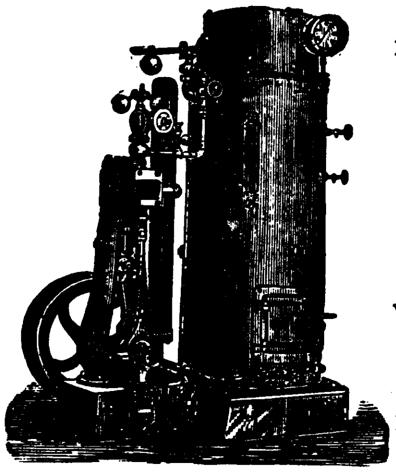

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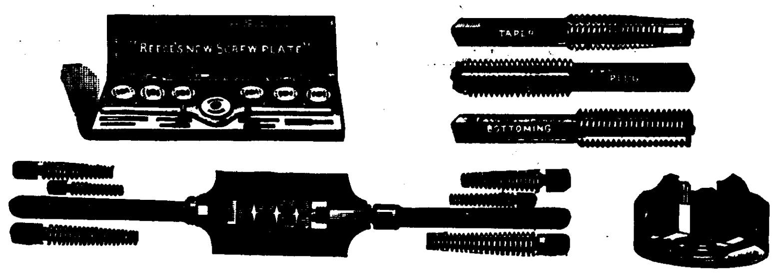

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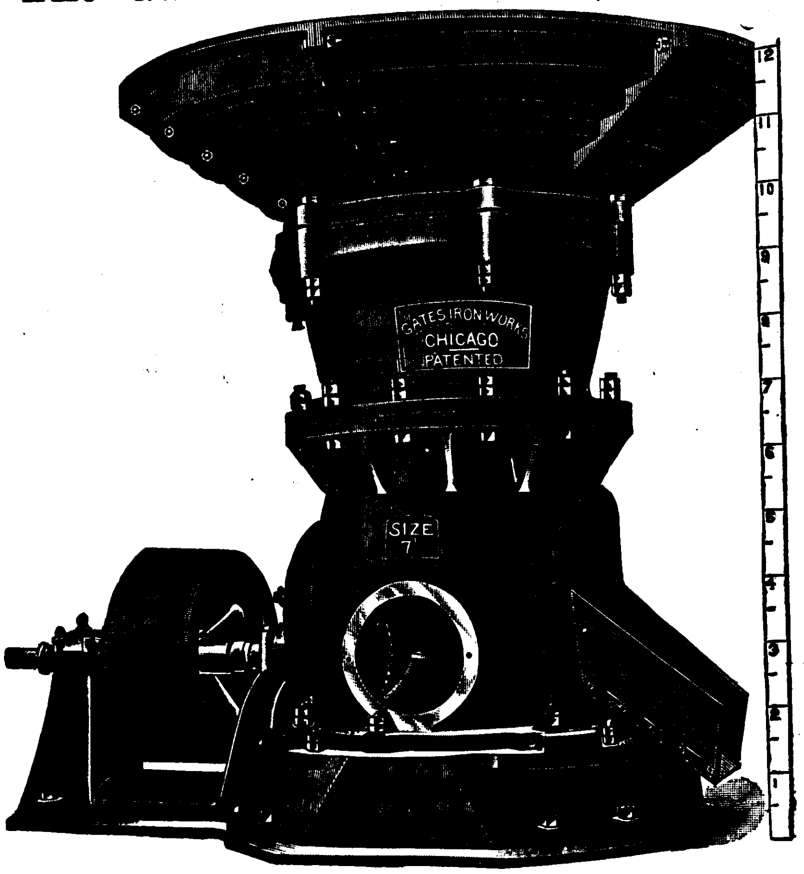

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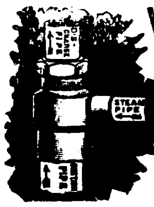

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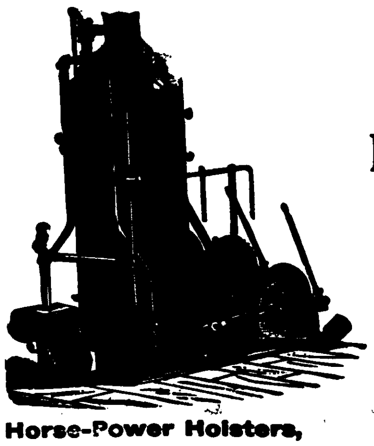

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ONTARIO MINING INSTITUTE.

(Proceedings of April Meeting continued.)

The Rainy River Gold Fields, Ontario.

(Discussion on MR. F. HILLE'S Paper.)

DR. A. P. COLEMAN said Mr. Hille's was a very interesting paper, and, in general, it ran along the lines that he had himself found to be correct last summer. Mr. Hille had used the word "protogene," which was, perhaps, not familiar to some of those present. It signified a variety of granite in which the mica or hornblende had been changed into a talcose or chloritic mineral. The granites of which the writer had spoken, especially under the head of "protogene" were very interesting, because they form the country rock of the richest and most continuous veins that had been found in the district. They were true fissure veins. The fact that they radiate from large masses of rock generally called gabbro, but which is in reality anorthosite, leads to the conclusion that they are the result of volcanic disturbance at the time when these rocks were the basal or lower portions of what at the surface was given off as lava or volcanic ash. The Rainy Lake region had been examined since Dr. Lawson's time and since his own visit by two members of the Geological Survey staff of Minnesota, Messrs. Winchell and Grant, who have described it very fairly. Strange to say, they exactly reverse Lawson's account of the relationship of the rocks. Lawson supposes that the gabbro was the earlier of the two, and the granite a later eruption, while the two gentlemen named have taken the view that the granite was the earlier and the gabbro a later eruption. The evidence, so far as he (Dr. Coleman) had examined it, went to show that the later observers were correct. The gabbro does not show signs of having been subjected to any violent force, whereas the granite undoubtedly has. You find no veins in the gabbro, but you do find very well marked veins, and on a large scale, in the granite. An eruption of the gabbro burst the previously consolidated granites, and gave rise to the fissures that were afterwards filled by segregation or in some other way. The ore is somewhat refractory in its character. Mr. Hille has mentioned the chief sulphides that occur in it, and there is no doubt that in most cases the gold is carried very largely by the pyrites, and also to some extent by the other minerals. However, he could not agree with Mr. Hille's suggestion that some other mill than the stamp mill would be more suitable for treating the ore. It was his conviction that the great blunder in Ontario has usually been in getting some other mill than the stamp mill. His idea was that you ought to get a mill that really will work; but hitherto the method seems to have been to get the mill that least is known about. The results of this kind of management can be seen in the neighborhood of Rat Portage. He did not mean to say that those other mills would not work well in other regions or under special conditions in our own districts, but up to the present they have not worked well. He said: "Take the mill that has been proved to work." The first thing, however, that should be done in any mine was to prove that you have gold. He had strong objections to taking in a mill of any kind until a depth of a couple of hundred feet had been reached, and it had been proven that there was enough gold bearing quartz to pay for the mill. Up to the present only stamp mills had been introduced into the Seine river district. This, he thought, was wise. Most of them are small. One is a 10 stamp mill in the Shoal lake region, and two others are 5 stamp mills.

MR. J. F. LATIMER inquired if the ores of the Rainy Lake region carried much sulphide.

DR. COLEMAN—Yes, in several sections.

MR. LATIMER—Any arsenic

DR. COLEMAN—A little, not very much. Not enough to be any serious drawback. I may say that there is no district except that near Shoal Lake, where granite is the country rock; otherwise, the geological conditions are pretty uniform.

MR. LATIMER—There are a few veins on Lake of the Woods, in granite.

DR. COLEMAN—They are rather, I believe, in gneiss. The Bad mine, for instance, is between two layers that are probably both gneiss.

Gunpowder and Nitroglycerine.

By W. HODGSON ELLIS, Toronto.

An explosive is a body which can, by a chemical reaction, suddenly develop a quantity of gas, large compared with the volume of the body before the reaction.

There are two ideas contained in this definition.

1st. An increase in volume due to chemical reaction.

2nd. The increase is sudden. The force of an explosion is measured not in foot pounds merely, but in foot pounds per second.

To illustrate, consider an analogous case. A cubic foot of water will yield about 1,700 cubic feet of steam. If this change takes place slowly as in a steam boiler under ordinary conditions, the expansion can be made to work, which can be regulated at pleasure—to grind flour, for instance.

If the change takes place instantaneously the boiler is shattered. This is an explosion, although water is not an explosive according to our definition; for the steam is formed from the water, not by a chemical action, but by a physical change merely.

Now, one explosive differs from another not only as to the nature of the chemical action which brings about the explosion, but also as to the rate at which this change takes place; and in studying the effects of a given explosive we have to attend to two things:—(1) The volume of gas which a given volume of the explosive yields; and (2) the rate at which this gas is developed.

Thirty years ago there was practically only one explosive—gunpowder (though many explosive substances were known). Today we have a fresh one patented every week, and it appears to be worth while considering to what causes the differences in the properties and efficiency of these bodies is due, and how far a knowledge of their chemical constitution can throw light on their behavior, and upon their suitability for different purposes.

There are two kinds of explosives:

1. Mixtures of two or more bodies which can be made to combine together, forming compounds which, under the conditions of the experiment, occupy a greater volume than the mixture.

2. Compounds which can be decomposed, yielding products which occupy more space than the compound.

As an example of the first class we will take a mixture of oxygen and hydrogen. As an example of the second class we will take chlorine monoxide, Cl_2O. Let us consider the second case first.

The equation representing the reaction is:

$$2Cl_2O = 2Cl_2 + O_2.$$

From this equation it follows that two volumes of chlorine monoxide yield two volumes of chlorine and one of oxygen, measured under the same conditions of temperature and pressure; that is, two volumes become three volumes, temperature and pressure remaining constant. But temperature does not remain constant. The decomposition of chlorine monoxide is attended by a disengagement of heat, and the heat so evolved is sufficient to raise the products of decomposition (supposing their specific heat to remain constant) from 0° to 1709° C. At this temperature 3 volumes of gas will become 22 volumes. This is therefore the space which two volumes of the original compound would occupy if it were free to expand. Hence 1 volume would become 11 volumes, or the gases produced by the decomposition would occupy 11 times the original volume of the compound. If now the reaction takes place in a closed space which prevents the gas from expanding at all, then the pressure increases in proportion to the volume the gas would occupy if free. So that in this case the pressure will be 11 atmospheres.

Let us now consider the first case. The reaction

$$2H_2 + O_2 = 2H_2O$$

is exactly the reverse of the one we have just been considering, and in it 3 volumes become 2 volumes—*i.e.*, if the temperature remained constant and the steam remained uncondensed, there would be a diminution in volume instead of an increase. But the temperature does not remain constant. In this reaction also heat is evolved and the quantity of heat is enough to raise the steam nearly 9,000° C. (if its specific heat remained the same). At this temperature 2 volumes would become 66. Hence the original 3 volumes would become 66, and one volume 22 volumes. That is, if the reaction took place in a closed space the pressure would be 22 atmospheres, or just double the former.

The importance of the part played by the heat disengaged in an explosive reaction is well brought out by these two examples.

To the first of the two classes that we have been considering belongs gunpowder. To the second nitro-glycerine.

It has been shown by the analyses of Bunsen, Karolyi and Abel and Noble, that the reactions which occur when gunpowder is fired vary with the composition of the powder and the conditions of the experiment and that the equation representing the explosion of military or sporting powder is a very complex one. In the case of blasting powder, however, of the composition of that examined by Sir F. Abel and Capham Noble, in their classical researches on the composition of fired gunpowder, we may deduce from their results the following equation:

$$4KNO_3 + 2S + 7C = K_2S_2 + K_2CO_3 + 3CO_2 + 3CO + 2N_2.$$

From this equation it follows that 552 grammes of gunpowder will yield 8 x 22327cc. = 178616cc. of gas, measured at 0°C and 760 mm. bar. Hence 1 gramme will yield 323cc. But since the heat evolved by the explosion of one gramme of gunpowder is about 500 calories, and since the specific heat of the products of the explosion may be roughly put at about ¼, the calculated temperature of explosion will be 2000°c. and the 323cc. will expand to 2689cc. One gramme of gunpowder occupies about 1cc. The sulphide and carbonate of potassium are liquid at this temperature and occupy about ½cc. Hence the pressure will be over 5,000 atmospheres or 40 tons to the square inch. Abel and Noble have found experimentally 42 tons to the square inch.

Saltpetre contains as much oxygen as 3,000 times its bulk of air, and gunpowder is merely a contrivance for burning carbon by means of this enormously compressed oxygen and forming carbon dioxide and carbon monoxide gases, while the nitrogen of the saltpetre is liberated at the same time.

The explosion of nitro-glycerine may be represented by the equation $4C_3H_5N_3O_9 = 12CO_2 + 10_2 + 6N_2 + O_2$, from which it follows that 1 gramme gives 713cc, and 1cc. (= 1.6 grammes) gives 1141cc., which is expanded by the heat evolved at least eight times, (Berthelot) probably more than this.

But the nature of this reaction is totally different from that which takes place in the explosion of gunpowder. That is a combustion propagated from particle to particle at a comparatively slow rate. The explosion of nitro-glycerine on the other hand is a detonation, a breaking up of the molecules propagated with a velocity comparable to that of sound—exceeding 5,000 feet per second.

Six cubic inches of nitro-glycerine gives about a cubic yard of gas, requiring about $\frac{1}{10000}$ of a second for its formation, (Lewis.) A square yard of surface carries an atmospheric pressure of 9 tons, and this has to be lifted in the $\frac{1}{20000}$ of a second—*i.e.* more than one million foot tons per second. Figures such as these amply account for the well known shattering effect of nitro-glycerine, and for its destructive effects when tamped only by the superincumbent atmospheric air—effects which are commonly alluded to as the tendency of nitro-glycerine to "strike down."

It is a most important property of nitro-glycerine that this enormously energetic fashion is not the only way in which decomposition takes place. On being heated it first volatilizes slowly without decomposition. If the temperature is raised to its boiling point, which is somewhere near 180 C (350° Fahrenheit) it is converted into vapour with much rapidity and the vaporization is attended by partial decomposition. It may be set on fire and will burn quietly away because the heat is carried away by the gaseous products before it has time to be communicated to the rest of the nitro-glycerine. But if the temperature of any of the nitro-glycerine be raised to a little above this temperature (180 C—350 F) the decomposition takes on the character of detonation and is propagated as such through the whole mass and even to neighboring masses.

The importance of these facts on the practical employment of nitro-glycerine, and especially upon the thawing of dynamite cartridges need only be alluded to.

Underground Photography.

By Mickle & Evans, Mining Engineers, Sudbury.

Underground photography is a subject which has received a considerable amount of attention during the last few years. Mr. Burrow, of Cornwall, deserves especial credit for the patience he has exercised in his efforts to take good photos underground, and he has been rewarded by obtaining some excellent photographs. For obtaining sufficient light, he found after a great number of experiments, that it was necessary to use two lime lights in addition to flash lights, but even with all these appliances for giving light, only a small number of his trials were successful (about ¼).

We will show some slides obtained from photographs which we took in some of the nickel mines near Sudbury. In taking these photos we used magnesium powder only, as the use of limelights would be so troublesome and expensive as to be out of the question for most people. We made altogether about 70 trials, using different plates and lights, and obtained 7 or 8 good photos, and about the same number of passable ones, the rest were total failures. The chief difficulty appeared to be to obtain enough light to illuminate the large spaces, in addition to this the air was saturated with moisture and foggy, and generally smoky, either from the miners' lamps or blasting powder. We soon found that it was useless to attempt taking any photos where the miners had been working for any time, the only time at which anything could be done was early on Monday morning before the men went to work. Even then the air was too foggy some days to get good results. It was, moreover, possible to take only one photo in the same stope on the same day, (unless the ventilation is very good), as the smoke from the large quantity of magnesium powder used soon obscured everything. In all our trials the same camera was used, viz: a 5" x 7" Hawkeye folding camera. We got good results with Stanley plates sent, No. 50, and Cramer Crown.

We tried small flash lamps and magnesium ribbon, but found they were altogether inadequate, and it was not till we used two continuous blast flash lamps holding 120 grains of magnesium powder each, that we got any satisfaction at all; the powder in the lamp is blown through a flame of burning alcohol, and the blast lasts about half a minute. One lamp was generally held behind the camera and another off to one side, but of course not directly in view of the camera, by this means we were able to show a man in one case 150 ft. from the camera, one light was let off near the man but sheltered from the camera behind a rock. As the result of our experiments so far, it appears to be necessary in order to secure good results, to select a day on which the air is not foggy or smoky in the mine, to use only the most sensitive plates, to have some background which will reflect the light more or less, and not to face the camera towards very large stopes, if the stopes are more than about 50 ft. wide it does not appear to be possible to show the opposite wall clearly, and if there are any miners in the picture, they should not have their lamps in their hats as the flame only makes a blur and spoils their faces.

When these conditions are observed very fair results can be obtained by use of magnesium powder only.

Heinrich Boarner (a photographer in Freiberg) has also published some excellent photos taken in the mines near Freiberg, by magnesium flash light.

Does the Vibration of Stamp-Stems Change Their Molecular Structure?*

E. E. OLCOTT, New York City—I am sorry that I have not followed carefully the various contributions that have been made on this subject. I have been much surprised to hear the statements of Dr. Raymond, and regret to be obliged to quote my own experience in opposition to them; but I am very strongly of the opinion, from numerous observations, that some change occurs in iron as a consequence of frequent vibration. The place where I have seen examples of it so often is in the breaking off of the stamp-stems that has been alluded to. It is no uncommon thing to see around stamp-mills, even now, a number of short ends of the stems, broken off just above the boss or stamp-head, the crystalline faces on which are as distinct as in a broken pig of cast-iron. I have also seen these stems, after having been used, first at one end and then at the other, cut in two in the blacksmith's shop, at places away from the boss, where they show a perfectly fibrous structure. Now, I think that the stamp-mill mortar is an ideal apparatus for causing great vibration at one particular point; and I should say that the numerous occurrences of the iron breaking in that way and the frequent observation of crystallization furnish, perhaps, a stronger argument in favor of the phenomenon than the experiments made by imitating for a short time the strains that the stamp-stems sustain. It is a subject that I will try and investigate a little further. As I say, I have no wish to oppose my observation, perhaps prejudiced by the practical mill-men, to the eminent authorities that have been quoted.†

WILLIAM KENT, Passaic, N.J.—I have been reading up on this subject for nearly twenty years. I saw the porter-bar mentioned by Dr. Raymond in 1875, shortly after it was broken, and everybody who saw it then thought it was an unmistakable evidence of crystallization. In earlier times the belief in crystallization was almost universal. Afterwards people began to differ on the subject, and there were opinions expressed on both sides. In 1879, in a paper "On an Apparatus for Testing the Resistance of Metals to Repeated Shocks" (*Trans.*, viii., 76), I think I was a little on the fence, though rather a little over on the side of the crystallization theory. Now, I have read whatever I have come across on that subject in the last fifteen years, including Dr. Raymond's paper, which I received the other day, and I am still not satisfied and am strongly inclined to believe with the gentleman (Mr. Olcott) who has just spoken. There is no higher authority than Bauschinger, who has recently died; and Prof. A. Ledebur quotes him as saying: "Strains of iron and steel repeated frequently, millions of times, bring about no change of structure."

That statement seems to me most astonishing when it is well known that you can take a bar of iron or steel and, after it has been subjected for years to shock and vibration, to all appearance there is no change in the piece of metal; yet, if you test it, you will find that it is more brittle; and some day that piece breaks. You may not find the evidence of cubical crystallization, but it always breaks with that appearance which we call crystallization. Now, can we say that that piece has been standing all this shock and vibration and has finally broken without molecular disintegration having taken place until just before it broke? Can we say that that piece has experienced no change of structure? I remember that at one of our meetings we were shown some pig-iron that was very hard to break; it took about four hundred blows of a sledge to break it, and yet finally it did break with a single blow. The same way with wrought iron and steel. It resists shock a long time, then breaks. Something has happened to it. It may not be crystallization. I do not hold that iron once fibrous becomes crystallized; but to say that there is no molecular change is, I think, going too far. The statements made about Wöhler's experiments proving anything about crystallization do not, in my opinion, prove anything at all; because in his experiments there were repeated steady loads placed on gently, and they were not shocks at all. In the paper that I presented fifteen years ago, and to which I have referred, I pointed out that no scientific experiments on the resistance of steel to shock had been carried on, and gave a design for a machine to test this point. I am very sorry that it has not as yet been built. If it were built, I think it would settle this matter of crystallization. The statements made during the last ten to fifteen years about what has been proved, or alleged to be proved, amount to nothing; and I claim that the statements that no crystallization happens are all theories and not deductions from actual experiments. If we can get a translation of Bauschinger's experiments, it would be very important; but I do not think he would go so far as to say there was no molecular change. He says that no change of structure took place; but the expression "no change of structure" is commonly broadened so as to cover every possible kind of molecular change. It may be all right to say that crystallization does not happen, or to say that there is no crystallization which has been determined by the naked eye or by the microscope, or that nothing happens so far as we can see; but as long as pieces of iron, after long service, do break with ordinary loads when they are apparently just as when they were new, we must believe that during this long service something happened to the iron which weakens it, which something is equally dangerous whether we call it crystallization, change of structure, molecular change or molecular disintegration.

JOHN WILKES, Charlotte, N.C.—As a builder and user of stamp-mills for the last twenty-five years, I have to differ in regard to the effect stated here. I do not go into any theories at all, because I have none; but my experience has been that a change certainly takes place in a stamp-rod near the boss or head. Some time ago the custom was to upset or cut in two after the ends broke off, and weld together in the middle. Those stamp-rods we found broke again in the middle, away from the weld, where the iron had been worked in the forge-fire. Now, stamp-users in my section of the country only change the ends. The ends break clearly. When millers were not careful in regard to their work, the stamp-rods broke in a very short time, sometimes in six months; but with greater care, now, the life of the stem is about two years and a half.

Vice-President J. F. Holloway, New York City (in the chair)—By changing the ends you mean reversing the rods and putting the head on the other end?

Mr. Wilkes—Yes, sir. Without an exception, all broken ends show a granular crystallized appearance. Some of them I have seen show a granular structure as large and as perfect as in Scotch pig. That they did present a granular effect is without doubt, and it continued above the break, as these rods, when upset, did not break in the weld, but within a foot, more or less, of the portion of the iron which had been again worked in the forge. During this discussion, and since the paper was read in Chicago, I have taken pains to examine rods which have been sent to us to be turned over. Within the last three weeks, rods have been sent to us that had been in use three years. One of them had quite large crystals, such as you would see in Scotch pig-iron. It was my intention to have brought one of those stamp-ends here, as it would have shown the members of the Institute that the fact remains, whatever the theory may be. If there is any place where this question of vibration can be brought up and looked into, it is in a stamp-mill. Think of a weight of some 750 to 800 pounds dropping eighty times a minute for days and months. If granulation or crystallization would take place anywhere, it certainly would be there. I am not a theorist myself. I accept the explosion of the crystallization theory. At the same time, in a stamp-rod, the fact of granulation or crystallization does exist without any doubt. Within the last year we have begun to substitute steel instead of iron, but with what effect I am not as yet able to say. We find that in mills that are properly taken care of, so that the vibration is reduced as much as possible, rods have a longer term of life. Packing the end of the rod with cloth before it is driven into the boss-head will increase the life of the rod. Scientific men, to whom I listen with a very great deal of interest, may be able to tell whether steel will stand this vibration better than iron or not. We have found that the use of steel in other parts of the stamp-mill where the vibration comes has proved advantageous.

Mr. Holloway—I would like to ask Mr. Wilkes whether it has ever been the practice of people using stamps to take these stamp-rods out at intervals and reheat them in a wood-fire?

Mr. Wilkes—I do not know of anything of the kind having been done. As a user of stamp-rods, as well as a maker, I question whether a wood-fire would do away with this granulation, which certainly does exist after some years' use.

Dr. Raymond—Is there any notable tendency on the part of stamps in the south—with which section of the country Mr. Wilkes is more particularly acquainted—to break just under the tappets?

Mr. Wilkes—I do not know of any breakage of that kind. The breakage is just in the edge of the box or the head.

WILLIAM R. WEBSTER, Philadelphia, Pa.—I would like to ask Mr. Wilkes if the boss on the rod is put on by upsetting?

Mr. Wilkes—No; it is only where a rod is broken that we upset it. We use

* A continuation of the Discussion arising in connection with Mr. Rickard's paper on "The Limitations of the Gold Stamp-Mill."—(Transactions of the American Institute of Mining Engineers, xxiii., p. 574.)

† See Mr. Olcott's later communication to the Secretary on a subsequent page.

THE LATE W. H. JEFFREY, RICHMOND, QUE.,
(Of the Jeffrey Asbestos Mine).

the best refined iron. The rods are turned up, and then tapered in the lathe to the taper of the head, the end of the rod being made a little smaller than the rest of it. Both ends are tapered. The mortice in the head is tapered, and the stamp-rod is driven in; it only requires one or two blows to make it tight. In all the fractures I have never observed one that extended out of the level above the boss-head an eighth of an inch. It is as if it had been cut off with a knife.

MR. HOLLOWAY—It is the practice of lumbermen, I know, to take their log-chains and throw them on a log fire and heat them up at regular intervals; and it has been found from experience that the life of a log chain is very much prolonged by doing that.

MR. WILKES—I should think that might be a good thing to do. At the same time, the use of a log chain is very different from the vibrations of a stamp-rod. I know of no place where the vibration is so great as in a stamp-rod, particularly in a mill that is not taken care of properly.

ALBERT R. LEDOUX, New York City—It may be interesting to put on record an experiment which I made that confirms very strongly the statements in the authorities, that even the best wrought iron will break under certain circumstances with the fracture of cast-iron. A few years ago a steamship broke her shaft just at the point where the crank arm joined the shaft. It was forged on. Under the Admiralty law, the case having come up in the United States Court, it was held that if that shaft broke from a flaw within it, although the owner of the vessel could not possibly have ascertained that the flaw was there, yet he was liable for the loss of the cargo—which happened to be fruits from the West Indies. If, on the other hand, the break was caused by the stress of weather, then the loss would fall on the insurance company. It was, therefore, an important matter to show why the shaft broke. I was an expert witness in the case, and had opposed to me an eminent marine engineer. He examined the fracture of the shaft, and testified that it was undoubtedly due to the poor quality of the iron; that the fracture was granulated; and that the granulation was not due to age, but to the fact that the shaft was poor in the beginning. I simply placed in evidence Kirkaldy's work, and called attention to the fact that there might have been a sudden strain upon the shaft, and, if so, according to Kirkaldy, it might break with crystalline fracture. In order to test this theory of Kirkaldy's, I went to the Rogers locomotive works and asked them to give me one of their best wrought-iron car-axles. This axle we broke on an anvil by means of a steam-hammer, bending it back and forth until it was broken with fibres as long as your finger. It was a new axle. We then laid one half of the axle, with the fibrous end on the anvil, and tapped it gently until we had straightened it. Then the piece was placed between two rather narrow supports, and the full force of the hammer was allowed to strike it with a blow of many tons. It suddenly broke, and I had a piece six inches long, one end of which was beautifully fibrous and the other end showed coarse crystals. That piece we took into court and established our case.

R. P. ROTHWELL, New York City—I think there can be no question among those who have used iron and steel under such conditions as have been described that there is a molecular change under certain circumstances. Whether that change is due altogether to shock or not is, perhaps, an open question. At least, the same effect seems to be obtainable by different means. At one time I was using a very soft steel wire rope. It was too soft for ordinary use. We were using it on a slope, and the lower end of it would become highly crystalline. Periodically we would have to cut off six or eight feet of it. The wire before its crystallization (and I call it crystallization for convenience) was extremely tough. You could twist it round and round many times without breaking it; and when it did finally break it showed the finest silky texture. But where it broke at the end of the rope in use, it appeared under a magnifying glass as if the carbon of the steel had collected into flakes of graphite running across the structure of the steel, and it had broken through these graphite structures. We attributed this effect to the acid waters of the mine. It was a coal-mine, and the rope would get wet at the foot of the slope. Now, a stamp-stem is sprinkled constantly with water, and that water is very likely to be more or less acid. It may be admitted freshly, yet still it is almost always in contact with pyrites in the ore. I merely suggest whether there may not possibly be some such action as that which we observed with the steel wire rope?

MR. HOLLOWAY—Is it not true that at the bottom of the slope there would be a little slack at the end of the rope, and that in taking up the slack the tension would come suddenly on that end of the rope?

MR. ROTHWELL—Yes, to a certain extent. It would not be sudden, however. With a wire rope 500 or 600 feet in length there is so much spring that you would get no sudden jar—nothing that you could fairly look to as a cause for crystallization in the wire.

MR. WILKES—There is no question in my mind but that mine water will have an effect in the way Mr. Rothwell described. In the South, however, miners do not use mine water in their stamp mills, if it is possible to get surface-water, on account of its effect on amalgamation. Therefore, the water we use could not have much effect on the iron.

JOSEPH C. PLATT, Waterford, N.Y.—This discussion brings up some reminiscences of the time when I was a young man and employed in puddling. I remember distinctly breaking puddling tools, the ends of which were about seven-eights of an inch in diameter, with a hammer weighing not over four pounds, when striking the tool a blow only sufficient to jar off the cinders. It was a blow which would not have probably driven a ten-penny nail half an inch into a plank, and yet it broke the bar in a manner that would indicate that something was wrong with the iron. These handles were used probably for 25 years. The end that was put into the furnace was, of course, renewed frequently. When a tool became hot it was pulled out and another put in, and it was simply subjected to the jar of the puddle-bar on the front-plate under the notch. It was a very common occurence for the handle to break off under a blow such as I have stated. It seemed to me a very strange thing that iron which had lasted for years would suddenly break in that manner.

A MEMBER—It was at blue heat, probably.

MR. PLATT—No; that end of the tool did not get very hot. That was the cold end.

W. F. DURFEE, West Brighton, Staten Island, N. Y.—In a lecture delivered May 11, 1887, at Annapolis, Md., before the United States Naval Institute (See Trans., U. S. Naval Institute, vol. xiii., No 3 pages 369-376), I discussed this question at considerable length, and the following statement, condensed from that lecture, expresses my view to-day as completely as it did eight years ago. The portions omitted in this abridgement were in the nature of explanatory repetitions and illustrations, adapted to a popular audience, but not necessary here.

Wrought iron is realy a mechanical mixture consisting, at its best, of clusters of crystals (which may with propriety be regarded as compound crystals) of iron, separated from each other by films or threads of cinder, as the unavoidable result of the process of manufacture. When the puddler's balls are squeezed or hammered, for the purpose of expelling the cynder and welding the granules or crystals of iron into a homogeneous mass, the attempt is never wholly successful; for the cinder, as the metal cools, quickly becomes pasty and flows with difficulty, so that portions of it, inclosed in the interior cavities of the ball, are simply flattened out or elongated, but not removed. Hence the bloom is a complete mass of granules or crystals of iron, separated from each other by films or strings of cinder of very irregular dimensions.

By crystals of iron I mean ultimate units of that metal bounded by well-defined planes whose intersections always form salient angles. A number of such crystals may cohere and form an aggregation, and such aggregations, or compound crystals vary in size, and are often spoken of as single crystals, just as we speak of crystals of galena or calc-spar, when as a matter of fact, the ultimate crystal of each of these substances remains undiscovered, and as undiscoverable as the boundaries of space.

In forging a bar it is the usual practice to turn it about its axis through en angle of 90° between the blows (or series of blows) of the hammer and in rolling a bar it is commonly turned through the same angle between passes through the rolls. Consequently, when a bloom is rolled or forged into a bar the metal is acted upon in two directions, at right-angles to each other, and its compound crystals will be compressed in directions normal to the exterior surface of the bar and at the same time extended in the direction of its length. Thus the ends of adjacent crystals are forced toward each other, and the intervening cinder, endeavoring to escape is compelled to move at right angles to the axis of the bar and to unite with the films or threads of cinder which have become established in parallel lines of least resistance along the flanks of the compound crystals and at right angles to the direction of the force upon the bar.

The direct consequence of the elongation of the compound crystals and the effort of the intervening cinder to escape in the direction of least resistance is the establishment of that structural peculiarity in the resulting bar known as "fiber," which is a conspicuous feature of wrought-iron not found in any other variety of ferruginous material. When any of the films or threads of cinder in a bar of wrought-iron are so large as to be distinctly visible on its surface to the unassisted eye they are called "sand-seams" or "cinder cracks."

If its compound crystals are merely pure iron, the bar can be readily bent cold without fracture, and, if pulled asunder by a gradually augmented force, its fibrous texture is at once evident; but in case the compound crystals contain in chemical combination some substances, such as phosphorus or silicon, which tend to diminish both the cohesive attraction between crystals and the mutual attraction of the compound crystals, then the bar cannot be easily bent cold without rupture, and exhibits, when broken, a so-called "crystalline fracture." Notwithstanding this appearance, however, the mechanical structure of the bar is the same as before, that is to say, the cinder and the elongated compound crystals are still arranged in lines parallel with the axis of the bar, although it is quite probable that the average length of the compound crystals may not be much less than in the case of a bar of purer iron.

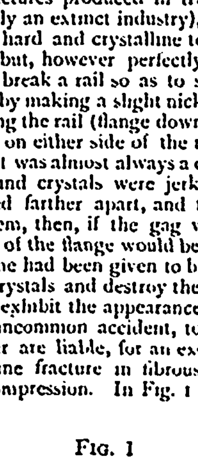
Whenever a bloom is subjected to a force of compression always acting perpendicularly to the same plane, as is the case when it is rolled into a a sheet or plate, both its compound crystals and the accompanying cinder are flattened and extended parallel with that plane, and the resulting sheet or plate has more of a laminated than a fibrous structure, being built up of a number of leaves or strata of iron, separated from each other by films of cinder, which, when unduly thick at any point, cause defects in the plate that are called "blisters."

Can a bar of wrought-iron of a pronounc[illegible]rous structure be ruptured so as to exhibit a crystalline fracture? I answer, Ye[illegible]wo ways: first, by a sudden application of a force of extension commonly calle[illegible]rk;" second, by a prolonged repetetion of a force of compression, sometim[illegible]d a "jar."

The first method of rupture may be said to consist of a transverse separation of the compound crystals of the bar, as distinguished from a sliding of their interlocking flanks upon each other, as is the case when the rupture presents a fibrous appearance. I have often seen crystalline fractures produced in truly fibrous iron. In the manufacture of iron rails (now nearly an extinct industry), it was always considered desirable that they should be of a hard and crystalline texture as to their heads, but soft and fibrous in their flanges; but, however perfectly this distribution of metal was made, it was always possible to break a rail so as to show a crystalline fracture in its flange. This was accomplished by making a slight nick across the flange (to determine the point of fracture), and placing the rail (flange down), in the straightening press, on supports placed a short distance on either side of the nick and then putting in the gag "heavy" just over it: the result was almost always a crystalline fracture in the flange; in short, the elongated compound crystals were jerked asunder. But if the points supporting the rail were placed farther apart, and the rail given an opportunity to yield considerably between them, then, if the gag was put in "light" a number of times in succession, the fracture of the flange would be sure to exhibit a fibrous texture, due to the fact that sufficient time had been given to break up the films of cinder along the f[illegible] of the compound crystals and destroy their transverse cohesion, thus permitting them to slide apart and exhibit the appearance of disrupted fibres.

We are indebted to a not uncommon accident, to which the hammer bars of a peculiar type of steam hammer are liable, for an excellent illustration of the second method of producing a crystalline fracture in fibrous iron, the result of the repeated action of a percussive force of compression. In Fig. 1 the bar of such a steam hammer

FIG. 1



STEAM-HAMMER

is represented. As has been stated, there exist, in a bar of fibrous iron, films of cinder between the ends of its elongated compound crystals. These, from the nature of their formative process, cannot possibly be of uniform thickness. This, considered in connection with the fact that the greatest force of the percussive action per unit of area of any cross section of the hammer bar is exerted upon a section made by a plane cutting the bar at right angles immediately above its head, justifies the belief that at or near this point fracture would be most likely to occur. It is also evident that the percussive action of the hammer would have more destructive effect upon the thick than upon thin films of cinder; while, at the same time, the force of cohesion between the ends of adjacent compound crystals will be diminished in some inverse proportion to the thickness of the films of cinder between them. It therefore seems exceedingly probable that the fracture due to continued percussion will take place, if not in the plane-above named, yet in one very near to it, in which the cinder films chance to be of greater thickness than those in that plane, and, as a matter of fact, fractures in such bars are usually within a few inches of the point where the bar enters its head, as at G-H, Fig. 1.

The particular point in the circumference of such a hammer bar where the imminent fracture first appears is often determined by the manual peculiarity of the "hammer-man." A left-handed man will incline his work to the left, and a man who is right-handed will be likely to use the right side of the anvil more than the left. In the latter case, the work B, Fig. 1, will tend (whenever it is in the position shown), to produce a tensile strain at the point G, which, as the work is shifted to the center or occasionally to the left side of the anvil, becomes a compressive strain. We should, therefore, expect (as is, in fact, the case), that the initial manifestation of the fracture would be found at that point, and that it would gradually extend towards H, until the bar was finally "jarred" asunder. The separation would take place through films of cinder between the ends of the elongated compound crystals of the bar, thus exposing those ends, and exhibiting what is called a crystalline fracture.

The belief in the so-called crystallization of wrought iron, as the result of prolonged use, is, I think, altogether a mistake; and I am clearly of the opinion that the crystallization observed in the case of any particular fracture existed, just as we see it, at the time the metal was given the shape in which it was ruptured. After a bar of distinctly fibrous wrought iron has been subjected to multitudes of sudden jerks of extension or jars of percussive compression, the cinder in some cross section of it (in which this impurity is slightly thicker than elsewhere), gets broken up, cohesion is destroyed, and the bar breaks with a crystalline fracture.

I have had a specimen prepared for the purpose of making the foregoing explanation of the apparent crystallization of fibrous iron more evident. It is a short piece of square bar of wrought iron. One end is decidedly crystalline in its fracture, showing distinctly that the bar was originally built up of five flat bars. The other end is, for more than one half of its area, as decidedly fibrous as wrought iron can well be; and this end would have been uniformly fibrous in appearance had the workman who made the specimen exercised the requisite care. Thus, in a sample not over two inches in length, we have an instance of a fracture which most observers would call very bad, and another which as certainly would be called good.

It is a well known fact that wrought iron is improved in strength by repeated working. This may be accounted for thus: In the initial heating and shaping of the metal, its crystals were left with a comparatively thick film of cinder between them; but by each successive re-working, the crystals of metal are driven into closer order, some of the intervening cinder is expelled, and what remains is very much reduced in thickness, so that the cohesive attraction (whatever that may be) between these crystals, having less space to act through, acts with augmented intensity. It is well to remember when we speak of "less space" in a matter of this kind, that we are dealing with a very small quantity indeed—one that is a near neighbour to the infinitesimal.

W. H. SHOCKLEY, San Francisco, Cal.—With regard to the use of mine water in the battery, the custom on the Pacific coast is the same as Mr. Wilkes states it to be in North Carolina. Mine water is not used in the battery when it can be avoided.

I do not think the water causes the stamps to break, as suggested by Mr. Rothwell; for they last longer in a wet-crushing mill than they do in a dry-crushing one, where no water at all is used.

From my own observation, I do not think the vibration causes the stamp-stems to crystallize and hence to break. The chief strain on a stamp-stem is a bending-strain, caused by pieces of rock tilting the stamp when struck by the circumference of the shoe. This gives a strain, nearly all the effect of which is concentrated at the place where the stem enters the boss; and it usually breaks at this place. I have noticed on shafts that have been broken flattened places on the fractured surface, showing that the bending caused enough motion to wear the surfaces smooth.

The pieces of metal mentioned by Dr. Ledoux and Mr. Durfee prove conclusively that the appearance of the fracture does not show what the internal structure of the metal was before it was broken.

If the vibration causes stamp-stems to crystallize and break, it certainly requires a very long time to produce that effect; for I have known stamps to be in use for four years, dropping 95 times per minute throughout that period, which would give something over 200,000,000 blows.

As a matter of interest, however, I remark that all the blacksmiths and manual workers of iron with whom I have talked believe that iron will crystallize under shock.

MR. WEBSTER—Some years ago, an inspector of bridge-material, after making thorough tests of double-refined iron bars for eye-bars, was so well satisfied with the tension-, bending- and nicking-tests that he made a special report to the rolling mill, saying that it was the best material he had ever inspected. After these bars had been manufactured and shipped to the mill-site, a test of the full-sized bars was received, which showed very poor results, the bars having been broken through the head and in the neck with bad crystalline fractures and low ultimate strength. The bars were all condemned and taken out of the structure. A thorough investigation was made of this material by nicking tests, starting in the centre of the bar and going towards the end; and in all cases good results were obtained from the body of the bar, and crystalline fractures in the neck. Bending-tests without nicking showed the same difference. In many cases the bars did not bend 10 degrees in the neck, but even at the first stroke or two of the small hydraulic jack that we were using, the sharp, snapping sounds were heard and the material gave way all at once. The crystals were very large. Additional tension-tests of the full-sized bars were made, and some of them broke in the neck with as low an ultimate strength as 42,000 pounds per square inch, the fractures being all crystalline. Had these bars been in use several years, when this trouble was discovered, it no doubt would have been cited as another instance of crystallization of the material, caused by the vibration.

I cite this to show the importance of knowing the heat-treatment to which iron has been subjected before we attempt to theorize on the change of structure due to vibration.

In 1884, Mr. Peck, superintendent of bridges for the Missouri Pacific Railroad Company, called my attention to the fracture of some eye-bars, taken from the wreck of one of their bridges, which had been knocked down by a derailed train. These bars, he claimed, were made from good material by one of the leading bridge companies of the country, and yet they broke off short like pot-metal. Upon thoroughly investigating, we found that the bars had broken through the neck, with a coarse, crystalline fracture. I called his attention to the trouble often caused in that portion of the bar in the course of manufacture; and he embodied in his new specifications a clause which called for "eye-bars to withstand bending to a curve of 90 degrees in the neck." This test was carried out by subjecting to a welding-heat a piece of the bar about 16 inches long, allowing it to cool slowly without putting work upon it, and then bending it under a press. Several lots of material were condemned as not meeting this test.

In 1881, while we were making bending-tests of double-refined bar-iron under a small hydraulic press, the work was interrupted after several pieces had been bent about 170 degrees over a 2-inch round. Twelve hours afterwards, these pieces were put on end under the hydraulic press and we attempted to close them down further. Much to our surprise, they broke off short, the fracture being 100 per cent. granular. At first it was thought that the cold might have had something to do with this, as it was in the winter season and the pieces had been left out over night; but upon repeating the experiment and keeping the pieces indoors all night, at a temperature of about 70° Fahr., we got the same short fractures as obtained before. The same bars, when broken in the ordinary way, that is, without any interruption of the test, gave fibrous fractures and were satisfactory in every respect. This experiment was repeated on different sizes and makes of iron; and sometimes the fracture was changed and sometimes not. (I refer to the fractures as granular, as they were entirely different from the crystalline fractures cited above as being produced by the heating of the bars.) It would be interesting to follow up a set of experiments on this line and carefully note all the conditions, including chemical composition, in order to get at the cause of this apparent change of structure.

I believe I have still a piece of one of these bars, about four inches long, one end of which is entirely granular and the other end fibrous.

DR. RAYMOND—On page 12 of the pamphlet discussion of this subject already issued, in the last paragraph but one, allusion is made to the photograph of the broken connecting-bar of the Washington navy-yard, as showing "the laminated structure due to rolling." As the bar was made under the hammer, I should have written "forging." This error will be corrected in the *Transactions*.

This discussion illustrates forcibly the importance of attaching definite meaning to the terms employed in describing observed facts. "Molecular change" and similar phrases—even "change of structure"—may be (and, I fancy, have been, in this discussion) employed as signifying no more than incipient fracture, or the progressive separation of the units of structure in the line of stress, or the gradual diminution of tensile strength under repeated stresses. Strictly speaking, not one of these phenomena necessarily involves *molecular* change, such as is involved in the re-arrangement of the molecules, to form crystals. That they do indicate, in a certain sense, a structural change, is not denied. But this change may be the same in kind as that produced by any kind of fracture. When any two continuous elements of structure are pulled apart, whether gently or violently, gradually or suddenly, there is a change of structure, if we choose to call it so. But it is useless to confound that change with one that is supposed to take place prior to any rupture between the elements. When Mr. Kent speaks of "molecular disintegration," I understand him to mean a loosening of the existing structure, not the formation of a new one; and, in that sense, I conceive that he is stating exactly the position assumed by modern investigators, who fail to find any proof of a radical change of structure preceding fracture.

Mr. Kent does "not hold that iron once fibrous becomes crystallized," yet declares that "the statements that no crystallization happens are all theories." I must repeat my protest on the latter point. The advocates of the crystallization-theory have no right to call simple disbelief in this proposition a "theory." It is incumbent on them to prove their position; they cannot demand that doubters should prove a negative. As to the only theory here under discussion, it is perhaps not fairly represented by the proposition that "iron once fibrous becomes crystallized." If that be the theory, then it suffers under a double lack of proof; for there is no evidence that any iron is fibrous prior to rupture. We produce a fibrous or a non-fibrous fracture at will, according to the method of breaking.

Mr. Durfee's explanation of the process of fracture in wrought-iron seems to me to satisfy the observed facts, although I do not think that the presence of films of cinder between the elements of structure is absolutely necessary to an explanation. Planes of small cohesion might suffice. What Mr. Durfee has pointed out concerning the breaking of steam-hammers is, to my mind, pertinent and conclusive; and I deem it highly significant that he has directly observed, in such cases, incipient fracture.

It seems to me also significant that Mr. Wilkes's stamp-stems break only just above the head and not under the tappet, while Mr. Austin reports that in western mills the stamps break in both places. I am inclined to infer that the North Carolina arrangement of tappets and cams is superior; and I may go further and say that possibly some better connection between stem and head might reduce the amount of breakage in both types of mills. I venture to believe that if a stamp were composed, for instance, of one solid cylinder of iron, of equal diameter throughout, there would be no sign of "crystallization" in it if it ran fifty years. In other words, I think there is no proof of an inevitable destruction of the material, by the operation of a universal law, which cannot be largely prevented by strengthening the parts now exposed, without special protection to nicking- and bending-strains.

In this connection I would call attention to two very able and thorough articles by Mr. Paul Kreuzpointner, of Altoona, Pa., entitled, "Do Iron and Steel Crystallize in Service?" and published in the *Iron Age* of July 5th and September 27, 1894. Mr. Kreuspointner is the accomplished assistant of Dr. Dudley in the Altoona laboratory of the Pennsylvania Railroad Co. His discussion of this subject ought to convince any one who still inclines to the "crystallization theory" of the baseless and untenable character of that theory. I will quote but one sentence from his second article, which gives a new reason for disputing the traditional error. He says:

"It would hardly be worth while to take the old superstition about the crystallization of iron under shock seriously at this late day, if it were not for the fact that this superstition is being transferred to steel. This is really a misfortune to the constructing engineer who may happen to believe in it, and to the consumer of steel in general."

MR. WILKES—Referring to what Dr. Raymond has said concerning breakage under the tappet, I have no doubt that the best shapes for cams and tappets should be used, so that, when the lift begins, the blow may be as light as possible, and the friction between cam and tappet during the whole lift to be as small as possible. This shape we have secured in our practice by adopting true curves at first, and modifying them as observation of their behavior in actual work suggested. While we were using iron, we succeeded in this way in reducing vibration, wear and tear to a minimum. Since we have adopted steel for the parts referred to, a great further reduction in wear and breakage has been secured, as the result, in my opinion, of the retention of the original form of the cams and tappets, and consequently, the more certain keeping of the stem in its proper place during the lift. This permits a fairer blow, and more effective work. The stamp mill is often regarded as a rough machine that can be taken care of by anybody. But it needs, like any other machine, to be kept in order, if it is to do good work. Suitable care bestowed upon it will effect improved results as important as those to be got from any other kind of machinery used about a mine. A properly constructed and properly handled stamp mill is, by reason of its simplicity and its economy in metal consumed per ton crushed, still the favorite appliance for reducing ores for amalgamation and concentration.

MR. OLCOTT (later communication to the Secretary)—The result of a little study on the subject shows the weight of scientific argument to be against the crystallization of iron from shock or vibration at ordinary temperature. I have read the two able articles on the subject by Mr. Kreuzpointner, to which Dr. Raymond has called attention. The salient points of these papers, as affecting the stamp stem discussion, seem to be:—

1. That the crystalline appearance on the fracture is caused by the manner of breaking. That is, where fibers are broken transversely they show granular or crystal-

line faces, but where pulled apart longitudinally, the same iron shows a fibrous structure. In other words, the stamp stem may have been weakened and finally broken off by successive shocks, and short kinks or bends, operating transversely, as the result of striking uneven surfaces in the mortar, etc.

2. The iron in a bar may be crystalline at one point, but fibrous at another.

3. Iron may have been crystalline at the point tested, but assumed a fibrous appearance at the tensile fracture, due to the flow of metals.

4. Mr. Kreuzpointner not only gives his own opinions, but quotes eminent German authorities in support of the idea that changes in the component elements of iron are necessary for changes in its crystallization, and that these changes cannot occur at low temperatures.

5. The results of Dr. Wedding's researches are given to show, also, that repeated stresses cannot produce crystallization.

While, therefore, there is a strong weight of argument against the crystallization of iron in service, Wohler and Spangenberg agree that alternate and intermittent stresses tend to deteriorate and fatigue metals; and Mr. Kreuzpointner says:—

"If we consider how, with insufficient dimensions and impaired cohesion, sudden shock will produce sudden fracture, then we have all the elements necessary to produce the well-known crystalline appearance of the fractured surfaces.

"The fractures will thus appear crystalline, even if the iron were ever so fibrous, because of the suddenness of rupture which did not allow the metal time enough to flow, giving, consequently, a clear transverse break of the fibers, which, as already explained, are nothing but elongated crystals, the transverse sections of which are the measure of their sizes."

Wohler declares, as the result of his experiments, that "the members of structures which are subject to alternating strains, pulling and pushing, or bending and twisting, ought to be made larger in the proportion of 9 to 5."

Pieces of iron, planed, polished, and etched, are said to give "undoubted evidence of the crystalline conditions existing before the iron was ever subjected to any strain."

The foregoing seems to establish that, though there may be the weakening of stamp stems by repeated shocks, which finally may cause them to break suddenly, *thereby showing the crystalline faces of the iron to great advantage, there has been no* enlargement in service of such crystalline faces in the iron.

H. M. HOWE, Boston, Mass., (communication to the Secretary)—Will Dr Raymond let me modify the statement, which he gives, *Trans.*, xxiii, 560, of my position in regard to the crystallization theory of rupture under repeated stress and vibration? My argument on page 196, *et seq.*, of my Metallurgy of Steel, was that, though it was quite conceivable on *a priori* grounds that vibration might make iron crystallize, yet there was no evidence that it ever does. My summing up was that we have "every reason to believe that the granulation and crystallization of iron under vibration and shock is a myth."

We seem to be at cross-purposes with Mr. Argall. He seems to think that people have denied that iron under certain sets of conditions, some of which include shock and vibration, breaks with a crystalline fracture: whereas, so far as I know, nobody has ever denied this. It is not the occurrence of a crystalline fracture but its explanation that is in dispute. I suppose that he must have fallen in to this confusion; for I see no other way of accounting for his setting forth the undisputed crystalline fracture of stamp-stems in such a way as to imply that it answers the question at issue.

Let me try to sum up briefly the condition of our knowledge. Repetitions of stress, wholly unaccompanied by vibration and shock, are well known to induce some kind of deterioration which eventually breaks iron. Vibration and shock, unaccompanied by great stress, or at least by prolonged repetition of considerable stress, have never, so far as I know, been known to break it. *This points to repetition of stress*, and not to the vibration and shock which only in certain cases accompany or cause it, as the real cause of such breakage.

Examination of the fragments of pieces thus broken by repeated stress, even when accompanied by vibration and shock, has indicated that the injury was local;* and careful microscopic examination of the fragments close to the fracture has detected no crystalline change, but at most a shattering and incipient separation of the preexisting particles, grains or crystals *whichever you call them.*† *All the evidence has* been thus against the theory that vibration caused even a local crystallization.

The crystallization-theory thus was a discredited one. Fresh evidence might indeed rehabilitate it. But I fail to see that Mr. Argall has given us the faintest ray of evidence or of reasoning in favor of that theory.

We know that iron, if nicked on one side and bent backwards, yields a fibrous fracture, but that the same bar, if nicked all around and broken with a sharp blow, yields a crystalline one. The two different modes of causing rupture induce it to follow different paths, and yield different fractures; for the fracture is nothing more than the path of rupture. In this case nobody supposed that nicking all around and breaking with a single sharp blow has crystallised the iron; it has simply developed a new path for rupture. Thus a crystalline fracture is shown to be no proof, but at most only a suggestion, of crystallization. The planes along which the rupture of the nicked bar travelled existed before rupture followed them, just as the cleavages in a feldspar crystal exist before I cleave the crystal with my knife, and as the image exists in the exposed but undeveloped photographic plate.

Mr. Argall vainly attempts to escape from the fact that "iron when fractured suddenly presents invariably a crystalline appearance, when fractured slowly its appearance is invariably fibrous," by his unqualified assertion that "In the first case the fibers are not given time to stretch, but are broken off at right angles to their longer axis, whence the apparant fine crystallization; while, in the latter case, actual crystals are developed in the iron, some reaching as muce as 0.25 inches in diameter."

Let us see how true this theory is. First so far as our present evidence goes, there probably are no fibers in iron such as Mr. Argall supposes, prior to rupture. Its particles apparently are nearly equiaxed.

Next, when a crystalline fracture forms in suddenly breaking iron, its faces are not as Mr. Argall asserts, at right angles to the imaginary fibers, or to the axis of the fibers which would actually have formed during fiber-favoring rupture. They are in general approximately at an angle of 45 with those axes.

Finally, it is not the suddenness of breaking, as such, that gives us a crystalline instead of a fiberous fracture; for in certain extremely rapid breakages, as for instance when a bar is torn apart longitudinally by an explosion of gun-cotton, we get invariably a silky fibrous fracture.*

The simple truth is that each new mode of causing rupture seems to direct it along a special peculiar path, and causes a special fracture. The fracture thus depends jointly on the properties of the material broken, and the conditions under which *breakage occurs. Why rupture follows this or that special path under special con*ditions, is for the elastician and mathematician to determine with great care.

Even for them the question is no easy one; and it certainly cannot be brushed aside off-hand or answered at random by those who run.

With these facts before us, shall we wonder if the special set of conditions under which breakage occurs in stamp-stems directs rupture along still a new special path, and thus yields a special kind of fracture? Is this special kind of fracture really any stronger evidence of crystallization than the other kind of crystalline fracture which we had long known that we could cause by r[illegible]ing all round?

The defenders of any discarded theory, of this one as of the corpuscular theory of light, need not trouble themselves to show that their theory is conceivable; that it does not violate "any law of modern physics or of the molecular theory of matter." What we need is evidence which this theory explains, and which other theories cannot explain. We have no room for theories which are simply conceivable or even possible. We want those which are probable through evidence. But evidence, like the fracture of stamp stems, which accords equally well with either theory, really helps the accredited theory but does not help the discredited one.

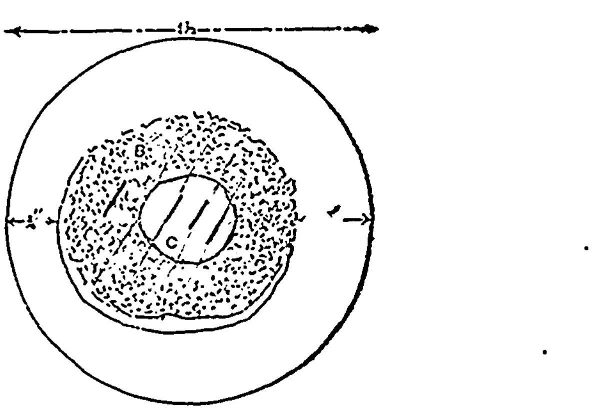
If Mr. Argall or Mr. Wilkes will send me a piece of broken stamp stem containing the fracture, I will gladly try to procure some evidence which will count, whether it be for or against the crystallization-theory.

It seems to me that the chief teaching of this discussion is care in the use of words. Had Mr. Argall contented himself with saying (*Trans.*, xxiii., p. 557), not "vibration under all conditions will crystallize iron," an assertion certainly *wholly* unjustified and probably very far from the truth, but "severe shock will eventually weaken or destroy iron," he would have asserted all that was necessary for his purpose. By going beyond this, and needlessly asserting that *all vibrations* injure iron, and by specifying that the particular way in which they injure it is by causing a crystalline change within it, he gave criticism a most pressing invitation.

His calling those whose opinions he attacks, "dogmatic theorists" seems unfortunate. *If by theorists he means those who habitually study the causes of the pheno*mena, or "theories," he simply says that their habits should qualify them to form trustworthy opinions as to the cause of this pheaomenon. If he means that they are ignorant of the conditions under which metals fail in practice, he is simply mistaken. And as to dogmatism, those whom he attacks have not *denied*, but *questioned* and *doubted* crystallization by vibration; while he positively asserted at first that *vibration under all conditions* will crystallize iron; and his later modification merely limits the proposition to certain conditions, *without changing its character as* · *positive assertion.* It is bad enough for the sceptic to be excommunicated, but to be called *dogmatic* to boot, and by the Pope at that, would be rather bewildering.

DR. RAYMOND—Since the foregoing discussion took place, I have received from Mr. Argall, in a private letter, the following statement, which seems to me worthy of preservation in the record as a pertinent observation. He writes that on the 24th of July last, he was delayed for some time near Hill City, South Dakota, by *reason of the fracture of an axle under the tender of Burlington engine No. 256:* "The axle broke off close to the wheel; an old and rusty crack, varying in depth from three-quarters to one inch, ran completely round the journal; next came coarsely crystalline iron, while in the centre the iron was beautifully fibrous, and showed the bars from which the axle had been forged. These, by the way, as indicated by heavy lines in the drawing, were not properly welded."

The accompanying figure made from a pencil sketch in Mr. Argall's letter, illustrated his statement. I will only observe as to the conclusions to be drawn from this case, that the facts seem to me consistent with the theory of progressive fracture, and with the well-known relation between the nature of the stress causing fracture and the appearance of the fracture-surface.



Fracture of Railway-Axle.

The indications of imperfect welding observed by Mr. Argall may fairly be taken as evidence of improper heat-treatment for the process of forging; and this, as has been emphasized in the present discussion, is a source of crystalline structure (or, more precisely, of that condition which yields a crystalline or granular fracture under circumstances in which a fibrous fracture would otherwise be expected) The existence of the old crack round the outside seems to indicate that this part of the mass was in such a condition as to break without such elongation as might have held the whole axle together, until a fibrous fracture of the whole had been effected. In other words, improper heat-treatment may have over heated the outside and under heated the centre of the forging, so that the former became "crystalline," while the latter, not hot enough to weld perfectly, retained the capacity of elongation before fracture, which is called "fibrous structure."

On this hypothesis, the axle, if broken at any time after manufacture, would have shown on the surfaces of fracture a difference of quality between the outside and the inside. But it should not be forgotten that such a fracture would not fairly represent the process of repeated shock and stress undergone by the axle in practice. Even if the material were *uniform* throughout, the peculiar nature of the stresses to which it was subjected might well develop differences in the successive fractures of different concentric parts. Recent experiments have proved the somewhat surprising fact that locomotive wheels advance not in constant contact with the rails, but by a series of jumps. If I remember correctly, these experiments were confined to driving wheels; but it seems to me that the same proposition must be true in some degree of all railway wheels, especially those which are nearest to the drivers, and thus receive most *directly the effect of the successive jumps of the latter.* We have to consider, in that case, the effect of trasverse blows, repeated at the rate of 1,000 to 2,000 times per minute. Considering this rate of rapidity, and the weight supported by a railway-wheel, I think I am justified in saying that the test is more severe than that to which stamp-mill practice subjects the stem of a stamp. But the effect of this series of blows is doubtless somewhat different. Each shock exerts a tensile strain upon the lower, and a corresponding strain of compression upon the upper half, of the axle. It is obvious that, *by virtue of the revolution of the axle, every part of the circumference* experiences these strains in rapid alternation, and that every part of the interior exper-

* Baker, Trans. Am. Soc. Mech. Eng., viii., p. 163, 1887. Howe, The Metallurgy of Steel, p. 199, Column 1. Sorby, Journ. Iron and Steel Inst., 1887, i., p. 265.

† Martens, Stahl und Eisen, vii., p. 238, 1887 Sorby Journ Iron and Steel Inst 1887, i p 265.

* Maitland, "The Treatment of Gun-Steel," Proc. Inst. Civ. Eng., lxxxix., pp. 120, 121, 1887.

iences them in degree dependent upon distance from the neutral axis. On the assumption of the complete homogeniety of the axle as to structure, condition and internal strains due to heat-treatment, it would still be natural to expect that the outer portions (under stresses not sufficient to rupture the whole mass practically at once) would break not only first, but with the smallest amount of elongation, and that the central portion, breaking last, would show the greatest elongation before fracture, because it would have been exposed to gradually increasing stresses, as the progressive fracture of the outer concentric portions increased the intensity of stress upon those remaining. Another point deserves consideration, namely, that up to a certain stage in such progressive fracture, both bending and elongation of the outer layer are resisted by the rest of the mass, a condition which diminishes with the decreasing diameter of the unbroken central portion.

If it be supposed that the axle, by reason of its heat-treatment in manufacture, or for any other reason (such as different quality of its original parts), was not homogeneous in the respects mentioned above, the differences in its fractured surfaces might be increased. The instance cited by Mr. Argall, therefore, while it may be consistent with the notion that the railway axle in question was once wholly fibrous, as at C, and had become, in use, crystalline at B, before its fracture, does not require or prove that theory.

R. A. HADFIELD, Sheffield, England (communication to the Secretary)—I have long entertained the idea that many of the so-called fractures by vibration were really due to previous, and often careless heat-treatment. I can say, after personally handling a very large number of specimens, that I have never yet found a case which could not be satisfactorily explained when the previous heat-treatment could be traced.

F. OSMOND, Paris, France (translation of a communication to the Secretary)—Having read the discussion of this subject as printed thus far,* I take occasion to say that I am fully in accord with Dr. Raymond's view. I know of no fact which demonstrates the crystallization of iron by vibration; and all that I do know is opposed to that opinion. The aspect of the fracture depends upon the original quality of the iron and the mode of rupture.

As to the formation of *beta*-iron by shocks and vibrations, that is another question. As Dr. Raymond has correctly pointed out, it is only in the case of permanent deformations that the production of *beta*-iron can be seriously argued. It appears to be, however, not impossible that the elastic limit may be exceeded *without apparent deformations* under the action of vibratory forces which operate at each point for an extremely short time only. But this is a mere hypothesis. If it is well-founded, it could be verified by determining the coercive forces of the iron before service and after rupture. The production of *beta* iron would be indicated by an increase in permanent magnetism. The truth is, we know at present almost nothing as to the transmission of mechanical waves.

* Not including the present pamphlet.—R. W. R.

Mining Reports and Mine Salting.*

By Walter McDermott.

There is such a great variety of badness in mining reports that a little grouping of the cardinal sins will be useful. In speaking of mining reports generally, for the purpose of illustration, I intend to cover, not only those made by mining engineers, but all those used in business, and so fairly subject to criticism,—from that of the learned professor of other sciences who is dragged from ths seclusion of his study and put underground to be made miserable with candle grease, down to the practical miner, who, having beaten a drill for a certain number of years, is prepared to dogmatize also on facts, figures, theories and conclusions.

Amongst the old friends we meet in numberless reports, and which seem to need a little protection against excessive wear and tear, the following will be considered: (1) the true fissure vein; (2) increasing width in depth; (3) increasing richness as depth is attained; (4) junction of veins; (5) ore in sight; (6) proximity to a rich mine; (7) failure from mismanagement. Now, Heaven forbid that I should be held as speaking disrespectfully of any one of these things, each estimable in itself. My remarks are pointed only against their indiscriminate use, and particularly against their public use as catch-penny phrases in a way to imply more than they actually mean.

There has been more joy over the term "true fissure vein" than over anything else in the history of mining. The investing public has become intoxicated with the exuberance of its descriptiveness. The practical miner has grasped its effectiveness, and the first ring of his pick on an outcrop satisfies him that he has got the the genuine article with tap roots in the antipodes. What is a true fissure vein? It is supposed to be a fissure in the country rock filled with veinstone, which may be expected to go down to a considerable depth. The veinstone itself sometimes carries pay ore. This does not seem much to base any elaborate calculations on; and not only is it insufficient, but experience all over the world has shown that some of the most valuable ore deposits are not found in fissure veins at all. Even as far as mere depth is concerned, it is by no means yet established that true fissure veins go any deeper into the earth's crust than bedded deposits, contact, or pipe veins; and it would be of no consequence if they did go deeper, since they cannot be followed. Properly used, the term "true fissure" is usually descriptive, but where used as an incantation to call up visions of wealth to unlimited depth, it needs suppressing.

It is naturally gratifying to the owner of a mine to see his vein increasing in width as he goes down. It also looks well as described in a report, and must naturally be mentioned when it occurs; but in some reports the implication arises that it is a vital point and to be calculated on as continuing. If a vein went on increasing in width, it would very soon attain enormous dimensions, and, if it outcropped in a country blessed with the law of the apex, its lucky owner would have a good claim to a very large proportion of the earth when he got down a few miles. It may pretty safely be assumed that the increase in width will not continue, and, when it stops, it is very likely to be succeeded by a corresponding decrease, so as to keep upt he usual average of things. When, say, a 50 ft. shaft sunk on a vein shows an increase in thickness from 1 ft. at surface to 6 ft. at the bottom, there is nothing to show that, in continuing to sink, the vein may not gradually or rapidly pinch again to its size at surface, or even much less. If any calculations were justifiable at all in such a case, general experience would certainly lead one to expect such decrease. The only positive conclusion would be that the vein is irregular in width. It looks nicer and more definite to say simply, "the vein is steadily increasing in width as sunk on," than to state that "the width of vein is variable, ranging from 1 ft. to 6 ft., and therefore, until further opened in length and depth, its average cannot be safely calculated on." The one statement is as true as the other, but the effect of the two on a reading is not the same.

*Abstract of a paper read before the British Institute of Mining Engineers.

There is a touching confidence in the belief of many practical miners that veins get richer as they go down. Experience and disappointment often fail to shake this comfortable belief. Most practical men are able to cite a great many more examples of rich mines becoming poorer with depth than the reverse. I remember being struck with the inconsistency and persistency of the belief in depth in various camps of the Rocky Mountains. Up in the highest ranges, say 12,000 ft. above sea level, there are mines which need sinking on to prove their real value; and 7,000 ft below them in the foot hills are mines equally needing depth. Probably the thought at the bottom of this belief rests, like some of the attractiveness of the true fissure veins, in the old idea of a central seething mass of precious metals, and in the forcing up of a molten vein-filling. This faith in the saving grace of depth and of true fissure veins in the face of facts can be explained only by the definition of faith as given by the little girl—"believing what you know is not true." The hankering for depth has its justification of course, in the necessity for sinking usually to get any developments, but, where access is obtainable to the foot of a mountain through which a vein runs, the same men who claim a special efficacy for depth in other cases will point to the vast advantages of having the ground above one to be opened by adits. The facts of experience show that, when a vein is rich at the surface, a hope that it may continue is a more proper attitutde than a belief that it will get richer in depth; and, when it is poor on surface, any change in sinking would be for the better.

Striking cases of enrichment of veins at their junctions occur; but, as many examples of junctions without richness also exist, it does not do to attach too much importance to the results to be expected. In some reports the future junction of two veins is often itself assumed on insufficient data, and the consequences are calculated on with a certainty which is still less to be justified.

Under the head of "ore in sight" is included matter which is of the very greatest importance, and which requires the very best work of an engineer. The estimation of ore in sight in an opened mine often involves the consideration of so many points, and is so largely a matter of good judgment, that one may expect some discrepancy in the reports of different engineers. There is nothing in which such vast discrepancies do exist, in fact, as in regard to this. Two good engineers will vary in their estimate; and, when it comes to inexperienced men, or to so-called practical men who have no reverence for the written word, the term "ore in sight" becomes a theme for the exercise of the highest flights of the imagination and the airing of a little rudimentary mathematics.

In the common mining report we are all acquainted with, it is not unusual to see the length of the chain multiplied by a cheerfully assumed average width of vein, then by 500 or 1,000 ft. for depth, and a tonnage deduced which reminds one of the figures used for astronomical purposes. Sometimes, to inspire extra confidence, the expert generously knocks off 25 or 50 per cent., and feels he has then done his duty, whatever happens. The character and ability of a man can sometimes be closely estimated from the way he figures up ore in sight after giving the dimensions bearing on it; and it often suffices to look at this calculation in order to determine a report to be, not only quite unreliable as to conclusions, but equally irresponsible as to data.

In connection with estimation of ore in sight, the system of sampling employed is worth mentioning here. In some reports the expert writes of taking samples "at random.' When a man says he has picked some samples from a dump "at random," and they assay well, he implies that such ore is plentiful on the dump, and that he did not purposely select it from its appearance. What his statement actually means is that on an important matter he was willing to trust to luck as to whether he hit poor or rich ore, or whether he was getting just what had been previously placed for him to get. Luck is a very necessary thing in mining, but it should not enter into sampling. If the sample is a random one, its value proves nothing. Some people seem to think this method of sampling is important evidence of an impartial mind, and that shutting the eyes is the best security against the frailty of human nature, which would otherwise lead a poor creature to pick out the richest looking ore he can find.

Another little weakness to be remarked in some reports is the willingness to make a liberal discount off the expert's own figures. The writer concludes, for instance, from his samples—perhaps taken at random—that a gold vein will average 2 ounces of gold to the ton, but, to be on the safe side, generously offers to take it at 1 ounce, and then with a light heart goes into calculations of profits by day, and month, and year. If a man knocks off 50 per cent. from his supposed reliable figures to be safe, it always occurs to me that the one who reads his report may feel tempted to lop off another equal percentage to be still safer.

There have been plenty of illustrations lately published in prospectuses of the great value the public places on a property which is near a well-known mine; yet everyone who knows anything of mining must be aware that mere proximity to a paying mine gives no assurance of similar success. Some of these reports are absolutely nothing but a statement that the claim examined is on the same reef as, or near to, another property which is popularly supposed to be exceedingly valuable, and that rich ore has been found on the claim.

In quartz mining it sometimes happens that a series of paying mines are found at intervals along a single vein. Occasionally the intervals between pay shoots are long, so that a good mine may be immediately surrounded by poor ores. In other districts one single good mine on a vein is all that is ever developed. The only actual advantage of the proximity of a good mine is the evidence it affords of there being payable ore in the district, or on a certain reef. Like other indications, it is of service only when used with discretion, but as an unqualified argument of the value of a neighboring claim it is most dangerous.

That bad management may spoil a good mine is so self-evident a proposition that no one will misunderstand a few remarks against the improper or thoughtless use of this excuse in a report as an explanation of previous failure in a poor mine. A well-known Californian mining man, when asked to take charge of a mine which had failed to pay—as it was explained—from mismanagement, answered that he did not want anything to do with a mine which would not stand bad management. This is a remark which contains much matter for reflection, and embodies the opinion of most practical men. In reports the statement is sometimes loosely made that milling results in the past cannot be relied on, owing to primitive machinery or processes hitherto employed. This argument has often been advanced on Mexican mines by experts who have not had time to find out that native methods of working often give better results than the rapid working by the most modern machinery.

After all these remarks as to what mining reports ought not to be, it is perhaps permissible to say a few words on what they ought to be. A report need not be long-winded to justify the fee paid for it, but should be so full in actual description as to enable a reader experienced in mining to draw his own conclusion from the facts given, without having to trust entirely to the deductions of the writer. Where a fee is paid for a simple expression of opinion or specific advise, there is no need of a report, in the sense of the word as we are now considering it. The important details to be set forth clearly are those relating to position, and facility of access to the property; local conditions as to fuel, water, and timber supply; extent and form of openings; variations in thickness of deposit; character and value, and form of occurrence, of ore. It is important in giving a clear idea of the property that the distribution of the payable ore in the deposit should be described. It makes a great difference sometimes in the conclusions to be drawn whether the value consists in rich ore occurring in a barren vein mass, or in high-grade ore scattered through a low-grade deposit, or in a uniform value throughout the rock. On account of the necessity for this description it is not always sufficient to state that an average width of vein contains an average of so much value per ton, as this may be in the nature of a conclusion, not of a fact, and so may need to be justified by detailed facts of the report. The extent and character of dump piles at a worked mine often afford valuable confirmatory evidence as to the character and value of the property.

Geology and mineralogy should naturally be used with discretion, but only for purposes actually bearing on the description and conclusions to be drawn,—not for mere padding nor for the airing of theories better treated in a purely scientific paper. I have seen a report which started with the nebular hypothesis and traced the progress of the earth from its pulpy state right down through its various stages to oxidation of the outcrop of a particular vein in the year of grace in which the report was written. These details were so full that there was no room left for anything but a very brief treatment of the merely commercial question of the value of the mine.

Examinations naturally differ greatly in the nature of the calls they make on the expert. In a district with which he is well acquainted there are often certain simple facts which enable him rapidly and safely to arrive at his own conclusions; in other cases it is often a matter of hard and concientious work, however clever or experienced the engineer may be, and any scamping of this work will imply unreliableness. An experienced man in making a report will have an open mind for possible new forms of ore occurrence, while refraining from prophecy about things not in sight. Events may work against the most careful and experienced man by unforeseen increases or decreases in value on opening new groand; but as mine examination is an art and not an exact science, it is by average results that an engineer must be judged.

There are all degrees of "fixing a mine"; from the legitimate showing of its best features by not taking out all the rich ore before offering for sale, or by various degrees of skulduggery, up to palpable salting of mines, dumps, and expert's samples. In the less illegitimate stages much can be done, and very frequently is done, in the way of a judicious stoping of faces in good ore, and by the observing of a discreet silence as to past weaknesses and irregularities of the ore deposits. In such cases it is simply the ordinary commercial position of "let the buyer beware," and the expert has to show by his report if he has experience, observation, and sense enough to form a sound judgment as to value.

In a mine which is thus carefully prepared for selling, it is not at all uncommon *for the owner to go beyond the legitimate limit already indicated,* and to misrepresent facts by filling up or concealing old workings which would, if examined, produce an unfavorable impression. The next step in the downward path which leads to a hotter place (but in the meantime also sometimes to affluence) is the scooping-out of the inside of apparently solid blocks of good ground by openings afterwards filled up or timbered over. Some of the most experienced mining men and engineers have *fallen victims to this and the previously described course of conduct;* while some have just escaped being caught by a mere accidental indication of the fraud, or by "peaching" of some miner who helped in the work and had not been squared. Naturally the danger from the sources mentioned is much less in new mines of limited extent than in old mines extensively developed. In a mine which has been worked for some time the visiting engineer is at a great disadvantage as compared with the men who have worked in it for years, and perhaps devoted their greatest skill to making, not only a good record, but to concealing the exhaustion which is approaching. It happens occasionally also that the owners complete their work by "picking the eyes out of the mine" in the interval between the expert's report and the turning over of the property to the purchasers. The richer the nature of the pay ore in the mine, the greater the danger from this rascality, which needs specially providing against in the terms of purchase, and by other precautions.

The above-mentioned very real and not uncommon dangers, against which the engineer has to guard, *are not, however, "salting" in its proper and technical sense,* which is generally understood as covering any interference with the expert's chance of arriving at a true estimate of the value of ore. The salting may be done on the ore before the expert's arrival, or during his sampling, or on his samples when taken, or while panning or assaying.

Although cases are well known of faces in a mine being salted with such success as to catch the unwary, this form of salting is usually too difficult to carry out, and too superficial in character to offer much chance of catching an old bird. With ore dumps and alluvial deposits it can be done with better chances of success, but is naturally of an expensive nature if carried out on a really systematic plan. Cases are on record of successful salting of alluvial ground with precious stones as well as with gold, and the expert must clearly be on the watch against this, when circumstances allow of the possibility of its occurrence. With ore dumps it is often very easy to arrange a veneering of good ore over a very large *pile of poor or barren rock,* and then, when the ingenious gentleman who takes samples "at random" comes along, he will be sure to obtain a gratifying result.

The salting of samples is, however, much more common than any other form of getting ahead of the expert. It is less expensive than salting in advance, more deadly, and can be nicely adjusted to circumstances and to the individual weakness of the victim. When the owner of the mine, or anyone connected with him, is allowed to assist in the sampling itself, there is no lack of opportunity with some ores for the artistic salting while in the mine; but, as a rule, engineers do not have the requisite faith in human nature to accept such assistance, unless the character of the ore and kind of samples required make salting impossible at the time. In a strange district, where assistance of some sort has to be obtained in breaking and transporting large samples, and the character of such assistance is not absolutely certain, the engineer must guard himself by duplicating entirely alone certain test samples. Assuming that samples *have been secured without any chance of outside interference,* the business is by no means ended, for the enterprising salter will follow those samples until actually panned or assayed, or taken out of his reach.

To the successful cultivation of the art of salting no great knowledge or experience of mining is necessary, any more than a study of architecture is essential to the practice of burglary. True ability will assert itself in this as in other employments by the invention *of new means to meet special cases,* and by a proper discretion in regulating the dose of salt administered to the temperament of the patient. Sometimes the honest miner will freely relate stories of methods by which experts had been salted, implying delicately that no such scheme would be successful with his hearer, but reserving one, undescribed, for purposes of personal illustration later.

The microscope or a very strong glass is often of very great service. In silver ores the silver-bearing minerals can often be washed out and identified; and with gold ores the color and form of the metallic particles are sometimes suggestive. *Once,* in Dakota, I was taken to see a vein said to be rich in silver, but the appearance of the vein-matter raised an immediate doubt as to what form the silver could be concealed in. By panning I obtained some native silver; but when examined under a glass some of the pieces showed traces of native copper attached. The only place I know where native silver and copper occur actually welded together is the copper region of Lake Superior; and, on questioning a little the honest miner who was my guide,—*and who had kindly assisted in crushing some samples,—I found he had formerly* worked on Lake Superior. No great intellectual effort was then necessary to account for the occurrence of the silver in the very unpromising looking vein-matter.

In the case of panning tests on gold ore, or gravel, or for precious stones, it is of course comparatively easy for anyone who is allowed to be within a short distance of the expert to get in his salting work, and solitude is the only protection. The salter may use a quill tooth-pick as a weapon for long range shooting, or have gold dust in his nails for short range; or charge his pipe or cigar, and not watch where his ashes fall. Cases have been known of gold pans prepared in advance by a valuable varnish which gradually rubbed off in use. Although it is not possible to mention all the *devices, there may be some utility in putting on record for others the better-known* ones; for it is certain that many young engineers start out with confidence of much learning, ready to undertake responsible examinations, and without any clear idea of the dangers they are courting. A man may acquire a fair amount of practical experience, and confidence begotten of the same, without happening to get into surroundings of any real danger, and so, when least expecting it, may yet be nipped. All men of experience agree that the only absolute protection is solitude; and that trusting to knowledge of the old tricks or to personal watchfulness is quite insufficient if any person is immediately around.

General Mining Association, Ltd.

A Dividend of 12¼ Per Cent.

The Ordinary Half-yearly General Meeting of the shareholders of this Company was held at the offices, London, England, on 19th ulto., when the report and accounts for the year ended 31st December, 1894, were submitted as follows:

"The sales of coal were as follows:—

	1894. Tons.	1893. Tons.	Increase. Tons.
Sydney Mines	236,125	209,185	26,940

	£	s.	d.
The profit on the year's trading, as set forth in the accounts, amounts to..........	£19,002	12	11
Brought forward from 1893	684	14	1
	£19,687	7	0
Out of which the Directors propose a dividend of 14s. per share, free of income tax, viz..........	19,228	6	0
Leaving balance to carry forward..........	£459	1	0

From the commencement of the shipping season there was a good demand for coal, and the total shipments exceeded those of any previous year.

The financial crisis in Newfoundland, with which colony transactions have always been important, will, it is feared, eventually result in a loss to the Association.

It is as yet difficult to form a reliable estimate of this; the Board have, however, provided for what it is believed should fully cover it, and, after so doing, are able to recommend the dividend above referred to, which they believe will be considered very satisfactory, especially when it is remembered that a return of £2 10s. per share on capital account was made on 24th September last.

The Board are continuing to sanction such improvements as will tend to facilitate the shipping and delivery of the coal."

Report of the Mine Manager.

I beg to submit the following annual report on this colliery for the year 1894: We employed an average number of 288 colliers during the season; the pit worked 272½ days drawing coal; and the total quantity of 256,812 tons of coal was raised. But little shipping was done early in the year; only 11 cargoes were shipped in January, 1 in March, and 6 small cargoes in April. From the 1st of May, however, until the close of the year, the demand for coal was steady and continuous. The total shipments for the year were 218,028 tons, and the local sales 18,096½ tons of large, run of mine and slack coal. Early in the season our western shipping pier at North Sydney was repaired, about 50 feet were added to its length; the trestle work or superstructure which carries the roadway, was entirely renewed, and the roadway raised to a height of 6 feet above its previous level. The bridge, whereby the roadway to this pier crosses the public road, was also renewed and raised in height. A new and powerful locomotive, *built to specification, by the Baldwin Locomotive* Works at Philadelphia, has been purchased; and 21 coal cars, to carry 6 tons of coal each, have been provided.

A Fairbank's truck weighing scale, to a capacity of 20 tons, was imported and set upon our railway. A new ventilating fan of 10 feet diameter was purchased and set up, to be used when necessary to assist or replace the old Guibal fan. Hadfield Cast Steel Wheels were, during the season, supplied and fitted to 210 of our pit coal tubs or boxes, to replace the cast iron wheels hitherto in use. A boiler feed heater was purchased, and set up in connection with the exhaust steam from our large winding engine, to warm the feed water for the use of our boilers. 1,251 yards of the 4in. iron pipes, which conduct the boiler feed water from the main reservoir to the pits, have, during the season, been replaced by pipes of 5 inches diameter; and a bore hole 283 feet 4 inches deep by 5 inches diameter, has been bored to a small feeder of pure water in the vicinity of the reservoir. This feeder is available during dry weather, either to supplement the supply from the reservoir, or to provide some of our workmen's houses with good water. A pair of new cylinders have been imported for the locomotive 'Stephenson,' and will be put in this winter, as soon as the locomotive 'John Bridge,' which is having a new fire box fitted at New Glasgow, shall be completed. Repairs, as usual, have been made on a number of our stationary boilers, on our coal tubs, waggons, railroad and plant generally, and everything is in good working order. Progress has been made with the erection at bank of the 'Lingan' engine, to be applied to work the north side underground haulage; and some new slidings, spears, or guides, of pitch pine, have been placed in the winding shaft. One breakage only occurred during the year to our main pumps. In June the clack door piece in the Staple set, which had been cracked for some time, gave out and had to be withdrawn and replaced by a new one.

(Signed) R. H. Brown.

Accounts for the Year Ended 31st December, 1894.

BALANCE SHEET.

Liabilities.

	£	s.	d.	£	s.	d.
To Share Capital, viz., 27,469 shares of £8 each...	219,752	0	0			
Less £2 10s. per share repaid to shareholders..	68,672	10	0			
				151,079	10	0

To Sundry Creditors—		
At the Mines	3,078 12 3	
At Halifax	2,248 16 11	
In England	1,149 6 8	
Unclaimed Dividends	312 11 0	
do Return of Capital	1,256 10 0	
		8,045 16 10
" Reserve—		
Per last account	29,850 0 0	
Maintenance and Renewal Account— From 1893 £38,750 0 0; Sydney Mines, for current year 1,500 0 0	40,250 0 0	
		70,100 0 0
Low Point, Barrasois and Lingan Mining Company, balance subject to collection of book debts		4,047 4 8
" Profit and Loss—		
Balance from 1893	684 14 1	
Profit this year, per Account "B"	19,002 12 11	
		19,687 7 0
		£252,959 18 6

Assets.

By Property of the Association, viz.—		
Pits, Railways, Engines, Wharves, Buildings, Machinery, &c.	123,201 9 8	
Other property, including real estate, stores, mining implements, &c., valued per inventory	41,031 17 6	
		164,233 7 2
" Sundry Debtors—		
At Halifax	21,953 18 4	
At the Mines	2,870 1 4	
		24,823 19 8
" Bills Receivable—		
In England	4,033 15 4	
In Halifax	6,398 5 9	
		10,432 1 1
" Government and Indian Securities	38,478 19 3	
Accrued interest thereon	407 8 9	
		38,886 8 0
" Cash—		
At Halifax	1,720 5 6	
do on deposit	9,246 11 6	
At the Mines	1,204 10 4	
At London bankers and office	2,412 15 3	
		14,584 2 7
		£252,959 18 6

B PROFIT AND LOSS ACCOUNT.

Dr.

To Coal stock on hand 1st January, 1894		648 18 11
" Sydney Colliery general working expenses, railroad expenses, shipping charges, royalty, &c		61,994 15 11
" Maintenance and renewal of plant, railroad, wharves, &c.		1,500 0 0
" Management expenses at Sydney Mines		1,739 16 6
" Income tax (average of three years)		472 6 0
" Expenses of management in London—		
Directors' salaries	£900 0 0	
Secretary, clerks, and auditors' salaries	720 0 0	
Office rent, printing, advertising, stationery, telegrams, postages, travelling and petty expenses	630 10 3	
		2,250 10 3
" Legal expenses		286 1 5
" Bad or doubtful debts in Newfoundland		5,000 0 0
" Balance—Profit carried to Account "A"		19,002 12 11
		£92,895 1 11

Cr.

By Proceeds of sale of 236,125 tons of coal and miscellaneous receipts at Sydney Colliery		88,938 18 4
" Rents of cottages and lands		1,211 11 8
" Interest and exchange	2,218 19 4	
Less interest, etc., paid	119 16 4	
		2,099 3 0
" Transfer and other fees		2 5 0
" Profit on real estate sales		220 1 1
" Received on bad debts account		155 6 7
" Stock of coal 31st December, 1894		267 16 3
		£92,895 1 11

The Sinking of the Ladd Shafts.*

—

By George S. Rice, E.M.

—

At Ladd, which is in Bureau County, Illinois, the coal measures are overlaid by a drift deposit, 160 to 200 feet thick, of clay, sand, and gravel, interspersed with boulders, sometimes of large size. It seems to have been the accumulation at the bottom of an ancient lake, as the material is in more or less regular layers containing shells and pieces of float wood which were found all the way down to the solid rock. The surface of the latter was evidently scoured by the great glacier and is level, if not slightly basin-like in form, as indicated by the prospect drill holes. The surface drains slowly till it reaches the bluffs of the Illinois river, which is distant, as the water flows, about eight miles from the shafts.

The result of this slow drainage above open sandy strata, and a slightly basin-like rock bottom, is to make the drift water-soaked and full of pockets of quicksand.

The coal seam worked at present is the third from the top, geologically, No. 2, and in the Ladd shafts is 460 feet from the surface, but after the 160 feet of drift is pierced, sinking presents no especial difficulties.

The officials of the Whitebreast Fuel Co. were made aware by their prospect holes that water was to be encountered, but did not expect the enormous quantity nor the treacherous ground, consequently, the beginning of the work was marked by several unsuccessful attempts. The ordinary methods of cribbing and spiling were first tried, and then an ordinary timber drop shaft. But, in addition to large quantities of water, much difficulty was experienced on account of the variable nature of the ground, alternating hard and soft strata, the presence of boulders, etc. This made a drop shaft impracticable, since it would settle unevenly and could not be controlled.

Success was finally attained by introducing a heavy steel shoe, which was forced ahead of the lining by jackscrews, additions being made in sections to the lower edge of the lining. In principle this is similar to the method of tunneling in soft ground with the use of an advance shield, and is almost identical with the old Guibal system, first employed for shaft sinking about 1856, with this difference: that in the Ladd shafts, the shoe was rectangular instead of round.

Four shafts were begun, one after another, the fourth having actually reached solid rock, and lacking but little of completion, when the curbing near the bottom gave way, and a strong inrush of sand and water destroyed six months' work.

The first shaft was started June 1, 1888, by experienced sinkers. The customary method of sinking through drift was employed, that is, excavation was followed closely by timbering with 2 in. by 12 inch planks laid flat. The water was handled first with barrels. At a depth of 50 feet water and sand burst up from the bottom, and the cribbing became so swung and twisted that the shaft had to be abandoned.

The second shaft was started in the latter part of June, 10 feet west from the first, which was to be used as a sort of sump until the second shaft had gone below it. When the second shaft did get below the first, great trouble was again experienced from water and sand. Spiling was tried, driven in advance of the timbering around the edges, but the rushes of sand and water threw them out. Meantime a pump was put in; but at a depth of about 70 feet the rushes were so strong it was found that ordinary methods would not do. A heavy wooden shoe was proposed, to be sunk from this point, building the curbing on top of it, in other words, making a drop-shaft through the very soft ground from the point where the ordinary method had stopped. The ground back of the gap where the successive rounds of timbers were added on, as the drop-shaft sank, was to be kept back by a stationary shield of plank outside the curbing. The shoe was made and started; it could not be made to sink evenly, and almost at once became distorted and stuck, and the rushes became so bad that the stationary curbing above was pulled apart and the shaft was so racked that it was abandoned.

Mr. Phillips now designed the steel plate sinking shoe and the plan of suspending the curbing on which he received Patents No. 424,819 and No. 424,820. The first experimental shoe may be briefly described as a steel plate box, open top and bottom, the upper part inclosing the bottom of the curbing, the lower part divided by plate braces into six compartments. The shoe to be hung when it was so needed, by chains to lines of iron rods running from trusses across the shaft at the surface. These rods were in the corners of the shaft and also helped support the curbing by means of cross timbers every 10 feet, through which they ran. The timbers were set into the curbing, and later when the curbing rested on the solid rock were to be cut out. While the shoe was building, the shaft in which it was to be placed, No. 3, was started about August 1, 1888. The cribbing was again of 2 inch by 12 inch planks laid flat, with two temporary lines of buntons of 6 inch by 8 inch timbers with 10 inch intervals. The outside dimensions of the shaft were 12 by 16 feet. It was planned when the shaft reached the solid rock to timber up with an inner cribbing 8 inches thick, puddling between the two cribs, leaving a shaft way 6 feet 3 inches by 10 feet 6 inches, divided by a partition 6 inches thick. The shaft was carried down 50 feet by ordinary methods before the shoe was ready.

The latter was taken down piece by piece, put in place and bolted together, which proved a hard job in the mud and water, but which was successfully accomplished. The shoe and the method of hanging the curbing proved a decided success, and sinking steadily proceeded to a depth of 125 feet. At this point, however, such a burst of sand and water came up from the bottom that it drove the men from their work. While the shoe had worked well, it had proved to be too light for the conditions and the compartments too large; so it was decided to let the shaft stand for the time being and put down another shaft, which might lessen the water and thus permit the work on this to be resumed.

Accordingly an improved and heavier shoe, with 15 compartments, instead of 6, was built, and on January 8, 1889, the fourth shaft was started, located about 50 feet east of the first. This shaft made good progress considering the severe winter weather, till a depth of 138 feet was reached, which was on March 8th, just two months from the start. But here there was a tremendous burst of water and sand, the water amounting to over 640 gallons per minute, which soon drowned out a large Deane pump with a 6 inch discharge, and a Blake with a 4 inch discharge. Before another pump could be brought into action, the water was 80 feet up the shaft.

Then followed long delays, while certain pistonless pumps were tried and found wanting. Very little sinking was done till May 9th, when it progressed slowly, meeting great difficulties. Boulders were encountered, which got under the edge of the shoe and had to be blasted, and bad rushes of sand and water. The sand added immensely to the difficulties of pumping. At times a man had to be kept constantly at work cleaning the suction strainers so they would draw. It also cut the valves and linings of the pumps, so that the pumps had to be changed and completely repaired at least once a week. The removal of the enormous bodies of sand and water from around the shaft was felt clear to the surface, which sank a foot or more in places over a large area, sometimes on one side, sometimes on another. This caused the shaft to swing and threw great strains on the supporting trusses and on the curbing. This was further aggravated by the uneven pulls of the shoe, due to its being hard perhaps only under one corner or side. These strains sometimes forced the cribbing planks from the level, and it would be necessary to level up again so that the shoe might descend vertically and the next courses would be tapered, that is, the planks would be adzed so as to be thinner at one end than at the other. This necessarily weakened the plank, and together with the strains from the general distortion of the curbing, was undoubtedly the cause of its giving away later. However, the shaft progressed to a depth of 158 feet, which was reached May 20th, and brought the crib within 4 feet of the rock. At this juncture the pumps on hand completely played out, and another delay ensued till June 26th, four days after which the rock was reached.

The shoe was then secured, the compartments were cut out, and the timbering carried down to the rock. The rock at this point proved to be 3 feet thick, and this

* School of Mines Quarterly.

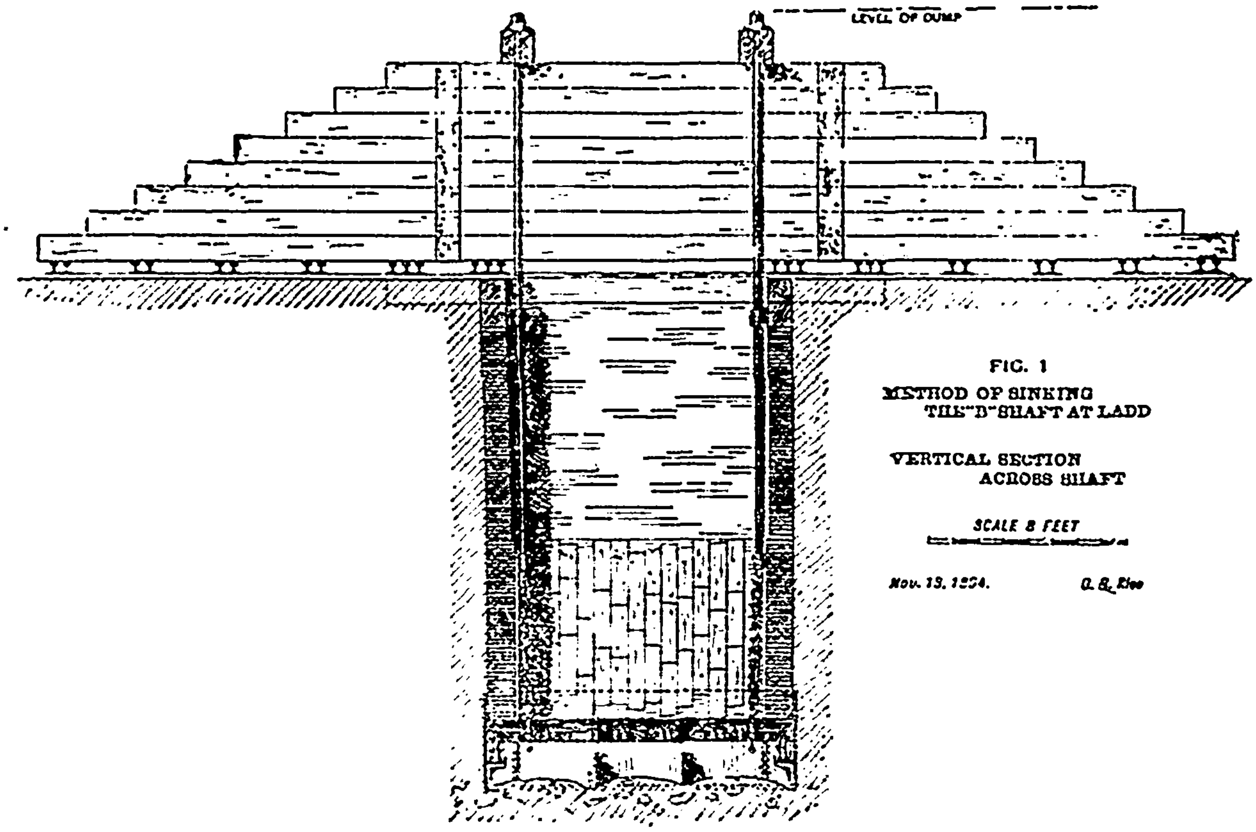


FIG. 1

METHOD OF SINKING THE "B" SHAFT AT LADD

VERTICAL SECTION ACROSS SHAFT

SCALE 8 FEET

Nov. 13, 1894. C. S. Rice

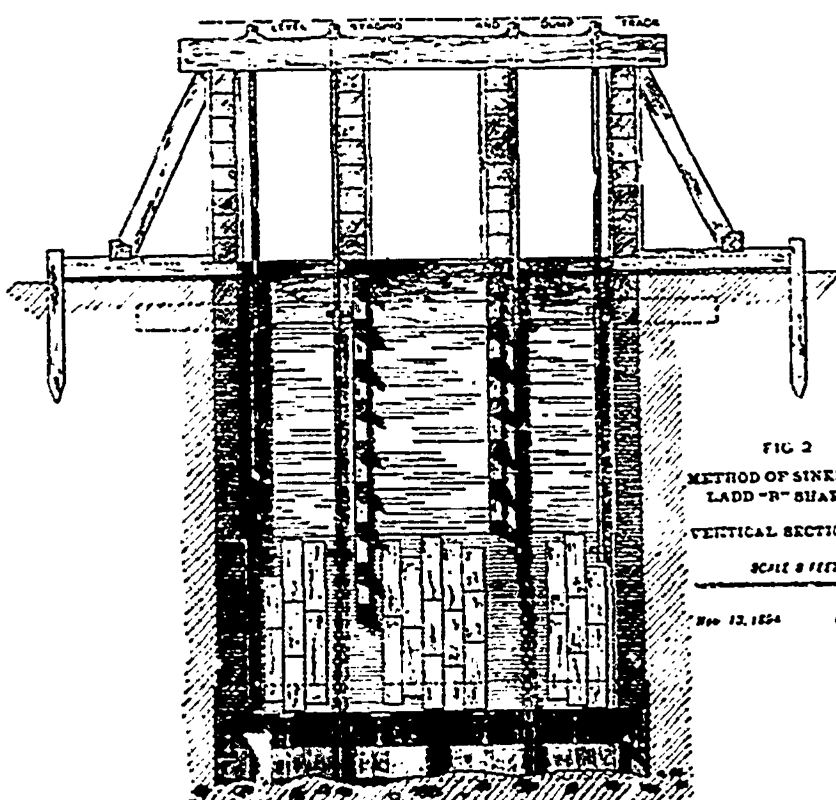


FIG. 2

METHOD OF SINKING LADD "B" SHAFT

VERTICAL SECTION

SCALE 8 FEET

Nov. 13, 1894 C S Rice

was also penetrated to the shale immediately below. From this point the inside lining and puddling and permanent partition was begun, working upward from the bottom and removing the temporary buntons and cross-timbers as the work advanced. The inner linings had been built up about 8 feet, when suddenly the curbing gave way just above it, at the east end, flooding the shaft with sand and water. Fortunately this happened at lunch time, when all were on top but two men who were looking after the pumps; these barely got out, for in a few minutes the shaft had filled half way up.

This happened July 14, 1889. Not discouraged, the company soon arranged for another attempt. The shoe having proved successful, a duplicate one was ordered, but thicker cribbing was used for the lower part, namely, 2-inch by 14-inch planks flat. At one time the experiment was tried of alternating 2-inch by 12-inch and 2-inch by 14-inch plank, made flush inside, but presenting a rough exterior; the idea being to give the shaft a better hold on the ground, also to make it less easy for the sand and water to wash down outside the cribbing. However, in practice it did not prove of any particular advantage in these respects. On the other hand it occupied as much space as a solid 14-inch wall and was not so strong; thereafter, 2-inch by 14-inch timber was used exclusively. Another improvement was in the use of hangers or iron lugs spiked to the cribbing, instead of the oak cross-pieces which had been set into the cribbing, thereby weakening it, and which were often broken under the pull, and also were in the way in handling the pumps. The shaft was locat d 100 feet east of the fourth attempt. As a daily journal was kept by Mr. James Anderson, then engineer of the company, of all attempts after the third, and as this sinking was typical of the difficulties, the diary will be given unchanged and uncolored by the views of the writer, except for such slight additional words as are necessary for clearness:

August 9—Shoe arrived from Chicago; unloaded and put it together in place.

August 10—Sunk shoe down into the ground and moved trusses into place; sunk 4 feet through grade filling. Depth, 4 feet.

August 11—Got tower up and started sinking, 3 p.m.: sunk 4 feet through grade filling and soil. Depth, 8 feet.

August 12—Put in hangers and rods, and started buntons in east end; sunk 7 feet through yellow clay. Depth, 15 feet.

August 13—Buntons now in both ends and going in regular fashion; sunk 7 feet, through 4 feet yellow clay, 3 feet blue clay. Depth, 22 feet.

August 14—Some water; handled by barrels; amount of water, 3 gallons per minute; sunk 6 feet through blue clay. Depth, 28 feet.

August 15—No trouble; water 3 gallons per minute; sunk 5 feet through blue clay and gravel. Depth, 33 feet.

August 16—No trouble; water 3 gallons per minute; sunk 4 feet through muddy clay. Depth, 37 feet.

August 17—No trouble; water 3 gallons per minute; sunk 5 feet through blue clay. Depth, 42 feet.

August 18—Water came in fast at 9.30 p.m.; put in a No. 9 Blake pump; water 104 gallons per minute after tapping; sunk 5 feet through blue clay and sand. Depth, 47 feet.

August 19—No trouble; water 104 gallons per minute; sunk 4 feet through blue and yellow clay, sand and gravel. Depth, 51 feet.

August 20—Sand all around south side and one-half of east end; hard clay and gravel under the rest, causing rushes. We do not dig out below press plates; water averaged 90 gallons per minute; sunk 5 feet through clay, sand and gravel. Depth, 56 feet.

August 21—We bored 2-inch auger-holes to relieve pressure and prevent rushes; Did not do much good; drove spiles but rushes threw them out again; water averaged 104 gallons per minute; sunk 3 feet through clay, sand and gravel. Depth, 59 feet.

August 22—Caved clear to the surface at the east end; a crack in the curbing was caused by rushes below the last clamp; shaft swung 6 inches out of plumb, inclining to west; water averaged 104 gallons per minute; sunk 1½ feet through clay, sand and gravel. Depth, 60½ feet.

August 23—The material is getting soft all over, principally sand and gravel; the shoe sets square, and we also got the timbering levelled; water 140 gallons per minute; sunk 1½ feet through clay, sand and gravel. Depth, 62 feet.

August 24—Had to stop on account of shortage of suspending rods; put in a Deane pump in the west end; the trusses are pulled down about 1 foot; water, 140 gallons per minute; sunk none. Depth, 62 feet.

August 25—Have now good solid clay all around, except under the northeast corner, where it is sand as yet; water 140 gallons per minute; sunk 2½ feet through clay and sand. Depth, 64½ feet.

August 26—Rushes of sand and water occurred all day; water 140 gallons per minute; sunk 2½ feet through clay and sand. Depth, 67 feet.

August 27—Had a very bad rush of sand, filling about 8 feet up the shaft; trusses almost broke down; water averaged 140 gallons per minute; sunk none. Depth, 67 feet.

August 28—Cleaned out the rush and blocked with wood between timber and shoe in place of jack-screws; withdrew the pumps; started to tear down trusses; shaft filled with water.

August 29—Finished tearing down; got levelled , for new trusses.

August 30—Started to build up trusses and top works.

August 31—Finished them and started pumping out water in shaft.

September 1—Got the water all pumped out and shoe cleaned out ready for sinking; water still coming in at rate of 140 gallons.

September 2—Rushes of sand with the water all day; started a Nye pump in the caved-in shaft of the previous attempt, located about 50 feet away, to try to relieve the pressure of water; water 140 gallons per minute; sunk 1 foot through clay, gravel and sand. Depth, 68 feet.

September 3—Same as yesterday; sand running up from a hole in the northeast corner; lowered the water in the neighboring shaft to 85 feet from the surface, so it is 17 feet below bottom of present shaft, but without any effect in relieving from water; water averaged 140 gallons per minute; sunk 1½ feet through sandy clay and sand. Depth, 69½ feet.

September 4—Got through with the sand pocket at northeast corner, but as a consequence of the rushes of the past few days, a hole came to the surface, causing the upper part of the shaft to swing 2½ feet east; threw in bales of hay till it stopped running; then filled up with clay; water 140 gallons per minute; sunk 2 feet through sandy clay and sand. Depth, 71½ feet.

September 5—Got all the water cut off from below; what there is comes in through the timbering; water 140 gallons per minute; sunk 2½ feet through sandy clay with gravel pockets. Depth, 74 feet.

September 6—No trouble; water 108 gallons per minute; sunk 3 feet through blue clay. Depth, 77 feet.

September 7—No trouble; water 83 gallons per minute; sunk 3 feet through blue clay. Depth, 80 feet.

September 8—No trouble; lowered pumps and water in neighboring shaft 20 feet, making water 105 feet from surface; water 70 gallons per minute; sunk 2 feet through blue clay. Depth, 82 feet.

September 9—No trouble; water 70 gallons per minute; sunk 3 feet through blue clay. Depth, 85 feet.

September 10—No trouble; water 70 gallons per minute; sunk 3 feet through blue clay. Depth, 88 feet.

September 11—No trouble; water 83 gallons per minute; sunk 3½ feet through blue clay and sandy silt. Depth, 91½ feet.

September 12—No trouble; water 83 gallons per minute; sunk 3 feet through sandy silt. Depth, 94½ feet.

September 13—Very fine sand running in with the water; water 104 gallons per minute; sunk 2½ feet through sand, very fine. Depth, 97 feet.

September 14—Some small rushes at east end; lowered Nye pump in neighboring shaft 10 feet; water 104 gallons per minute; sunk 2 feet through sand and gravel. Depth, 99 feet.

September 15—Small rushes again on east side, and one on south side; had to split a boulder in the southwest corner; water 104 gallons per minute; sunk 2½ feet through sand, gravel, and clay. Depth 101½ feet.

September 16—No more rushes, but still pretty soft on east end, so we cannot dig below shoe; hard jacking; water 83 gallons per minute; sunk 2½ feet through cemented clay and gravel. Depth, 104 feet.

September 17—Hard now all over; cannot make any room for shoe, as sand above is so very fine that it washes down through the smallest cracks; water 83 gallons per minute; sunk 2½ feet through cemented clays and gravel. Depth, 106 feet.

FIG. 3
PLAN OF FINISHED "B" SHAFT.

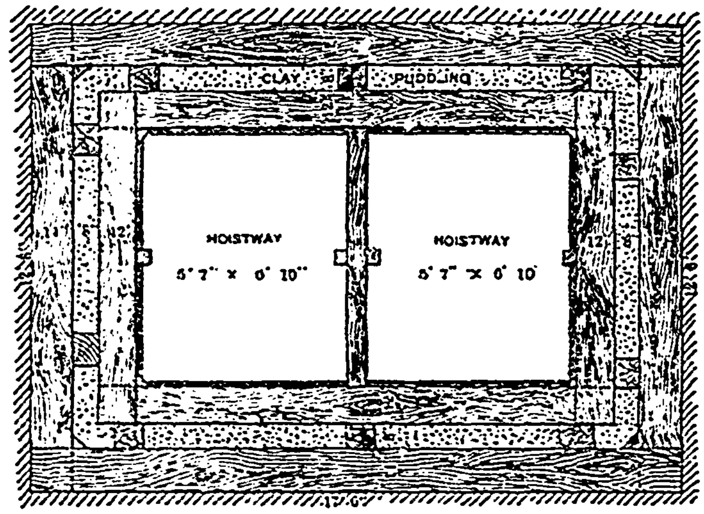
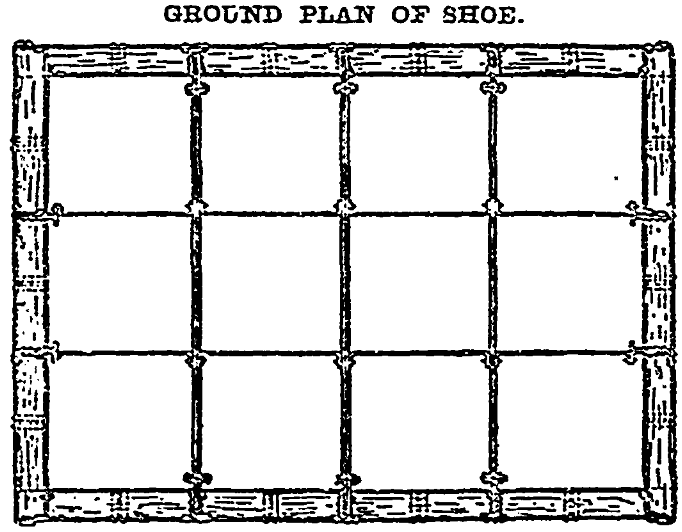


FIG. 4
GROUND PLAN OF SHOE.



September 18—Had a bad rush in the northwest corner, filling the shoe with fine sand, and causing at the surface a circular cave 100 feet north of shaft; water 83 gallons per minute; sunk 2 feet through sandy blue clay with boulders. Depth, 108 feet.

September 19—Had some large boulders, but the clay, while soft and sandy, is quite tough, and it seems probable that on jacking the shoe through it, the rushes will be cut off; water 70 gallons per minute; sunk 2 feet through sandy blue clay with boulders. Depth, 110 feet.

September 20—Lots of little boulders, but good jacking; water all cut off from the bottom; water 56 gallons per minute; sunk 4 feet through sandy blue clay with boulders. Depth, 114 feet.

September 21—Same condition as yesterday; water 56 gallons per minute; sunk 4 feet through sandy blue clay with boulders. Depth 118 feet.

September 22—No difficulties; water 42 gallons per minute; sunk 3½ feet through mucky clay. Depth, 121½ feet.

September 23—Changed Blake pump from east end to the centre and hung a Deane pump in east end; water 42 gallons per minute; sunk 3 feet through mucky clay. Depth, 124½ feet.

September 24—No difficulties; the mucky clay started to swell or heave up in bottom of shoe; water 42 gallons per minute; sunk 4½ feet through mucky clay. Depth, 129 feet.

September 25—No trouble; for some reason the neighboring fourth attempt shaft is making far more water than this shaft; water 42 gallons per minute; sunk 5½ feet through mucky clay. Depth, 134½ feet.

September 26—Put in another Blake pump in place of one removed for repairs; water 42 gallons per minute; sunk 5½ feet through mucky clay. Depth 140 feet.

September 27—No trouble; lowered Deane pumps; water 42 gallons per minute; sunk 4½ feet through 3 feet mucky clay and 1½ hard pan. Depth, 144½ feet.

September 28—Lowered Blake pump; broke lever; struck the large stream at 1.30 p.m.; running 500 gallons per minute; first rush brought about 10 barrels of sand; started the Deane pumps and kept the water down; water after rush 500 gallons per minute; sunk 2½ feet through sandy clay. Depth, 147 feet.

September 29—Lowered the west Deane; water now coming very clear; water 420 gallons per minute; sunk 2 feet through greenish clay. Depth, 149 feet.

September 30—Lowered both Deane pumps; the water all coming up as yet in the southwest corner and clear; water 350 gallons per minute; sunk 3 feet through clay with pockets of gravel. Depth, 152 feet.

October 1—Lowered east Deane and the Blake pumps; are now about the level of the water bed. water 350 gallons per minute; sunk 4 feet through sandy clay. Depth, 156 feet.

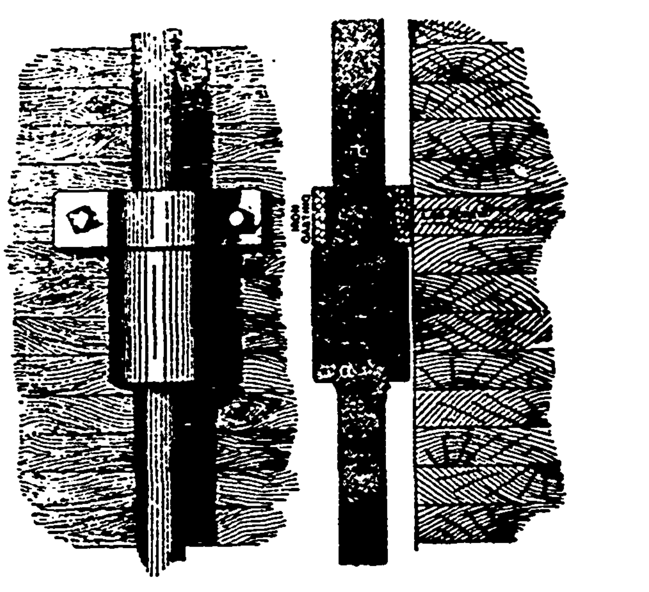
October 2—The discharge hose blew off the east Deane pump three times; at the same time the Blake pump played out, causing six hours delay; water clear and gravel not running; water 350 gallons per minute; sunk 3½ feet through gravel. Depth, 159½ feet.

October 3—The west Deane pump refuses to work, so we put in one more Blake pump; the water is coming in from all over; gravel has cement bands, sometimes running nearly across the whole bottom; water 350 gallons per minute; sunk 2½ feet through gravel. Depth, 162 feet.

October 4—The gravel being cemented together in cakes, it is very tough digging and jacking; the shaft is in good shape, no pulling; water 350 gallons per minute; sunk 3 feet through gravel. Depth, 165 feet.

October 5—Getting into the blue shale overlying the limestone; water 350 gallons per minute; sunk 3 feet through 2 feet of gravel and 1 foot of shale and gravel. Depth, 168 feet.

FIG. 5 FIG. 6



DETAIL OF ROD COUPLING

October 6—Got shoe on to rock; water cut off from under shoe; water 350 gallons per minute; sunk 2 feet through shale. Depth 170 feet.

October 7—Getting into rock, and some of compartments of shoe removed; pumps bothering; water 310 gallons per minute.

October 8—Getting more sump room in rock, and timbered down through shoe on to the rock; water 310 gallons per minute.

October 9—Got all the shoe braces out, and got farther down into rock; water 310 gallons per minute.

October 10—Got squared down through rock, and at 5 30 p m. started inside cribbing and puddling from bottom; in this and the following shaft the inner cribbing was of 2 inch by 12 inch timber laid flat; the space between the outer and inner cribbing was 10 inches, which was filled with the puddling; water 310 gallons per minute; sunk during past four days 3 feet through limestone, practically finishing the difficult part of the shaft. Depth, 173 feet.

October 11 to 25—Occupied in building up inside cribbing and puddling between; water being allowed to fill up behind.

October 25—Tore down old top works and started permanent tower.

November 5—Started to pump the shaft out.

November 1—Got water out, but found puddling was not a success; the difficulty had been in getting it packed under running streams; caulking was now tried without effect, the shaft making 200 gallons of water per minute.

Nevertheless, sinking was resumed November 12th, and steadily progressed through the solid rock till coal was reached, except for two delays of a week each, when endeavors were make to shut out the water. Flooring was put on, but to no effect. Then the experiment was made of pumping in cement between the inner and outer cribbing, a method notably successful in the Croton aqueduct of New York city, to fill voids behind the brick lining; but here the conditions were such that it failed; the streams of water were too strong for the cement to set, and it washed out again.

After this no attempts were made to shut water out of the shaft, and except puddling, none in the later shafts. However, to keep the hoistways dry and also prevent the water from falling clear to the bottom of the shaft, water-rings were put in each shaft just below where the water enters, from which the water is piped to a pumping station on an upper seam. The water-rings are assisted in collecting the water by lining the shafts above them with flooring raised from the curbing by nailing on top of laths, thus keeping the water behind the flooring till it enters the ring.

Under the circumstances at Ladd, the writer believes this way is even better than if the shafts had been made water tight. The water has so materially lessened since the first shafts were sunk as to cause belief that the bulk of it was held in the ground like an underground lake, and that this has now been drained, so that what is coming now is the seepage from the surface water-shed. The total quantity from the present three shafts averages this year (1894) about 135 gallons per minute. As the water is of excellent quality, it is used in the boiler plant and the town water system. While largely in excess of present needs, it will no doubt all be wanted in the future. Moreover, had the shafts been made tight, there would be the constant menace of a large body of water liable to be let down on any rupture of the shaft, a thing unlikely and yet always feared. As it is, there is no pressure whatever from the water, the shafts draining freely the natural flow of the strata.

Before the shaft last described, now known as "A" shaft, had reached the coal the sixth attempt or "B" shaft, was started on November 14, 1889, 50 feet west of the third attempt, now known as the air shaft, but which was temporarily abandoned at 125 feet. The latter shaft was now kept pumped out, materially helping in the sinking of "B" shaft, which made much less water than the previous shafts. Even when "B" shaft got below the third attempt there was not nearly so much water, for the ground seemed already largely drained after a year and a half of steady pumping. Accordingly "B" shaft was sunk much more rapidly than its predecessors. This was not entirely due to less water but partly to the experience gained by the sinkers in meeting the peculiar difficulties of the field and partly to the improvements made in the appliances. Among the latter was the plan of suspending the curbing from solid wooden triangles instead of the open Howe truss, which could not be designed to meet immensely varying strains, and so on several occasions had been crushed. Another improvement was in the shoe in making the plate braces so they could be easily removed on reaching the solid. They were made heavier but fewer in number, forming 12 compartments, instead of 15, as in "A" shaft. This shoe was highly satisfactory in all respects (see Figs. 3 and 4).

The only serious difficulty that "B" shaft encountered was when, at a depth of 50 feet, a hole came to the surface along side of the shaft at the east end, causing it to swing 6 inches out of plumb. The hole was promptly filled up with clay, which stopped the running, and no further trouble ensued. On December 31, 1889, the shoe was down on the solid rock.

The speed of sinking the fourth, fifth and sixth shafts is as follows:—

Fourth Shaft.—Started January 8, 1889. Reached rock June 30, 1889, a period of 174 days. Of these, 96 days were lost in delays, 78 days only being spent in sinking. Depth of shaft to rock, 162 feet. Average progress per working day, composed of three 8-hour shifts, 2.1 feet. Maximum rate of pumping, 640 gallons per minute.

Fifth Shaft "A."—Started August 10, 1889. Reached rock October 6, 1889, 58 days total, of which 7 were lost in delays and 51 spent in sinking. Depth of shaft to rock, 170 feet. Average progress per working day, 3.3 feet. Maximum rate of pumping, 500 gallons per minute.

Sixth Shaft "B."—Started November 15, 1889. Reached rock December 31, 1889. Total, 47 days, of which but two were lost in delays; 45 were spent in sinking. Depth of shaft to rock, 160 feet. Average progress per working day, 3.6 feet. Maximum rate of pumping, 350 gallons per minute.

There was no detailed record kept of the third or air shaft, but after getting "B" shaft down, sinking was resumed from where it had stopped over a year before on account of the lightness of the shoe, and now that "B" shaft was draining the water there was no trouble in getting the air shaft down. Thus three of the original six attempts were finally successful; and all the shafts in which the shoe was used succeeded in reaching rock.

I will now give a description of the details of the shoe, method of hanging the curbing, etc., as finally developed and used in sinking "B" shaft.

Beginning at the top, there is first in order a platform of 2-inch plank laid on the surface about the shaft, and covering an area 30 by 46 feet; on top of these, running across them and parallel to the sides of the shaft are 60-pound steel rails. These form the foundation of the four solid wooden triangles which carry the weight of the curbing not sustained by the friction of the ground. Each triangle is made of 8 pieces of 12-inch by 12-inch timber, the bottom one 48 feet long, the next 4 feet shorter, and so on to the top one, which is 20 feet long. The triangles run across on top of the rails and the narrow way of the shaft. On them and across them rest two 16-inch by 16-inch timbers 20 feet long. These are nearly over the side walls of the shaft; through them pass the 8 rods which sustain the curbing, four to each side or timber, huge washers under each rod head distribute the strain over the timber, which in turn distributes it to the triangles. The whole forms an almost rigid structure, so that when subsidence comes, everything goes down at the same time. The hanging rods are steel, and made in 10-foot lengths, the ends upset or thickened so that screw-couplings are made without weakening. The upper lengths are 2½ inches in diameter, every three lengths down the size decreases ¼ of an inch, so that the bottom lengths are 1¾ inches in diameter. The support to the curbing is, as finally adopted, an iron lug placed under the screw-coupling piece at each joint and spiked to the cribbing.

The shoe as finally designed and used in "B" shaft was 12 feet 8 inches by 17 feet 6 inches inside measure, built of ¾-inch steel plate, the sides 4 feet deep, of which the upper 16 inches was the shield embracing the bottom of the curbing. The lower part of the shoe was divided into 12 compartments by three transverse braces of ¾-inch plate, doubled, 22 inches deep, and two longitudinal lines of braces, of ¾-inch plate, 16 inches deep. Around the inside of the shoe 12 inches from the bottom runs a shelf 9 inches wide of ¾-inch plate, braced below with brackets, and with a 2-inch ledge in front. This forms the press-plate on which are placed the jack-screws to force down the shoe; directly above is the shaft-cribbing against which the jack-screws bear. Although the shoe itself weighs 8 tons, the jacking was often very hard. The mode of operating is to apply the jack screws till the shoe has been forced down from 2 to 10 inches, depending on the ground, never more than 10 inches, which leaves but 6 inches of shield lapping the cribbing. Then the shoe is levelled carefully, the jack-screws removed, the 2-inch cribbing-plank put in place and spiked upward to the previous course. It is further tied, till the next hangers are put on, by boards nailed up and down the curbing. The cribbing is arranged with butting-joints, the planks alternately overlapping, a simple and a very strong way with plank laid flat. It is further strengthened by triangular corner-strips.

Two-inch planks are used for the cribbing instead of thicker timber, because more easily handled in the cramped space at the bottom of the shaft, and they are little less strong for the same thickness of wall. After as many courses of cribbing are in as the space allows for, frequently in bad ground only one, the jack-screws are replaced and the operation repeated. Separate plate-covers were provided for the compartments of the shaft "B" shoe, but it was found that the rushes of sand could be kept down if the excavation were not carried below the press-plates; and as the covers would hamper the work they were not used. They were kept at hand, however, the idea being, that when dangerous ground was expected, all the compartments except one or two would be closed.

Meantime the excavation and pumping goes on according to circumstances, and with the customary appliances.

To provide for supporting the shoes when a very soft spot is reached, chains, one in each corner, pass around the braces and hook to the hanging rods. An improved detail would be the insertion of a long turn-buckle at the lower end of each chain, fastened by clevis to a brace. At Ladd full weight was never thrown on the chains, the shoe always binding on some part; in soft ground, where there was danger of rushes, excavation was never advanced below the bottom of the shoe. There were usually three pumps hanging in the shaft, one in each compartment. The vertical Deane plunger pump with a 4-inch delivery was the favored type. The pumps were hung by hemp cables from capstans at the top, so as to be readily raised and lowered, the steam and water connections to the pipe lines being made with flexible hose.

In conclusion, I will say that I think this system of sinking shafts well fills the gap in deep shaft sinking, between the solid ground systems and the true drop shaft system. For instance, here at Ladd, the first failed in two hard-pushed attempts, the second also failed after a shorter trial, but the boulders and hard ground met deeper, fully showed how impracticable it would have been. Of other known systems, the pneumatic is out of the question for over 70 or 80 feet of water pressure, and while the Poetsch freezing system alone seems applicable to nearly all circumstances, its present great cost makes it prohibitive except in extraordinary cases. On this account, leaving the freezing system out of consideration, where there is a ground filled with water and over 80 feet in thickness to be pierced, too soft for solid ground systems and yet containing boulders, cemented material, or some hard ground which would prevent any kind of a drop shaft, the method described in this paper is sigularly well adapted.

Dominion Railway Subsidies

To Canadian Coal Companies, 1893.

Boston and Nova Scotia Coal Company.—By the Dominion Subsidy Act, 57-58 Vic., ch. 4, 1894, a subsidy to this company limited to $113,600 (in lieu of one previously granted in 1892) was authorized for the construction of 35½ miles of railway from a point on the Cape Breton Railway at or near Orangedale to Broad Cove, on the western side of the Island, and under date the 16th of November, 1894, a contract was entered into with the company for the work subsidized, the date for completion being fixed as the 1st August, 1896.

No payments have been made up to the 31st December, 1894.

Dominion Coal Company.—By the Subsidy Act, 55-56 Vic., ch. 5 (1892), a subsidy, limited to $89,600, was authorized for 28 miles of a railwny to complete connection between Sydney and Louisburg, Cape Breton.

On the 26th of January, 1894, a contract was entered into with the above company for the work from Bridgeport to Louisburg Harbor. The first 10 miles section from Bridgeport has been completed, but no payment on subsidy account has been made up to the 31st of December, 1894.

Nova Scotia Steel Company, Ltd. By the Subsidy Act, 55-56 Vic., ch. 5, the grant of assistance to the above company for 12½ miles of railway from Eureka Junction on the Intercolonial Railway to a point at or near Sunnybrae, including a branch line to the charcoal iron furnace at Bridgeville, was authorized, the limit of aid being $40,000.

Under date of the 23rd of November, 1892, the company were admitted to contract for this work.

During the fiscal year there was paid $5,454.16, making the total payments up to the 31st of December, 1894, $38,400. For the previous yea. $38,400 was paid.

Medicine Hat Railway and Coal Company.—By the Act 50-51 Vic., ch. 23 (1887), authority was given for the grant to the above company of Dominion lands to the extent of 6,400 acres per mile, for a railway from a point at or near Medicine Hat, on the line of the Canadian Pacific Railway, to the coal fields in or near Townships Nos. 12 and 13, Range 6, west of the 4th Principal Meridian, a distance of about 8 miles.

By an Order in Council of the 6th July, 1887, the grant was made to the company accordingly, it being provided that the road should be completed and in operation by the 31st of December, 1888.

By an Order in Council of the 24th of January, 1889, approval was given to a draft of a formal contact with the company, and an extension of time to the 2nd of June, 1890, was granted for completion of the road. A contract was signed on the 14th of February, 1890, for this work.

By the special Act 53-55 Vic., ch. 79 (1891), the charter of the company was revived and its powers were extended, and by the special Act 57-58 Vic., ch. 80, the time limit for completion was further extended to the 1st of January, 1898.

Alberta Railway and Coal Co., Ltd. (property purchased from the Northwestern Coal and Navigation Co., Ltd.)—Dominion lands to an extent not exceeding 3,800 acres for each mile of the company's railway, from Medicine Hat to the coal banks on the Belly River, about 110 miles; also lands to an extent not exceeding 3,840 acres for each mile of the company's railway from Lethbridge to the Crow's Nest Pass, a distance of about 100 miles. A grant not exceeding 2,600 acres for each mile of the company's railway from Dunmore station, on the C.P.R., to Lethbridge, a distance of 109½ miles, on condition of a standard gauge; and also 6,400 acres for each mile from Lethbridge to the International Boundary, a distance of 50 miles.

Red Deer Valley Railway and Coal Co.—$6,400 for each mile from Cheadle Station on the C. P. R., to the terminus of the proposed railway at a point in or near Township 29, Range 23, west of the 4th meridian.

Dominion Lime Co.—For seven miles of their railway from a point on the Quebec Central Railway, in the Township of Dudswell, to the Dudswell lime quarries, a subsidy not exceeding $3,200 per mile, or $22,400.

Cumberland Railway and Coal Co.—For fourteen miles of their railway from a point on the Springhill and Parrsboro' railway, near Springhill, to a point on the railway between Oxford and New Glasgow, near Oxford Village, a subsidy not exceeding $3,200 per mile, not exceeding in the whole $44,800.

Londonderry Iron Co. Ltd.—(Grant to Steel Co. of Canada)—A grant as subsidy (road to be first laid with new steel 56 lb. rails and after an Order-in-Council has been passed authorizing their transfer to the company) of 597 tons of used iron rails and fastenings loaned to the company, which rails and fastenings stand in the Public Accounts as an asset for $11,964.66.

Canada Coal and Railway Co.—(Grant to Joggins Railway)—For one and a quarter miles of their railway ending from the southern end of the portion subsidized by the Act 49 Vic., chap. 10, to the wharfs, not exceeding $3,200 per mile, nor exceeding $4,000.

Railway Earnings 1893-4.

(Fiscal Year ended 30th June.)

Company.	Gross Earnings.	Net Earnings.	Mileage.	Earn. per train Mile.
Alberta Railway and Coal Co. ..	$127,348 53	$49,688 35	64.62	$107 38
Cumberland Railway and Coal Co.	123,413 31	64,794 95	32.00	19 62
Canada Coals and Rail Co.......	20,350 90	6,400 77	12.00	203 50
New Glasgow Iron Coal & Ry. Co	28,638 80	14,663 78	12.50	177 33

Canadian Companies

Ontario Iron and Steel Co. Ltd.—This company is seeking incorporation under Ontario statutes, to manufacture pig iron, refined iron, steel and manganese, and nickel steel or other alloy of steel by any process; and the casting and manufacturing of such products into ingots, billets, structural forms, rails, plates and bars, rolling stock castings and forgings, corrugated and galvanized plate; to manufacture wire and wire cables; to construct iron and steel ships and vessels, bridges and buildings; and to manufacture coke or any form of prepared fuel; to buy or sell all necessary materials and patent rights for any of the said manufactures, etc. Authorized capital $600,000, in shares of $100. Directors, Grant E. Hamilton, New York; G. W. Caulfield, Youngston, Ohio; and H. G. Hamilton, Youngston, Ohio. The chief place of business is to be at Kingston, Ont. The daily capacity of the blast furnace is to be 285,000 pounds of pig iron, that of the steel plant 80,000 pounds of steel blooms, that of the blooming or billet mill 80,000 pounds of steel billet, and that of the rolling mill 80,000 pounds of steel or iron bars. This amount of product is expected to require the labour of from 300 to 500 hands at the works. Kingston is to provide funds to the extent of $250,000, secured by a first mortgrge on plant and stock, and none of the money is to be paid until all the material is on the ground for the erection of the furnace, and then only one-fifth. Until its loan is repaid the municipality is to take all government bounties earned on pig iron, steel billets, and bars, which are expected to amount to $100,000 a year. A joint committee of the Kingston City Council and Board of Trade made a report in favor of the proposal, and recommended that the company be required to furnish information satisfactory to engineering and financial experts appointed by the city, a report which the City Council adopted.

Finch Mining Co., Ltd., has been registered under the British Columbia (foreign) Companies Act, with an authorized capital of $6,000, in shares of $50 each. Head office, Pittsburg, Pa.

Belmont Bessemer Ore Co.—The annual general meeting of shareholders was held at Toronto on 23rd instant.

Cariboo Hydraulic Mining Co. Ltd.—Advices from Cariboo, B.C., up to May 10th, state that the Cariboo Hydraulic Mining Co. has now everything in readiness to start hydraulic operations, working continuously with three shifts of men. Cold weather since the 4th instant had reduced the supply of water and caused some interruption in operations, but since the mail left the weather has been warmer and the supply of water should be ample.

B. C. Terra Cotta Company, Ltd.—Notice is given that by an order made by the Supreme Court of British Columbia, dated the 9th day of April, 1895, it was ordered that this company should be wound up, under the provisions of the "Winding Up Act," and by a further order of the said court, dated the 10th day of April, 1895, it was ordered that A. F. Barham be provisional liquidator of the affairs of the said company. A meeting of creditors will be held with a view to carrying on the works of the company.

Tilbury Peninsular Oil and Gas Company is seeking incorporation under Ontario Statutes to search for oil, natural gas, etc. The operations of the company are to be carried on in the counties of Kent and Essex, in Ontario, and the chief place of business is to be at the village of Tilbury Centre, in the county of Kent. Authorized capital, $20,000, in shares of $50.00. The directors are: W. C. Crawford, C. C. Kippen, F. M. Scarff, P. E. Gurd, and Nathaniel Mills, all of the village of Tilbury Centre, Ont.

Le Roi Mining and Smelting Company.—This company has ordered a new hoisting plant of a capacity of 100 tons, and the boilers will be 100 h.p. The present hoist was put in before the Le Roi had developed its large ore bodies and has become inadequate to the demands of the mine. The company has now more than 1,000 tons of ore on the dump, says the Spokane *Review*. Superintendent George Bent says the present ore accumulations, together with the ore shipped during the winter and spring, were taken out in development work on the 350-ft. level on the east and west drifts, one of which is in about 110 ft. and the other 120 ft. The company is also equipping its property with electric lights.

The Lillooet, Fraser River and Cariboo Gold Fields, Ltd.—The following report has been issued from the London office of this company: "The following cable has been received from Mr. Frank S. Barnard, M.P., chairman of the Lillooet, Fraser River and Cariboo Gold Fields, Ltd.:—'Hughes reports greatly impressed with what he terms marvellous gold deposit in gravel. Is sinking shafts and prospecting vigorously and pushing forward development.' The secretary adds: 'Mr. Hughes has been appointed the company's mining superintendent and he has been for years one of the most successful and experienced mining engineers known in California.'"

Northern Gold Company.—Pursuant to a judgment of the High Court of Justice, Common Pleas Division, made in a cause of Phillip St. Lawrence against the Northern Gold Company and others, the creditors of the Northern Gold Company are, on or before the 2nd day of July, 1895, to send by post, prepaid, to A. C. Boyce, Rat Portage, Ontario, solicitor for the plaintiff, their Christian and surnames, addresses and descriptions, the full particulars of their claims, the statement of their accounts, the nature of the security held by them, if any, together with an affidavit verifying the claim, or in default thereof they will be peremptorily excluded from the benefit of the said judgment.

General Phosphate Corporation. An adjourned public inquiry with reference to the promotion of this company and the conduct of its business was held last month before Mr. Registrar Hood, at Bankruptcy Buildings, Carey Street, Lincoln's Inn, London, Eng. The company was registered on June 13th, 1890, with a nominal capital of £1,000,000, and was formed for the purpose of acquiring and working phosphate properties, and engaging in undertakings connected therewith. Upon the last occasion Mr. Knud Sando stated that he had received commissions amounting to £16,000 from the vendors of properties purchased by the corporation. He asserted that the directors were aware of this fact, although they never inquired what sum he obtained, nor did he inform them of it.

Mr. Knud Sando was again called, and stated that in January, 1890, he entered into a contract or option for the purchase from Mr. Stewart of the "High Falls" group of phosphate properties. The purchase price was originally £54,000, but it was ultimately reduced to £40,000. Witness informed Mr. Stewart that if the price was reduced to £40,000 he would be prepared to submit the property to the board for their consideration. He learned that Mr. Stewart would be satisfied if he received £29,000, and it was subsequently agreed between them that witness should receive any amount paid to Mr. Stewart above the sum mentioned. The property being purchased for £40,000, witness was entitled to £11,000, which was satisfied by a mortgage. In connection with the "Ross Mountain group," witness received a letter from an agent promising him £5,000 if he was instrumental in selling the property. The corporation eventually purchased it for £55,000, and he received his commission on the sale. The sum of £1,000, which he paid to Mr Davidson, was in respect of private services rendered in Canada. He denied that he had promised any remuneration to an expert who had furnished reports upon the properties to the corporation.

Mr. H. Mallaby-Deeley, a director of the company, was next called, and in reply to the official receiver stated that the matter was introduced to his notice in December, 1880. Mr. Sando sent him a commission note promising him £1,000 and twenty founders' shares if he succeeded in obtaining three directors for the proposed phosphate trust. The original idea was to form a company to acquire certain phosphate properties at the price of about £600,000, but upon mentioning the matter to several gentlemen, witness found that he could not obtain directors of sufficient standing and importance to carry out a scheme of such magnitude, owing to the fact that they would be bound to purchase certain properties. He informed Sando of this, and the scheme was ultimately altered so as to leave the directors entirely unfettered in their selection of properties. The commission note referred to was then destroyed by witness. Questioned as to what took place with reference to the qualification of the directors, witness said that Sir James Whitehead asked him whether Sando was giving him anything for the work he was doing. Witness said that he had no arrangements with regard to the corporation, but that Sando had agreed to qualify him as a director, and that he had agreed to qualify any director whom witness obtained. Sir James Whitehead expressed his disapproval of this course, and mentioned the matter at the next board meeting, when Sando was called into the room and informed that if he offered to qualify any of the directors they would not accept his offer. After the formation of the corporation Sando gave him twenty founders' shares for services which he had rendered in connection with a colonization company which Sando was about to form in British Columbia. Witness had obtained introductions to members of parliament who could assist in the scheme, and received the shares as remuneration on that account. Sando subsequently offered to purchase the shares from him for £1,000, but, as a matter of fact, the witness had only received £550.

Mr. H. Mallaby Deeley was again examined by the Official Receiver. He stated that on August 15, 1890, the board considered the purchase of properties, and a committee, consisting of Sir G. Baden-Powell and witness, was appointed to negotiate with Mr. Stewart for the purchase of the "High Falls" group, situated in the townships of Portland West and Bowman, in the Province of Quebec, at a price not exceeding £40,000. It was subsequently agreed that the property should be purchased for that sum. In the agreement for purchase it was directed that "Mr. Attwood, or some other person to be approved by the vendor," should report upon the property. The directors discussed the question of appointing an expert, and decided that they could not do better than appoint Mr. Attwood. He denied that it was part of the bargain that this expert should be appointed. The directors obtained the services of those experts upon whose opinions they considered they could rely. In 1891 the Company entered into a fresh speculation, known as the "North Star" scheme. The matter was introduced to the board by Mr. H. S. Foster, M. P., and the scheme had for its object the acquisition of the North Star and Washington mines, situate near the High Falls property, with a lease of certain phosphate mills in the neighborhood. It appeared that Mr. Lamson Wills had made a report upon the property, from which it seemed that the productive power of the North Star mine had greatly fallen off. In April, 1891, the heads of an agreement were signed under which the Company and the London and Colonial Finance Corporation, Limited, were to combine in order to carry out the scheme. The directors of the two companies were not satisfied with the report referred to, and Mr. Attwood was appointed to inspect the property. His report was satisfactory, and the Board considered that they were justified in entering upon the transaction. Witness was present when 117 founders' shares were allotted Mr. Sando.

The Official Receiver: I think you will agree that Mr. Sando was taking upon himself a very heavy responsibility under this allotment?

Witness said that Mr. Sando was to be relieved as applications for founders' shares were received. He was ultimately relieved of fifty nine shares.

The Official Receiver: That leaves a responsibility for £29,000.

Witness said that would be so if all the calls upon the shares were made. The directors were not aware at the time that Mr. Sando was almost without means, but on the contrary, they knew that he had paid the registration fees, although witness did not know that the money had been borrowed for that purpose. The directors had no knowledge as to Mr Sando's means, and made no inquiry upon the subject. Towards the end of 1890 the Company was in very low water so far as finances were concerned. A circular was issued in December of that year inviting further subscriptions for shares. The appeal failed, and no further attempt was made to obtain money by means of shares. The directors then turned to other quarters, and began seriously to think about a debenture issue. Eventually a debenture issue was arranged for £100,000, at 6 per cent. interest, and a commission of 15 per cent.

The Official Receiver: How much did the Company receive out of the £100,000?

Witness said that £5,400 in cash was received, and there was a right to call for a further £14,000, and the mortgages on the properties were paid off. The Company was in need of money, and it was necessary to pay off the mortgages before money could be raised.

The Official Receiver: I put it to you that if you had not spent £95,000 in the purchase of properties, with a paid-up capital of £45,000 only, you need not have raised this money?

Witness said that he could not accept this view of the matter. If the shares had been fully paid up, there would have been sufficient to carry on the mines without raising money on debentures.

Mr. Butcher next examined the witness, who stated that he was aware that Mr. Sando had entered into "options" with the original vendors of properties. He did not call the commissions which Mr. Sando was receiving "secret profits."

Mr. Butcher. Are you aware that promoters are not allowed by law to obtain secret profits out of a company?

Witness. I thought that a promoter could get as much as he possibly could out of a company. (Laughter.)

Mr. Butcher. I am afraid that it is a principle they sometimes act upon. (Laughter.)

Examined by Mr. Cock, Q. C., the witness stated that Sir James Whitehead resigned his seat on the board before any agreement had been entered into for the purchase of properties, and previously to the capital of the Company being dealt with in any way. At the time the directors allotted the founders' shares to Mr. Sando they did not intend to call up more than £2 per share. The directors fully believed that he would be in a position to provide the money for the shares. Sir James Whitehead resigned his position on the board on account of ill-health.

By Mr. Ridley: The properties purchased by the board were chosen out of a great number submitted to them, and he was not aware of any further precautions that could have been taken by the board to satisfy themselves as to the value of the properties.

The inquiry terminated shortly afterwards.

Guelph Norway Iron and Steel Company is applying for Ontario charter to manufacture iron and steel from ores and from scrap iron and steel, and to manufacture iron and steel into any products of iron and steel, etc. Head office: Guelph, Ont. Authorized capital, $80,000, in shares of $100.00. Directors: James Watt Christian Kloepfer, Frank Dowler, A. R. Woodyat, and J. E. McElderry.

North American Graphite and Mining Co., Ltd.—This company is reported to have acquired the Dickson graphite property in the Buckingham district and work is to proceed forthwith. Mr. H. P. H. Brumell, for a number of years assistant in the mining division of the Geological Survey of Canada, has resigned and will assume the management of the company's operations.

Kootenay Gold, Silver and Copper Mining Company, Ltd.—Registered at Victoria, B.C., 22nd April, 1895. Authorized capital, $100,000, in shares of $25.00 each. Directors: Charles J. Mitchell, Thos. R. Morrow, and George D. Scott. Head office. Vancouver, B.C. Mining to be carried on in the Kootenay district, Province of British Columbia.

Kootenai Hydraulic Mining Co., Ltd., is applying for charter of incorporation to acquire and operate mineral claims in the Pend d'Orielle River district, British Columbia. Head office: Rochester, N.Y. Authorized capital, $500,000.

Vancouver Gold and Silver Exploration and Concessions Company, Ltd. —Authorized capital, $500,000, in shares of $100. Directors: Johann Wulffshorn, R. G. Tatlow, A. Williams, Chas. Stinson, Robert Hamilton, J. W. Campion. Head office: Vancouver, B.C. Formed to operate in British Columbia.

Horsefly Hydraulic Mining Co. Ltd.—At the works of the company on the Horsefly River, Cariboo, B.C., the most interesting event since our last report has been the successful blasting operations which have been carried out to loosen up the cement gravel deposits. On the 1st ult., a blast was fired in the bank at the new pit, 160 kegs of powder being used. The ground was well broken up for a distance of 80 feet, and the result was all that could be wished. On the 8th ult., the larger blast was fired in the old bank. A drift had been run in the bank, at a depth of between 200 and 300 feet from the top of the bank, to a distance of 1,800 feet, where drifts were made right and left in the shape of a T. In this the enormous quantity of 40,000 pounds of powder had been placed for the blast. This was fired by electricity and the operation was completely successful. The surface of the immense mass was raised about 6 feet and then fell back into its former position and nothing was disturbed. So nicely had the calculation been made as to the requisite strength of the blast that not a stone flew 100 feet away. Hydraulic operations on the gravel will be greatly facilitated by the loosening up of the bank by this blast. The water was to be turned on on the 11th ult., and by this time it is probable that work is being carried on in full force. It is expected that the first clean up for this season at both the Cariboo and Horsefly claims will take place before the end of June and it is anticipated that the results will be very satisfactory to the shareholders. Should the water supply continue to be sufficient for full operations, the season's work on these two properties should give such returns as will show the immense possibilities for successful hydraulic mining that are still to be found in the Cariboo district.

Ottawa Hydraulic Mining and Milling Co. Ltd., applies for B.C. charter to acquire by purchase the lease of the ground situate at Boston Bar, on the east side of the Fraser River, containing 64 acres, more or less, which said lease was made by Mr. G. C. Tunstall, Gold Commissioner, to Edmund Alexander Watson on the 5th day of June, 1893, for the sum of one thousand dollars in cash, and for the purpose of acquiring by purchase or otherwise of any mines or mining property in British Columbia, whether alluvial or mineral, and for the purpose of working any such mines or claims in the most approved and workmanlike manner, and for the purpose of erecting quartz-mills and smelters and saw mills, and any other known appliance for the purpose of working any mines or ores obtained therefrom, and for the purpose of acquiring water and water-rights for the purpose of working any claims or property that may be acquired by the company. Authorized capital, $250,000, in shares of $5. Directors, Lt.-Col. Joshua Wright, North Bend, Yale District, B.C.; Capt. M. N. Garland, North Bend, B.C.; F. W. Va.' au, North Bend. Mines office, North Bend, Yale District, B.C.

Danville Slate and Asbestos Co. Ltd.—This company has purchased the Jeffrey Asbestos Mine at Danville, Que., at a price, so it is reported, of $150,000.

Dominion Coal Co. Ltd.—In his report to the Local Government, Dr. Martin Murphy, Provincial Engineer, has the following to say of this company's railway from Bridgeport to Louisburg. "The road has been constructed, so far, in a more permanent and serviceable manner than the contract calls for. The gradients and curvature have been reduced at considerable expense, so as to lessen the cost of transport. The cuttings are taken out to a width of 22 feet at formation level; the embankments are 16 feet wide. The permanent way is much heavier; rails are 80 lbs. per lineal yard, the contract being for rails 56 lbs. per yard. Servis tie plates of steel, weighing with fastenings, 100 lbs., connect the joints. The drainage a very important feature, is well provided for, by sideor 'off-take' ditches thus diverting the surface water from the slopes of cuttings and embankments and conveying it to the streams passing through the culverts and bridge openings. The culverts and bridge superstructure, speaking generally, are of a superior class of masonry. The bridge and trestle superstructure are of steel and are in strength and construction, built according to the progress of the time, heavier and stronger than the class of such work generally erected to carry lighter rolling stock. They are built according to the requirements of the Federal Government specifications. The class and character of the work throughout the ten miles now opened for traffic, is superior to any I have inspected in this country. The station building a Bridgeport and the station house, engine house, repair shop and freight shed, at Glace Bay are built on concrete foundation walls and are unusually large and commodious."

Nova Scotia Steel Co., Ltd.—Respecting the construction of this company's railway, Dr. Murphy, in his annual report, says:—"Eureka to Sunny Brae, 12½ miles, leaves the Pictou Branch of the Intercolonial Railway at Ferrona Junction, crosses the west branch of the East River to Ferrona, where the smelting works of the company are located, and runs up the valley of the East Branch to Sunny Brae. The first 10½ miles was opened for traffic to the public on the 1st of July, 1892, and the remainder is in operation since November following. The company applied for payment of subsidy according to the contract with the Provincial Government—(see Appendix 17, p. 15, Journals of the House of Assembly, 1891), the conditions being:—

(*a*.) "They shall have completed, equipped and put in operation the said line of railway."

(*b*.) "They shall have paid, or cause to be paid, the wages due to the workmen employed, and all charges for materials supplied for the construction of the said railway."

(*c*.) "They shall have constructed, completed and put in operation at some place within the County of Pictou, a blast furnace for the smelting of iron ores."

(*d*.) "They shall have established to the satisfaction of the Governor-in-Council, that they have *bona fide* expended in cash in the construction of said railway and blast furnace a sum of $400,000."

All these conditions the company have fulfilled, and have carried them into effect before the time stipulated for completion, viz., the 31st day of December, 1892, and further they have constructed the line of railway in accordance with the specification and all other conditions of contract.

After receiving formal instructions to examine the contract, to inspect the works, and to report accordingly, I made an inspection of the line on the 22nd May, 1893, reported the work satisfactory, but not quite finished, and recommended a payment of thirty-five thousand dollars on account. The subvention account stands thus:—

Twelve and a-half miles of railway, at $3,200 per mile....	$40,000
Payment recommended on account........................	35,000
Balance of subsidy remaining due on September 30th, 1893.	$5,000

The foregoing conditions have been complied with, the railway has been completed and the balance of subsidy paid on a certificate to that effect given on the 16th day of December, 1893."

The Mica Market.

During the past two months the demand for amber mica has quietly increased, and prices for large lots have advanced, owing to increased cost of mining. The principal demand has been for thumb-trimmed and rough-split, while some lots of trimmed have been sold. One dealer to keep up the supply of trimmed has been culling dumps of several Templeton mines and trimming all that would cut 1 x 3 inches. Three mines are at present in operation, the output of two being steady, the work being on veins, while in one the mica is in pockets with an inclination to phosphate shortly. All the mica mined finds a ready sale, principally to the United States, the consumption in Canada being small but increasing. Several sample lots have been sent to England, reports on which are favorable. There is a strong hope that the demand from England is on the increase.

The Care of Mine Pumps.

By J. Clarence Stine, Osceola Mills, Pa.

Acidulated mine water is probably as great a source of trouble and expense at mines drained by steam pumps as any other natural feature of a mine.

The best way to counteract its destructive effects on pumps is to use gun metal or some other similar composition for the water ends of the pumps. Owing to its first cost, gun metal is not often used, and besides there are some waters so acidulated as to attack it and similar compositions nearly as savagely as they do good hard iron. The writer has seen gun metal rendered soft and spongy in less than a month's time, has known one inch iron bolts to be eaten to the thickness of a lead pencil in three days, and has seen 3 inch iron pipe eaten so thin that a full length of it could easily be carried in one hand.

I was recently shown the water end of a pump, which owing to a sudden change in the water from "sweet" to bad, had been utterly ruined in less than a month's time. Every mine superintendent should keep on hand duplicate parts, liable to wear or corrosion of all pumps, as a breakdown of a few hours duration may, at times, cause irreparable damage. Aside from the parts subjected to wear by friction, the piece in double acting pumps likely to wear out first is the wall or partition between the bottom valves. This is caused by the water being discharged, from the valves nearest to it, against both sides, and, as the valves are usually located nearer the partition than the outside shell, the current must strike it with considerable force. Aside from this, it is attacked on both sides, and must, therefore wear twice as fast as the shell. When this wall is eaten through, the pump will do no work, as the water is forced from one side of the plunger to the other side. A method sometimes used in repairing this, is to melt and run sufficient Babbitt metal, or similar composition, into and around the wall to close the part eaten. This is only a makeshift at best, and a poor one. When hot the Babbitt metal lies close to the wall, and when cold it shrinks from it, allowing space enough for small quantities of water to pass through. This water gradually enlarges the passage way, and in a short time the pump is in a worse condition than before.

A method by which I have repaired several pumps, and which is original, as far as I know, is as follows: Drill down the top and bottom of the partition its full length. Then with a chisel chip out the entire partition, and chip both sides until sufficient breadth is obtained for a good joint. When the pump is a solid casting allow about a quarter of an inch taper so as to more easily fit the new partition. Then with a cape chisel about ⅜ of an inch wide cut a groove in each side of the same depth. These grooves should be carefully filed, and be made as nearly parallel with each other as possible. The success of the entire job depends on the fitting. Next is the new partition, which should be made of gun metal or a similar composition. Make a pattern, allowing enough for filling and shrinkage. (Brass shrinks about ⅛ of an inch in ten.) After the piece is cast it should be fitted into the grooves so as to make a perfect joint on all sides. Unless this is done the work will be a failure. When finished the bearing parts should be given a good coating of white lead and oil, and the piece be driven tightly into its place. If all the directions are carefully carried out, the new piece will outwear any other part of the pump. Of course it is better to get the casting at a foundry, but if there is no foundry handy the whole job can be done at the mine by any person having some knowledge of machinery. In this case it is better to make the casting first. The metal can be melted in an ordinary graphite crucible in the blacksmith's fire. With the exception of the casting, the work requires only such tools as are to be found at every well managed mine. All the tools necessary are a ratchet, chisels, hammer, drill and a few files. I have been called on to repair pumps in this manner several times and have never failed, and all pumps so repaired are at work, and, as far as can be seen, they are as good as new. One of them, a Cameron pump, has been running about two years, and to all appearances is good for many more. Another, a Blake pump, had been "doctored" in every conceivable way, but without success. After repairing it, as above described, it has run for several months and is giving excellent satisfaction. The bore of the cylinders of the pumps repaired, was, as nearly as I can remember, from 8 to 12 inches.—*Colliery Engineer.*

Rope Driving.—One of the most eminent engineers Mr. Nasmyth, favors the driving of machinery with cotton ropes in place of leather bands. As a result of many years' experience and close observation, he states that for heavy main drives it is both more economical and effective to use a series of ropes working in separate grooves, and in regard to the objection made to this system—that of the ropes extending unevenly and becoming variable in size, causing a portion of them to be more deeply in the grooves than others—he states that ropes are now made with such nicety and are fitted into grooves with such exactness, that little trouble from this source is experienced. In giving his reasons for thus favoring cotton as the material of which the ropes should be made, Mr. Nasmyth argues that strength alone should not be considered, but flexibility and elasticity, which properties pertain to ropes of cotton more than to those of any other material yet employed.

CANADIAN MINING INSTITUTE.

A MEETING of Delegates from the various Canadian Mining Organizations will be held in the Chateau Frontenac, Quebec, on Friday evening, 28th June at eight o'clock, for the purpose of making arrangements for carrying on the work of the Institute during the ensuing year.

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President General Mining Association of Quebec.

R. H. BROWN,
President Mining Society of Nova Scotia.

JAS. CONMEE,
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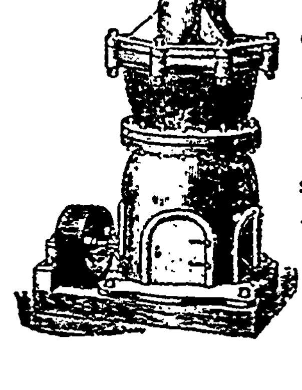

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IN THE CHATEAU FRONTENAC, QUEBEC,

Thursday and Friday, June 27th and 28th, 1895.

Under the Auspices of the General Mining Association of the Province of Quebec, there will be held a United Meeting of

The Mining Society of Nova Scotia, The Asbestos Club, The Ontario Mining Institute, and The General Mining Association of Quebec.

Meetings—Thursday Evening at 8 o'clock.

BUSINESS SESSION OF INDIVIDUAL SOCIETIES AT EIGHT O'CLOCK.

OPEN SESSION AT 8.30.

The Hon. E. J. Flynn, Commissioner of Crown Lands, in the Chair.

THE DEVELOPMENT OF OUR PHOSPHATE AND FERTILIZER INDUSTRIES. WHY THEY SHOULD BE ENCOURAGED.

(a) Phosphoric Acid in Agriculture.
By FRANK T. SHUTT, Chief Chemist, Dominion Experimental Farm, Ottawa.

(b) Canada—A Natural Manufacturing Centre for Fertilizers.
By MR. HENRY WIGGLESWORTH, New York.

(c) Phosphate's Future.
By CAPT. ROBT. C. ADAMS, Montreal.

RECENT IMPROVEMENTS IN, AND THE APPLICATION OF ELECTRICAL MACHINERY TO MINING (Illustrated).
By MR. W. F. DEAN, Montreal.

Excursions—Friday, June 28th.

On Friday morning, leaving the Chateau Frontenac at 10.30 a.m., there will be an excursion by Caleche to the principal points of interest in and around historic Quebec.

In the afternoon, at three o'clock, the members and their friends are invited by Messrs. Carrier, Laine & Co., of Levis, to an excursion by special steamer, visiting the Chaudiere Falls, the Falls of Montmorenci, the Dry Dock, and the large engineering works of their firm.

Any business or papers left over from the meetings on Thursday will be finished at an evening session in Chateau Frontenac at eight o'clock.

Saturday Morning—Excursion to Lake St. John and the Saguenay.

It is proposed, provided a sufficient number of members and their friends are available, to have an excursion to Lake St. John and the far famed Saguenay, leaving via Quebec and Lake St. John Railway, St. Andrew Street Depot, on Saturday 29th June, at 8.30 a.m. There is first-class hotel accommodation at Roberval, delightful scenery and famous fishing. Sunday and Monday (Dominion Day) will be spent here, and on Tuesday the boat will be taken at Chicoutimi for the excursion down the Saguenay, arriving at Quebec the same evening.

Clubs.

By courtesy of the President and Members, members of the visiting associations have been extended the priviliges of the Union and Garrison Clubs during their stay in Quebec.

Hotels.

By special arrangement reduced rates for members have been secured as follows:

Chateau Frontenac	$3 50
Florence House	2 00
Hotel Victoria	2 00

Transportation—Railways and Steamers.

INTERCOLONIAL RAILWAY OF CANADA—Members from Halifax and points on this line will, it is hoped, be carried to Levis and return for a single fare.

QUEBEC CENTRAL RAILWAY—Members from Sherbrooke and points on this line will be carried to Levis and return for a single fare on presentation of official Circular.

CANADIAN PACIFIC, GRAND TRUNK AND CANADA ATLANTIC RAILWAYS By special arrangement, members and their friends will be carried the round trip over these lines at a greatly reduced rate on obtaining Convention Certificate from Ticket Agent and on same being signed at Quebec by the Secretary. DO NOT FAIL TO ASK FOR IT AND ONLY BUY A SINGLE TICKET.

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From Chicoutimi to Quebec	2 75	

A cordial invitation to be present is extended to all interested in the mineral development of the Dominion.

JOHN BLUE, President.

B. T. A. BELL, Secretary.

NOW READY.

THE CANADIAN

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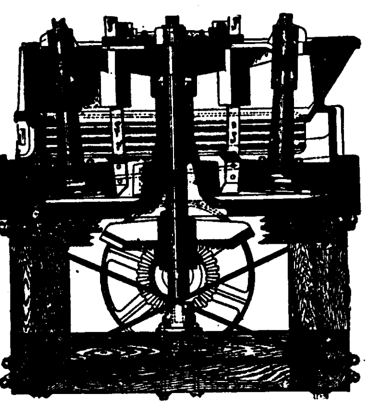

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3. *A COURSE OF EIGHT WEEKS, (January and February), for Prospectors, Mine Foremen and others interested in Mines and Minerals.*

Lecturers are sent to any mining centre where a sufficient number of students is guaranteed, to conduct SHORT COURSES in Blowpipe Analysis, Chemistry, Mineralogy, Geology, Prospecting and Mining.

The different courses are made thoroughly practical by work in the well-equipped Chemical, Assay, Mineralogical and Petrographical Laboratories. A Mining Laboratory furnished with Mills, Separators, Concentrators, etc., is in course of construction. It will be open for work in Session 1894-5. Surveying is practised in the field during the warmer months of the Session.

FOR CALENDAR OF THE SCHOOL AND FURTHER INFORMATION APPLY TO

WM. MASON, Bursar,

SCHOOL OF MINING, - KINGSTON, ONTARIO.

PROVINCE OF NOVA SCOTIA.

Leases for Mines of Gold, Silver, Coal, Iron, Copper, Lead, Tin

—AND—

PRECIOUS STONES.

TITLES GIVEN DIRECT FROM THE CROWN, ROYALTIES AND RENTALS MODERATE.

GOLD AND SILVER.

Under the provisions of chap. 1, Acts of 1892, of Mines and Minerals, Licenses are issued for prospecting Gold and Silver for a term of twelve months. Mines of Gold and Silver are laid off in areas of 150 by 250 feet, any number of which up to one hundred can be included in one License, provided that the length of the block does not exceed twice its width. The cost is 50 cents per area. Leases of any number of areas are granted for a term of 40 years at $2.00 per area. These leases are forfeitable if not worked, but advantage can be taken of a recent Act by which on payment of 50 cents annually for each area contained in the lease it becomes non-forfeitable if the labor be not performed.

Licenses are issued to owners of quartz crushing mills who are required to pay Royalty on all the Gold they extract at the rate of two per cent. on smelted Gold valued at $19 an ounce, and on smelted gold valued at $18 an ounce.

Applications for Licenses or Leases are receivable at the office of the Commissioner of Public Works and Mines each week day from 10 a.m. to 4 p.m., except Saturday, when the hours are from 10 to 1. Licenses are issued in the order of application according to priority. If a person discovers Gold in any part of the Province, he may stake out the boundaries of the areas he desires to obtain, and this gives him one week and twenty-four hours for every 15 miles from Halifax in which to make application at the Department for his ground.

MINES OTHER THAN GOLD AND SILVER.

Licenses to search for eighteen months are issued, at a cost of thirty dollars, for minerals other than Gold and Silver, out of which areas can be selected for mining under lease. These leases are for four renewable terms of twenty years each. The cost for the first year is fifty dollars, and an annual rental of thirty dollars secures each lease from liability to forfeiture for non-working.

All rentals are refunded if afterwards the areas are worked and pay royalties. All titles, transfers, etc., of minerals are registered by the Mines Department for a nominal fee, and provision is made for lessees and licensees whereby they can acquire promptly either by arrangement with the owner or by arbitration all land required for their mining works.

The Government as a security for the payment of royalties, makes the royalties first lien on the plant and fixtures of the mine.

The unusually generous conditions under which the Government of Nova Scotia grants its minerals have introduced many outside capitalists, who have always stated that the Mining laws of the Province were the best they had had experience of.

The royalties on the remaining minerals are: Copper, four cents on every unit; Lead, two cents upon every unit; Iron, five cents on every ton; Tin and Precious Stones; five per cent.; Coal, 10 cents on every ton sold.

The Gold district of the Province extends along its entire Atlantic coast, and varies in width from 10 to 40 miles, and embraces an area of over three thousand miles, and is traversed by good roads and accessible at all points by water. Coal is known in the Counties of Cumberland, Colchester, Pictou and Antigonish, and at numerous points in the Island of Cape Breton. The ores of Iron, Copper, etc., are met at numerous points, and are being rapidly secured by miners and investors.

Copies of the Mining Law and any information can be had on application to

THE HON. C. E. CHURCH,

Commissioner Public Works and Mines,

HALIFAX. NOVA SCOTIA.

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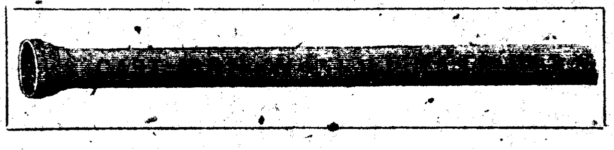

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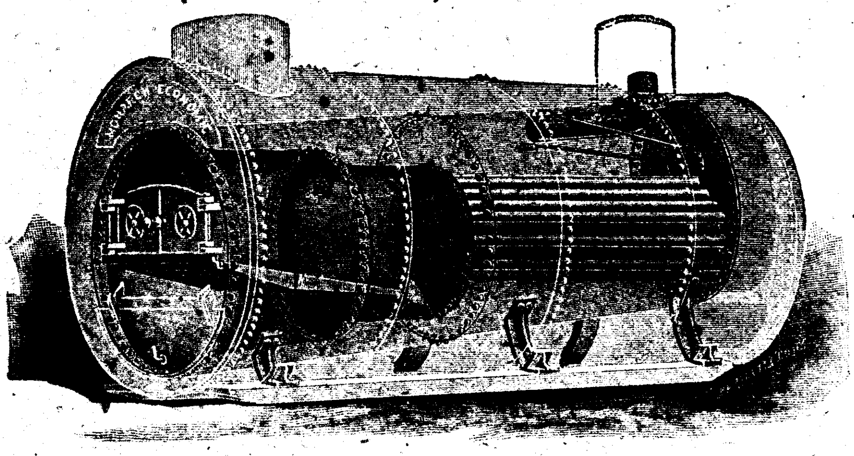

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