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Ontario as a Mining Country.

By Dr. A. P. Coleman, Toronto.

How many hundreds of years have passed since the first mine was sunk in Ontario history does not record, for those mysterious ancient miners, mound builders or whoever they may have been, who dug their trenches and mined the native copper of Mamainse with tools of wood and stone, have left no traces either in history or tradition. The first recorded mining operations in the province were also for copper, and in the same region, and date back to 1770, a century and a quarter ago; so that Ontario is not so young a mining country as one is apt to think.

So far as I can discover, it was thirty years after this date before the next mining venture was inaugurated; this time at the opposite end of the province, and for iron. The Bureau of Mines' report for 1892 states that iron was smelted at the falls of Gananoque river about 1800.

Next followed the mining of bog iron ore in Charlotteville township, near Lake Erie, in 1823, the ore being smelted at Normandale in a romantic valley close to the lake. Some years later iron was mined and smelted near Madoc and in Essex county. With the exception of iron mining at one or two other points, no further attempts were made, so far as I am aware, to develop our mineral resources until the Bruce copper mines on Lake Huron began to attract attention about fifty years ago. Since then many mines have been opened and almost as many abandoned.

Gold, silver, copper, nickel, cobalt, iron and lead, among the metals have been obtained by mining at one time or another in our province; as well as a number of non-metallic substances, such as apatite, barite, graphite, gypsum and mica, not to mention liquids and gases obtained by boring, such as brine, petroleum and natural gas.

It must be admitted that several of these products have been mined on only a very small scale. All the cobalt obtained from the Sudbury nickel mines would amount probably to less than fifty tons; but, of course, this metal is a rare one in all parts of the world. The amount of lead mined and smelted in the province would probably amount to only a very few hundred tons if we had the full statistics.

At present I believe the metals mined in Ontario are gold, copper, nickel and cobalt: the last three in the neighborhood of Sudbury only. Of the non-metallic minerals, mica and gypsum among the solids, brine and petroleum among the liquids, and natural gas, which I believe has been declared in an American law court to be a mineral, exhaust the list of substances.

Our mines of silver, of copper, except as a by-product of nickel ores, of iron and of phosphate, are in a state of suspended animation, if not entirely dead.

The list is not a cheerful one for a patriotic son of Ontario to contemplate, yet it may be useful to consider why mining matters have gone as they have, and also to enquire into the prospects for the future.

Let us take up the chief products of our mines one by one, beginning with the non-metals and ending with the metals.

Apatite or Phosphate.

Apatite mining was attempted in 1870 or 1871, but apparently the first shipments of phosphate from Ontario took place seven years later. Most of our apatite was shipped *via* Montreal, a smaller portion going directly to the States, and on this account the statistics given by the Geological Survey reports greatly under estimate the production of Ontario, all that went to England or Germany being included in the statistics for Quebec.

In 1891 they report only 1,551 tons from this province, while the first report of the Bureau of Mines for Ontario places it in the same year at 4,900 tons, worth $50,800. The prosperity of the phosphate mines ended in that year, however, falling to half the amount in 1892, and to only twenty tons in 1893; and since that time there has been no mining of importance, the cheaply mined Carolina and Florida phosphates, though of lower grade, having crowded ours from the market.

Until the best of these southern deposits, which can sometimes be mined with dredges or steam shovels, are exhausted, we cannot expect any important revival of phosphate mining in Ontario; though our mines should find some demand from local manufacturers of fertilizers, as our intelligent farmers begin to make more use of phosphates.

Barite.

Barite has been worked at only one mine in Ontario, McKellar Island in Lake Superior, where the body of mineral is described in the Geological Survey reports as sixty feet wide, and perhaps the largest on the continent. In 1890 the product is stated to have been 1,842 tons, valued at $7,543; but no further reports have been made, so that mining operations appear to have ceased.

Graphite.

When graphite was first mined in Ontario I have been unable to discover, but in 1877 we shipped 429 tons of plumbago, having a value of $1,553; and in the following year about twice as much. Since then the amount has greatly diminished, though late explorations with the diamond drill show important deposits that should be worked at a profit. All the mining has been done in the Laurentian of the Ottawa Valley, near the Kingston and Pembroke railway.

Gypsum.

Most of the gypsum of Ontario comes from the vicinity of Paris on the Grand river, Paris, Ontario, being in this respect at least like the greater Paris in France whose gypsum mines have provided "plaster of Paris" for many years. The amount mined in Ontario seems to vary greatly, 8,560 tons, valued at $11,715, being reported in 1887; but since then the amount has greatly diminished, so far as one can judge from the reports. In 1894 3,253 tons were mined, the value being $9,760.

Mica.

This mineral is mined in the Laurentian region of the Ottawa Valley, the deposits being very irregular and the output equally so. Mica mining in our province is first mentioned in the Geological Survey report for 1870-71, but no useful statistics can be obtained until 1891, when the Bureau of Mines began its work, since the output of Ontario is lumped together with that of Quebec.

In 1891 it is reported that 240 tons of mica, worth $31,200, were mined. In the following year only seven tons; in 1893 seventy tons, but for 1894 none at all. The new use of mica as non-conducting packing for steam pipes should furnish an outlet for much material that formerly went to waste in cutting dimension mica, and thus help out this industry.

PETROLEUM.

All the petroleum produced in Canada comes from the Petrolia region in Ontario, where the industry seems well established and the value of its products steadily increasing. The first important production of petroleum was about 1861, when a few thousand barrels were obtained from wells at Enniskillen ; but it is difficult to follow the rise of the industry statistically, since in the earlier years no distinction is made between the oil refined from American and Canadian crude petroleum. Apparently not more than 500,000 bbls. were obtained in any year up to 1887 ; but since then the amount has gradually increased, until in 1894, nearly 1,000,000 bbls. are reported, affording products valued at $2,146,937.

NATURAL GAS.

The closely related fuel, natural gas, though long known to occur in the province, has not been put to use until quite recently. In 1892, gas to the value of $160,000 is reported. In 1893, 2,342,000 cubic feet, valued at $238,200 ; and in 1894, 1,653,500 valued at $204,179. There are over one hundred wells producing in the Welland and Essex fields, but most of the gas is piped across the border to Buffalo and Detroit.

SALT.

Salt was first discovered in Ontario, when boring for oil at Goderich in 1865; and it has since been found at various points in southwestern Ontario, from Goderich to Essex Co., where it has been obtained within the last few months. Practically, all the salt produced in Canada comes from our province. The amount running from 30,000 to 60,000 tons, and the value from $100,000 to $230,000.

No salt is mined in the province, all being made from brine pumped from wells and evaporated; but the amount is unlimited ; beds of rock salt from six to one hundred feet thick having been proved to exist under hundreds if not thousands of square miles of territory.

It is to be hoped that the attempts now being made on a small scale to develop the chemical industries dependent on salt as a raw material may be successful. If we produced our own soda, soap, hydrochloric acid and bleaching powder, we should materially increase our home manufactures and add to the demand for Ontario salt.

THE METALS.

Turning now to the metals, we need not refer specially to lead, which has been worked in an experimental way only at a few points in the Ottawa valley; some thousand of tons of ore having been produced in all, but very little of it smelted or marketed.

IRON.

Iron is of much more importance. Ontario possesses deposits of all the chief ores of iron. The upper Laurentian of the Ottawa valley contains, especially near outcrops of crystalline limestone, many ore bodies, some of considerable dimensions, most of them magnetite but some hematite. Southern Ontario has more or less extensive areas of bog ore, and Western Ontario can boast of immense beds of magnetic ore in the Atikokan and Greenwater lake regions; and of still greater beds of hematite along the Mattawin river; while low grade siderite or carbonate of iron, has been found to the east of Port Arthur.

In the early days of the province iron ore was not only mined but also smelted in furnaces of small and antiquated forms, but producing charcoal iron of excellent quality. A good account of those primitive operations may be found in the report of the Bureau of Mines for 1892, where we find that magnetite was used in the Marmora region and bog ore on Lake Erie. Some novelties were tried, such as the use of wood for smelting in a furnace at Madoc. The iron was usually cast into stoves, potash kettles, etc., and found a ready sale in the province.

No iron has been smelted, I believe, since 1844 or 1845; though similar charcoal furnaces are working, apparently with good success, under quite similar conditions in the Province of Quebec.

These old furnaces were of course immensely protected by the difficulty of transporting such a cheap and heavy metal before railways were available. Probably only a few hundred tons of iron were produced in all, since the furnaces were of very small capacity.

Since those days a considerable amount of magnetite and also some hematite has been mined at various points in Hastings and counties to the east.

Between 1859 and 1873 Ontario and Quebec together shipped 207,000 tons of ore to the United States, much the larger proportion being from Ontario. From 1873 to 1891 there were shipped 423,700 tons; and, in all, Ontario seems to have exported more than 600,000 tons; but since 1891 no work of importance has been done in our mines, the rich and cheaply worked deposits of Minnesota and the imposition of duties in the United States having driven our ores from the market.

The main obstacle in the development of our iron mining industry has been the lack of mineral fuel for smelting; and it will be of much interest to see how the experiment at Hamilton of smelting Ontario ores with American coke will turn out.

It is probable that before long Ontario iron mining will again be of importance, especially in the region west of Port Arthur, where inexhaustible beds of hematite and magnetite form the Canadian extension of the wonderful Minnesota iron region, which now leads the world in production.

There seems no good reason, except lack of capital and enterprise, why some point on the upper lakes, where ores, flux and fuel can be brought together cheaply by water, should not become a Canadian Cleveland with a great iron industry; and we may not unreasonably hope to see this in the future.

Copper.

The copper mining of Ontario is naturally divided into two periods, an earlier one when the Lake Huron mines were operated, and the present when copper is obtained from the Sudbury ores as nickel-copper matte. The product of the Bruce, Wellington, and other Lake Huron mines, between 1846, when they commenced, and 1876, when they ceased work, is valued in the Report on the Mineral Resources of Ontario at $3,300,000. In 1886 we find copper once more quoted in our statistics, 164,000 lbs. having been produced; in 1892 there were 1,936 tons; in 1893, 1,431 tons. This copper is in reality only a by-product of the ore worked for nickel. There is some chance that the Mamainse deposits, which are really an extension of the famous Michigan region, may be worked before long, but the immediate prospects of copper mining as distinguished from nickel mining are not very bright, the low price of the metal discouraging fresh ventures.

NICKEL.

Ores of nickel were observed many years ago in connection with the copper ores of Lake Huron, but no deposits of value were found until the C. P. R. penetrated the wilds north of that lake in 1882, disclosing the great masses of copper pyrites and magnetic pyrites in what is now the Murray mine, near Sudbury. Before long these ores, first valued for their copper, were found to contain the more valuable metal. Nickel is first mentioned in our statistics in 1889, but the amount produced is not given, since the Canadian Copper Co., the only producer, refused to make its returns public. In 1890, 718 tons of the metal are reported; in 1891, 2,303; in 1892, 2,082; in 1893, 1,642; and in 1894, 2,570½ tons.

We have only one important rival as a producer of this metal, the French island of New Caledonia in the Southern Pacific, which provides an output about one-third greater than ours. The New Caledonia ores are of a totally different character from ours, consisting of garnierite, a green magnesian silicate; while ours are sulphides, chiefly pyrrhotite and pentlandite. There seems no doubt that our ore exists in unlimited quantities, and the only question to be considered is the amount of the metal which the world can consume. At present the supply seems to equal the demand, and, since the initial plant is costly, there is no object in new companies going into the mining of nickel. The price has been steadily falling, and, as satisfactory methods of refining it are perfected, this splendid new metal must take a more important place in the world. The use of nickel steel comes slowly into favor, and the great saving in weight for a given strength should bring this alloy into use for structural purposes, especially in shipbuilding. If the British government could only be convinced of its value in armor plates we should soon have a boom in nickel mining.

With refined nickel quoted at 45 and 47 cents per pound one would suppose there ought to be a market for solid nickel table-ware and kitchen utensils. Imagine a set of silvery kettles and frying pans replacing the present black utensils in the kitchen!

It is most desirable, however, that we should refine at least a part of our nickel in Ontario, instead of shipping all the matte to the United States or the Old World.

Silver.

The history of silver mining in Ontario is one of the most interesting and romantic in our mining annals. Silver was first found by the veteran prospector, Mr. Peter McKellar, in 1866, at what was afterwards the Thunder Bay mine; but much more important was the discovery two years later, of the most famous mine in the province, the Silver Islet mine. Close to the stormy north shore of Lake Superior, just east of Thunder Bay, a small islet, about 70 x 40 feet in dimensions, yielded to one or two blasts, silver to the value of $1,200. The next season 10 men secured over $16,000 worth of native silver in not more than 14 days of actual work.

In 1870 the Montreal Mining Co. sold out to American capitalists and development was begun in earnest. The little islet was enlarged by crib work and filling until there was room for 7 buildings with some space besides; while shafts were sunk to the depth of 1,230 feet. Some of this sinking was through rock tightly bound together with wiry native silver, which, with a number of rich silver bearing minerals, some new to science, formed the chief ore.

To treat the ore a fifty stamp mill was erected on the mainland, and the now widely-used Frue vanner was invented by Mr. Frue, the mine captain. The total production up to the end of 1884, when the pumping engines were obliged to shut down for want of coal, and the mine filled with water, amounted in value to $3,250,000, by far the largest return from any single mine yet recorded in the province.

The product of other mines to the west of Port Arthur brings up the total value of silver from the region to about $4,300,000, according to the Survey Reports. Since 1881, however, the amount of silver obtained has been trifling, and at present no mining is going on in the Thunder Bay district.

The mines, other than that at Silver Islet, seem to be shallow and very pockety. Nevertheless, if silver should again reach its old price it is probable that several of them could work at a profit.

Gold.

In August, 1866, two prospectors in the township of Madoc found flakes of a yellow metal like copper, which could be beaten out into thin leaves. They were informed by the geologist, Vennor, that the metal was gold. This find was on what was afterwards named the Richardson mine. Other discoveries in the same and neighboring townships followed, and caused a violent attack of the gold fever in the towns to the south. Probably less than $100,000 worth of gold was obtained in all from the region, and five times as much was sunk in useless plant. The failure seems to have been due partly to the pockety nature of the deposits, partly to the refractory character of the ore; for instance, near Deloro, where it is arsenical pyrites, but largely to ignorant and extravagant management. In 1871 gold was found by the McKellars in the western part of the province at the Huronian mine. Since then the yellow metal has been discovered at many points between the Madoc region and the Manitoba boundary. In fact it may be said that few gold producing countries in the world can boast of so wide a stretch of territory that has been proved to be more or less auriferous. Wherever the Huronian rocks appear there is a probability of the occurrence of more or less gold in them.

In spite of all this but one mine, the Sultana, near Rat Portage, can be said to have proved itself a paying venture, though several others begun within the last year or two promise well. The richest specimens come from the Ophir mine and Shoal lake on the Lake of the Woods, and from Wahnapitæ; but up to the present mines showing less brilliant specimens seem more likely to prove of permanent value.

The most hopeful portion of the Ontario gold mining region at present is the Lake of the Woods, where at least two mines, the Sultana and Regina, are producing their bricks of gold with great regularity. The Rainy Lake region, after a year of blank depression, is beginning to revive, and there is a probability that some of the true fissure veins on Shoal lake will be worked energetically during the coming year.

The Manitou region is attracting much attention, but is still only in the prospecting stage. The Harold lake property, opened up by the energetic Wiley Brothers, is also a producing mine and seems to have passed the experimental stage.

In and near Moss township, which has the once famous Huronian mine in its centre, interesting gold discoveries have recently been made, and a very large deposit of gold bearing quartz is being explored by the McKellars near Jackfish bay, on the north shore of Lake Superior, with results that promise well.

The Ophir mine in Galbraith Township, and the Vermilion mine in Denison, show no signs of life; nor are the Wahnapitæ mines doing much more than prospecting work.

The curious McGown deposit of gold and copper ores near Parry Sound is also nothing more than a prospect at present.

In the oldest gold mining region of the province, that of Madoc, Marmora, Belmont and other townships, little is being done, though Mr. Ledyard has shown some enterprise in developing his Belmont mine during the year. It would seem as if some of the deposits of arsenical ore in this region could be worked at a profit with the improved machinery and methods introduced since the shutting down of that costly failure the Deloro reduction plant; but no doubt it will take time before confidence is restored in the region.

In glancing over the results of our mineral industry as a whole, we find that petroleum products give the greatest aggregate returns, far exceeding the results of mining any of the metals. Defective statistics make it impossible to give even a rough idea of the whole produce of our oil wells; but for a number of years the sales must have amounted to more than $1,000,000.

Nickel should perhaps come next, that is, if the value of the refined metal is taken, which is perhaps not fair, since the matte is all exported. Then silver, copper and iron.

Our output of gold has been insignificant, in spite of the immense outlay on plant in the Madoc and Rat Portage regions. The production of salt no doubt far exceeds it in value.

Looking toward the future we may fairly expect well established industries, like the production of salt and petroleum, to continue the even tenor of their way for a long time to come unless some change in the tariff makes a marked change in their conditions. Nickel mining may be expected to increase gradually as the world is able to absorb more of that fine metal. Hand in hand with it, our output of copper will, of course, also increase. The immediate future of iron mining does not look very bright; but there must come a time when our western ore deposits, which are practically limitless, will give rise to an important industry.

There seems no immediate prospect of a revival of silver or lead mining in our province, nor are our large deposits of zincblede to the north of Lake Superior likely soon to be drawn upon.

Gold presents the brightest outlook of all for speedy expansion, especially in the part of the province west of Lake Superior; and I fully expect to see a well established gold mining industry there within a few years, something of a quiet and permanent character like that of Nova Scotia, but on a larger scale, since the extent of our gold field is much greater.

One of the most discouraging features of mining in the province is the lack of intelligent interest and enterprise on the part of our own citizens. Most of the more important mining ventures of Ontario have been in the hands of outsiders, especially our bold and energetic neighbors the Americans, who seem to lead the world of late years as successful miners. Perhaps our canny capitalists, when our cousins from across the line and a few stirring Britishers have got possession of our best properties, will begin to wake up to the fact that we have gold mines worth working right at home, and that many of them will give far better returns than mortgages or bank stocks in this time of depression.

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Observations on Mining in Thunder Bay District

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By Mr. Peter McKellar, Fort William, Ont.

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Last week, when about to commence to write this paper, I was unexpectedly called away to the Empress gold mine, Jackfish, where I was detained for several days. I will now have but a short time at my disposal, and will not be able to make it so complete as I intended.

Director Blue and Prof. Coleman, of the Bureau of Mines, have made a pretty thorough examination of the mining developments in this district last summer, and will, I understand, read a paper on the matter, at this meeting of the Institute. It would be useless for me to attempt to write on that subject, as I have not been through to the Rat Portage mines for a long time; I will therefore confine my remarks to a few observations that relate to mining here.

The district consists of a vast area of rocks which are largely composed of schists and rocks that are favorable for carrying metals and economic minerals. They have been, in many places, subjected to disturbances at various periods that caused fissures to be formed which were subsequently largely filled from solutions with quartz or spars and in most cases with one or more of the metalliferous ores. Examples of these are numerous, as those of the Thunder Bay silver veins, the Huronian gold vein, the Shoal lake and many of the Lake of the Woods gold veins, and the Jackfish bay gold veins, etc. Although, no doubt, there are gold lodes here that are not true fissures, as the bedded lodes, segregated and local gash veins, still I believe that there are more of the gold lodes true fissures than is generally allowed to be. It matters little what kind of a vein it is providing it carries plenty of the valuable ore; but veins, especially small ones, can be relied upon for permanency if true fissure veins, more than if any other kind. I find it a prevailing idea with mining men that a vein is not a true fissure unless it shows, crossing the stratification or slatey cleavage. In the case of highly inclined strata, I would expect to find such a vein conform with the stratification more frequently than otherwise, as forces that would cause fractures would have less resistance along cleavage planes than across them. Take, for example, the McKellar gold lode near Jackfish bay; it appears to follow in the cleavage of the schists for a long way on locations R 567 and R 568. At the Empress mine, R 569, it shows branches, striking out across the schists, and at right angles to the cleavage planes in places, Therefore, I think it probable that many of the so-called bedded or contact veins are true fissures.

I noticed many years ago that there appeared to be some connection between the granitic eruptions and the gold veins in this district Since then, as my knowledge of the formations widened, I am more thoroughly convinced that it is the case. In my pamphlet on *Mining on the North Shore of Lake Superior, 1874,* in referring to the Huronian (Jackfish lake) and Heron Bay gold lodes, I remarked, on page 24, "Having seen the granite in about the same position in regard to each of these gold-bearing lodes, which lie about 150 miles apart, I thought it worthy of mention, as it may or may not have something to do with the presence of the precious metals in these veins." Since then I have noticed in the vicinity of gold lodes that branches from those syenitic granite eruptions pass from coarse grain to fine, then into quartz similar to those of the gold-bearing veins in the vicinity—as at the Huronian, at Rossland, Lake of the Woods, and at Wahnapitæ country and many other places. I am not quite sure that I found them carrying the gold, and I have not now time to look up my notes; but I think it quite probable that they do, and that many of our gold lodes will be found to belong to this class.

In these gold localities, I believe that the quantity of gold in a fissure vein will change agreeably to the character of the enclosing strata, whether the gold is of deep origin or not. So that a portion of a fissure may be rich in passing through one stratum of rock, and poor or barren in passing through another, in the same way as is shown in the Animikie strata in the case of the silver veins, and also in many places in other mining countries. The gold veins traverse the Archean strata, which are almost invariably highly inclined and can be followed down to any depth within the same stratum. Therefore they are not liable to change their character downwards so completely as is the case with the silver veins within the flat lying Animikie beds. Below the Animikie the silver veins will pass through the Archean strata and probably will be, in places, valuable lodes. The results of the developments of the lately discovered silver at Pays Plant will go far in deciding this matter.

In the paper I wrote on *Silver Mines of Thunder Bay* last year, I gave my reasons for supposing a deep original source for the silver of the Thunder Bay mines—the source from which the immense quantities of the native copper rocks were ejected. The silver veins are true fissures and adjacent to the great Lake Superior trough. They intersect the Animikie and Archean rocks and show practically no gold in either. The ores of iron, copper, lead and zinc, seem common to both the silver and gold veins of the district. It does appear that the real silver veins here are only to be found in the vicinity of the great basic eruptions of the Keweenawan age, while the real gold veins are found generally, if not always, in the vicinity of certain granitic eruptions of the Archean age. It seems probable that fissures formed in the vicinity of these eruptions did descend to their sources or liquid pools, and that they received their metallic contents largely from the same.

The silver discovery above referred to was made last fall in Archean rocks, near the mouth of the Pays Plant river. It is similar in kind to the Thunder Bay silver veins—the gangue being mostly spar with the silver both native and sulphide, with galena and iron pyrites, etc., through it. The rich samples, that yield several hundred ounces of silver to the ton, resemble the bonanza ores of the Animikie veins very much. According to the reports of reliable parties, it is large, well defined, and continuous for a long way. It can reasonably be expected to continue its character downwards on account of the enclosing formation. It has been the general belief that the silver in the Thunder Bay veins was due to lateral infiltration and that only in the Animikie rocks need a search be made for silver, notwithstanding several outside veins showed favorable indications. This last discovery in the outside or Archean rocks near the great Lake Superior trough is additional proof in favor of the showing that the silver in these veins has been derived from a deeper source than the Animikie strata.

The splendid showing of the deeper mining of the gold veins of late, as that of the Sultana, Regina, and Shoal Lake mines, is strong proof of the permanency of our gold mines. The cloud that was hanging over them, as being shallow and superficial, is rapidly passing away as developments progress.

In conclusion I would state, that I fully expect the coming summer to be the liveliest season in the mining line that was ever witnessed in this western district.

The Financial Aspect of Mining.

By J. H. Chewitt, Ba., Sc., C.E., Toronto.

That such a great country as Canada, so admittedly rich in all kinds of minerals, with its well developed transport facilities, its enormous food producing areas, its magnificent timber and practically unlimited water supply and power, should be so backward in the important industrial branch of mining is cause for surprise and enquiry. The reasons for this state of affairs, and anything that may explain and remedy the lack of development in this direction, are subjects that must commend themselves to every good citizen, and above all to members of the Ontario Mining Institute, for consideration.

It has been stated that in proportion to the capital invested, mining has been less remunerative in Ontario than almost anywhere else.

I do not believe, nor do I think our Institute is willing to admit, that workable ore deposits are so few and far between that it is unwise to attempt development. I think the causes of failure may be looked for, very often, in other directions, and we may examine, a little, certain of these which have, among others, lately attracted my attention. They may be broadly set down under five divisions :

(1) Highly capitalized promotion schemes floated on surface indications.

(2) Application of treatments not suited to the ores.

(3) Untrained and incompetent management.

(4) Premature surface equipment, and buildings.

(5) Bad roads.

Under the first heading the following points suggest themselves as directly bearing on the legitimate capitalization of a mine. "The cash "value of a mine is that which will net a given annuity to the investors; "the amount of this dividend should increase with the risks run." (Ihlseng.) This can only be determined by actual development, which means the expenditure of a certain amount of money. The quantity of ore revealed, its grade, and cost of treatment should then determine the estimated value.

The proper (or justifiable) capitalization will be dependent upon this cash value, and the equipment necessary for production commensurate with the prospective annuity. But as no mine is inexhaustible, its life being calculable, a sinking fund must be provided in order to create a new capital within the period of its life.

On account of the greater risk run in mining investments as against investments, say in Government bonds, or first mortgages on choice lands, a much higher rate of interest is required, ranging from 10% to 50%, according as the risk is considered great or small.

The Banket beds of the Transvaal afford examples of companies with enormous capitals, in many cases from $5,000,000 to $10,000,000. organized on a basis to yield the moderate return of about 10 per cent. This was possible on account of the wonderful continuity in grade and character of the ore beds, now ascertained by extensive workings and deep borings. At the same time it is quite evident the equipment of a gold mine working on a $7.00 to $10.00 per ton ore, capitalized at $10,000,000, with the object of paying 10 per cent., should not cost, even in the Transvaal, over $250,000 to $300,000, or say 3 per cent. of the total capital. And just here comes the vital question: Is the cash value of the workable deposit $9,700,000? To authorize such a capital we see the mine must have a life of 15 years at least to repay the investors, which seems a long period to anticipate a uniformity of all the present conditions. Many things may happen in that time. It is probable the price of labor and supplies will rise, one cause being the immense production of gold going on all over the world. At present between 20,000 and 30,000 Kaffirs, employed in the Rand mines, are satisfied to work for an average wage of $15.00 a month—50c. a day. It is unlikely such wages will continue indefinitely to satisfy these workers, and any increase must affect prejudicially the value, as an investment, of the mines.

Again, until recently, a gambling spirit has pervaded mining. Attractive prospectuses giving glowing accounts of mountains of ore, based perhaps on Indian legends of pure gold and silver almost in bulk, have been put forth rather than the results of honest development, careful tests and examination. Money put into such ventures is speculation pure and simple, and though in one or two cases successful results may have been realized, in the majority of instances the capital has been lost and mining discredited, the only person benefited being the unscrupulous promoter. The result may be put in the words of a Liverpool gentleman to me recently, "Canadian mines stink to heaven"; and we have ourselves to blame, and not our imperfectly examined mineral field, for this state of things.

Secondly, the application of inappropriate treatments is another potent source of failure. Mining men know of many places where rotting timbers and rusting mills form melancholy monuments of misdirected capital. Such failures have been due to both inexperience and lack of technical knowledge. It has too often happened in mining that the man in charge has gained the wisdom of experience at the cost of his confiding employers.

But it must also be allowed that one of the main elements of successful treatment lies in the uniform composition of the ore, and many cases are known of sudden changes, such as galena to bornite, lixiviating ore to lead zinc ore, free milling to smelting ore, &c. These must be guarded against, as far as possible, by cautious preliminary exploitation. As an example of wise preliminary development before erecting a plant, the Hall mines at Nelson, B.C., may be cited. This company has quietly carried on its work of opening up for two or three years, and now with sufficient ore of known composition in sight to keep their smelter going for five years, they are in a position to operate on a most satisfactory and economical basis.

Thirdly, incompetent management has been, nay perhaps still is, the greatest cause of loss in mining investments. Influential directors have been too ready to translate some friend or relative from an office desk to the control of a mine. Untrained and out of sympathy with his surroundings, what is to be expected other than failure.

Fourthly, undue haste in erecting machinery almost before a drill has been struck, has led to much waste of money, where judicious work expended on a shaft, or careful tests with the diamond drill, would have revealed the pockety nature of the deposit, or the barren quality of the ore as depth was gained. It is well to remember that all veins do not widen, or become richer as you go down.

Neither is it necessary to build a palatial residence for the manager, nor to construct permanent houses for the miners, and schools for their children, before the mine has afforded some pretty satisfactory evidence that it will become reasonably profitable.

Lastly, bad roads have played a greater part in many failures than is commonly supposed. I am aware of a mine in Ontario, the road giving access to which is so bad that three barrels of concentrates form a load for two powerful horses; in fact more than once the third barrel has had to be thrown off in mid-journey to lighten the draught. In another case it took about five weeks to take in a 60 h. p. boiler about 40 miles. How can profit be realized when every ton of material brought in or taken out must be handled under such very unfavorable conditions.

In connection with the transport of ore and supplies, I do not think enough attention has been paid to light tramways, upon which a single horse can draw comparatively large loads with ease. Wire cable-ways, particularly over short stretches of difficult ground, also deserve more consideration, their cost of operation comparing favorably with that of light rail and tramways, while the first cost is many times less.

Above all and by way of summing up the whole matter:— "When the plans are being laid the educated mining engineer who possesses the business perception required for the successful conduct of any other manufacturing enterprise, will adopt tried and true processes, even though, as innovations not having the seal of local usage, they may be looked upon with suspicion and resisted by "men of the camp." To such careful, observant management, however, the many mines of Europe owe their continued prosperity after three hundred years of working.

By actual and costly experience the "practical man" learns what the "theoretical man" has been taught, to profit by the experience of others. System will replace obsolete hand-to-mouth methods, and thus many an idle mine may, by one keenly alive to improvements in mining appliances, be converted into a prosperous property.

A compromise between, or a union of theory and practice, in such a manner as to inculcate the principles of technical knowledge, will enable the engineer to bring the rosy anticipations of enterprise to the level of the facts of experience.

Improvements in the Dressing of Gold Ores

By Mr. F. Hille, M.E., Port Arthur.

Permit me to occupy your attention for a short while with a subject which I consider at this moment to be of great importance to our mining industry. It is this: the successful dressing of gold ores, and their preparation for a subsequent metallurgical treatment; not only for us in our western districts, but perhaps also for all the different mining camps, scattered over the whole Dominion.

Since the depreciation of silver and the closing of so many mines producing this metal, and since the demand for gold by different Governments, especially that of the United States, has increased so enormously, capital and the mining world in general have lately directed their attention greatly to the search for gold. Mines, yes, whole mining camps, which were abandoned years ago on account of their then unprofitableness, are worked now vigorously, and bring in many instances handsome returns. Not less active were the prospectors and miners in our own country, and we hear and read almost daily of new finds throughout the Dominion.

The awakening of this industry has brought forth, I had almost said, another one—a very voluminous literature on the winning of gold. Indeed a number of these papers really deserve the closest attention The dressing of gold ores is especially well considered, and the experience gained with the different machines and apparatus in vogue in the mills on this northern continent, is often very well presented. But exhaustively as the subjects are treated and the pros and cons of the improvements on these old machines propounded, I have missed almost wholly the mentioning of the practice of other nations.

We see in the dressing of ores the same old methods carried on as we have seen years ago; every other branch of our mining industry shows considerable improvements and innovations, but in our milling system we progressed not one step farther. Where some improvements in the saving of minerals are made, or attempted, it is done without the consideration of expense, saving of time, manual labor, or even complete effectiveness; as for instance the blanket process in the California mills. But what are the reasons of this pious retaining of an old, wasteful practice? Many—some of which would often invite severe criticisms, but I shall abstain from detailing them here. Enough that they exist not for the good of our industry. We always should be on the *qui vive* for that from which we could derive an intellectual or material benefit. The Australians are ahead of us in this respect. Some time ago the Government of Victoria appointed a commission for looking into the wasteful operation of the numerous dressing works in that country. This commission has handed in its report, and recommends very urgently the adoption of the so-called "Luhrig system," which these men studied on the European continent, as well as in their own country, in the works at Stawell, in the North German mine at Waldon, and Long Tunnel mine at Walhalla, which they considered "to offer object lessons of the highest value."

Now, gentlemen, I think it is high time that we experience also such "object lessons," and if it were merely for keeping up with the times, not to consider at present the economical advantage derived therefrom. I said above that our ore dressing has not kept pace with the improvements and innovations in the other branches of our mineral industry, and if our inventive genius is not strong enough to think out something with which we can improve these poor conditions in our works, then we should not hesitate to put aside for a while our "American pride," and look into the works of other nations to see if we can detect anything there that might lead to better results and to greater personal satisfaction. I cannot imagine myself in the place of a manager of any works, who does not care for a moment how high the tailings of his mill will go, who is simply satisfied with the result he is gaining, as long as the stockholders do not complain.

The waste in our mills is not justifiable; such working is crude and unscientific, and does not harmonize with the progress of our present age.

I have tried, gentlemen, to show you here with a hastily drawn plan the same system which the Australian commissioners recommended so urgently to their Government and mining world for adoption. It is known under different names: the "Luhrig," from the well-known milling engineer, D. Luhrig, in Dresden; or the "Bilharz," from the not less well known Government mining director, O. Bilharz, in Freiberg, or the

"Krupp" system, and this name is taken from a man who needs no introduction to you.

I show also the principal machines in a little larger scale here so that they might be better understood by those who should not be familiar with them. But before I commence their description I would like to say a few words in defence of my assertion as to the inefficiency of our present milling machines, in regard to the saving of minerals and metals, and the separation of the gangue from the former as adapted to the ores of this country.

We all know that most of the gold veins occur here principally in the metamorphic rocks, that is, in the upper series of the Huronian, the so called Keewatin. Most of these rocks are chloritic, talcous, sericitic and hornblendic in character; and even in the veins are found often stringers and bands of rock, of the same composition as the former, which after mining are hardly possible, even by hand-picking, to separate sufficiently from the ore. The minerals associated with the vein stone, which is usually quartz, are zinc blende, copper and iron pyrites and galena, seldom sylvanite or arseno-pyrite. The gold in these ores is mostly fine, sometimes microscopically fine, then again coarse, mechanically or chemically combined or free in the quartz, or in juxtaposition with the former minerals, but principally associated with the copper and iron pyrites.

The percentage of minerals to the gangue varies greatly, amounting often to over 50 per cent.; in most cases, however, much less.

Now, in buying machines for the dressing of such complex ores, we have to consider well what kind we should preferably select for the most complete, the easiest and the cheapest saving of the gold and economic minerals. But we should also consider at the same time the later metallurgical treatment of the ores, or concentrates, which is also an important factor, if we wish to have them reduced by smelting, chlorination, cyanidation, or if not by an electrolytic process would be more advantageous, more economic to the owner.

We should further keep in view our commercial and industrial conditions, and not less so the transportation facilities. This long list of considerations could be multiplied if we would add the many perplexing occurrences on the amalgamating tables and vanners. But the usual practice is to order a mill before the mine is made, before the people know what they have in their mine. This folly has brought many good properties to grief and still a greater multitude of poor stockholders.

I have repeatedly experienced the following:—"The enthusiastic mine owners wrote to a machine works to send a stamp mill which would treat an ore as the accompanying 'representative' specimens." The selection was left to the manufacturer, who of course sends one of the "latest pattern." The mill arrives, is put up, the stamps commence pounding in rythmical clacking, the slimes begin to flow over the amalgamating and concentrating tables, everything works nicely and smoothly, and the manager's face reflects his inner satisfaction of the—success. Also the assayer is present ready to take samples from the battery, the concentrates and tailings. A few hours are passed, the manager's face shows a strange metamorphosis What has happened? The tailings are too high! Now begins the experiment with the tables; the inclination is lowered, then raised, then lowered again, soon more water is allowed to mingle with the slimes. Several weeks are passed, the ore dump is giving out, the mill is running only half the time, the tailings are as rich as ever, but the company is getting poorer and poorer, and dies at last an unnatural death, but has in dying the satisfaction that its mill forms a wide, shining monument to the country's disgrace.

Now, gentlemen, really is it to be wondered at that so many mill owners are baffled when the expected results are not forthcoming? Surely not when you consider what the stamp has to fulfil as a grinder. From no other machine do we expect the same thing. It is expected to work equally well on a multitude of differently constituted ores, may they carry the gold fine or coarse, in chemical or mechanical combination, heavily or not heavily charged with minerals, slime-producing or not, soft or hard, and almost every vein carries a different ore. But all these considerations would not have such a great effect upon the ultimate result if the stamps would only grind a little more uniformly, and if we had a different apparatus or machines in addition to them. It would also be of not much injurious consequence if we used light or heavy stamps, a high or low discharge (although the latter would be always preferable with our ores); further, it would not make a great difference if they acted not only as grinders, but also as amalgamators, if we had a better amalgamating table in connection with them. But I consider the smooth, and often very narrow apron and sluices or tables in use in our mills, under no circumstances favorable to our ores. The slimes pass too, unobstructed, and from the narrowness of the plates in too deep a current over them. The chloritic and especially talcous slimes flow too close and compact over the table and hinder the fine, often floating, gold particles from coming in contact with the quicksilver.

Similarly act heavily mineralized slimes, and when they are in connection with the former muddy slimes there is no preventing loss, unless you increase the plate area of your amalgamating tables in width considerably, and thin out thereby the current of ore particles and give the table the right inclination. Or if you do not like to increase the space of your building, and to increase the work of the gathering of the amalgam, connect hydraulic classifiers directly with the stamps, get rid thereby of the muddy slimes, and acidulous water, so injurious to a successful amalgamation, and change from the Spitzlutten your amalgamating tables, and from them to the vanners. But you need in both cases slime tables, or as they have in California, blankets for arresting the fine metallic minerals, which go with the slimes from the classifiers, and those from the vanners which receive the finest graded product from the Spitzlutten. Because, if you have not these, you might loose as much and sometimes more on auriferous minerals than you have saved in free gold on your amalgamators.

Now I have exemplified only one case and the difficulties which will arise therefrom, but as long as we do not throw the stamp among the old iron, so long have we to put up with it, and have to counteract its defects by applying suitable apparatus in connection with it. I repeat here, I do not consider either our amalgamating table, or the Frue vanner or its relatives, the right apparatus for our mills. The latter might do where the ore carries only one metallic mineral, and if fed with "classified products," but where the components of an ore are many, and of varying specific gravity as is usually the case here, and we wish to separate them, then they are not economic machines, because we receive all the different minerals mixed together in one product. And further, where coarse grinding—30 meshes and under—has to be done to avoid the production of too much fine slimes, a large amount of coarse mineral particles are carried off with the tailings. And again, where fine grinding—40 meshes and over—has to be resorted to with the presence of such slime-producing rocks as ours, a large portion of the fine metallic minerals go with the tailings, then again the Frue vanner is not a desired apparatus. In this latter case it is often the practice to connect three and four vanners together, that is, each following receives the slimes from the one in front of it; or the slimes as they come from the amalgamating tables are divided into three or four currents, and fed on as many tables. This will help somewhat, but is not quite efficient, and gold and valuable minerals are lost in the tailings; while a large amount of gangue matter will be found under all circumstances among the concentrates. How annoying all these defects are to the manager, and expensive to the company, necessitating recourse later on to another process to regain this loss, everybody knows, and knows also that we have to handle for this purpose almost the whole bulk of ore over again. As I said above we can remedy these things considerably by using classifiers, but as long as we do not, that is, as long as we pursue the irrational practice and feed the whole muddy slimes and sands as they come from the stamps with their thousand different physical conditions upon these machines, so long have we to expect such poor results, that is, our tailings high in gold and minerals.

These above-mentioned three kinds of apparatus or machines, excluding the crusher, constitute here usually the whole outfit of a dressing work, of which we read in the papers almost every day, "to be the most modern dressing works in the country." Of course, if a country or nation does not adopt any improvement or innovation on an old fashion, a newly made or manufactured object is always modern with them, because they do not know better. This, I think, will be sufficient in supporting and substantiating my assertions in regard to the inefficiency of the outfit in our dressing works.

I come now to the description of a mill as shown on the plan before you.

In adopting this arrangement and the different machines I was led by the following reasons:—

1. The mill should have a capacity of about 40 tons.

2. Mixed with the ore is talcous slate from the walls of the vein, and from little stringers of the same material mixed with the vein stone.

3. The gold in the ore is partly fine, partly coarse.

4. The ore is well mineralized with copper and iron pyrites, blende and galena.

To crush 40 tons of ore I selected 15 stamps of 900 lbs. each; this not only will furnish me the desired amount, but will also solve the second consideration—as well as it is possible to be done with stamps; a uniform and at the same time coarse-crushing, in using 30 meshes phosphor-bronze wire cloth.

The mortars of the stamps have to be provided with copper plates for retaining the coarse and as much as possible of the fine gold; but for the amalgamation of that part of fine gold going out of the mortar with the slimes, I used Krupp's improved amalgamating tables.

To increase the capacity and enable the concentrating tables to do better and cleaner work, I put Spitzlutten or hydraulic classifiers in front of the former, and to separate the components of the ore I used Bilharz percussion table. Further to concentrate also as closely as possible, I added two buddles, and put in a number of settling pits to save every valuable mineral that should escape from the tables and spitz-kasten.

I had further in view that the ore should be handled as little as possible, from the time that it is dumped into the bin which feeds the crusher.

The accompanying sketch indicates the construction of the mill sufficiently. I might mention only that the crushing part of the works is separated from the building to avoid a rattling and shaking of the whole structure.

I can also pass over an exhaustive detailed description of the arrangement of the machines, as this is readily recognized. Instead of this let us follow the onward movement of the ore, as it passes from machine to machine, until it leaves the mill either as ready products or as tailings.

The ore after being dumped into the upper bin is fed automatically into the crusher, by a very ingenious arrangement, of which O. Luhrig, in Dresden, possesses the right of introduction. This feeder consists of a shoe which moves the ore from below the pointed end of the bin gradually forward on a grizzley, which again moves and feeds that part of the ore coarser than the space between the staves, slowly and regularly into the crusher. The automatic action of this shoe, which can be regulated at will, allows of a reduction of over half of the attendance where several crushers are in use. The smaller parts of the ore which are separated by the grizzley overhead and by the one below the bin relieves the crusher of a good deal of unnecessary work, and increases therefore the life of the jaws, toggle, and check-plates.

I have introduced, further, a little improvement at the lower end of the bin. In case the automatic feeder should be once out of order, a trap door which swings in a quadrant in nearly the middle of the lower bin-opening, closes the feed opening to the automatic feeder and opens another one right over the grizzley, from which the ore can be fed into the crusher with a hand-rake.

From the bin below the breaker the ore drops into a hopper with automatic feed, which forwards the ore into the mortars of the stamps.

I selected here, notwithstanding the partly fine state of the gold in the ore, a heavy stamp, in order to crush coarse and as uniformly as possible, to avoid a large amount of slimes.

We have seen above that I prevent thereby to some extent the amalgamation of the fine gold in the mortars, but you will see that this does not matter so much, if you have learned more about the amalgamator used here. On the other hand, I have gained by the selection of these stamps some important advantages, through the avoidance of fine crushing; that is, the lessening of the proportion of muddy slimes, and the coarser grinding of the concentrates, which if too fine have partly a considerable floating capacity and partly when in such masses, as is often the case in our ores, crowding the surfaces of the other machines to the disadvantage of the saving of gold. For one who is not familiar with the conditions which prevail inside the mortar box, it sounds strange to say that a heavier stamp should not grind as fine or finer than a lighter, and that the weight should not balance the high drop of the light stamp; but if we know what is going on in the mortar it is readily understood. The splash of the lighter stamp, although having a drop of sometimes up to 16 to 18 inches, is not so effective on the ore lying on the die through the resistance of the deep water which is standing in the mortar. The capacity is further hampered through the slow speed; and naturally on account of the higher discharge, the particles cannot escape so easily through the sieves at every splash of the stamp, and are therefore retained longer in the mortar and undergo the grinding process more frequently. The consequence is a larger amount of slimes, but on the other hand also a more ready amalgamation in the mortar, because the gold particles are left more time to settle and to amalgamate with the quicksilver. The creases therefore

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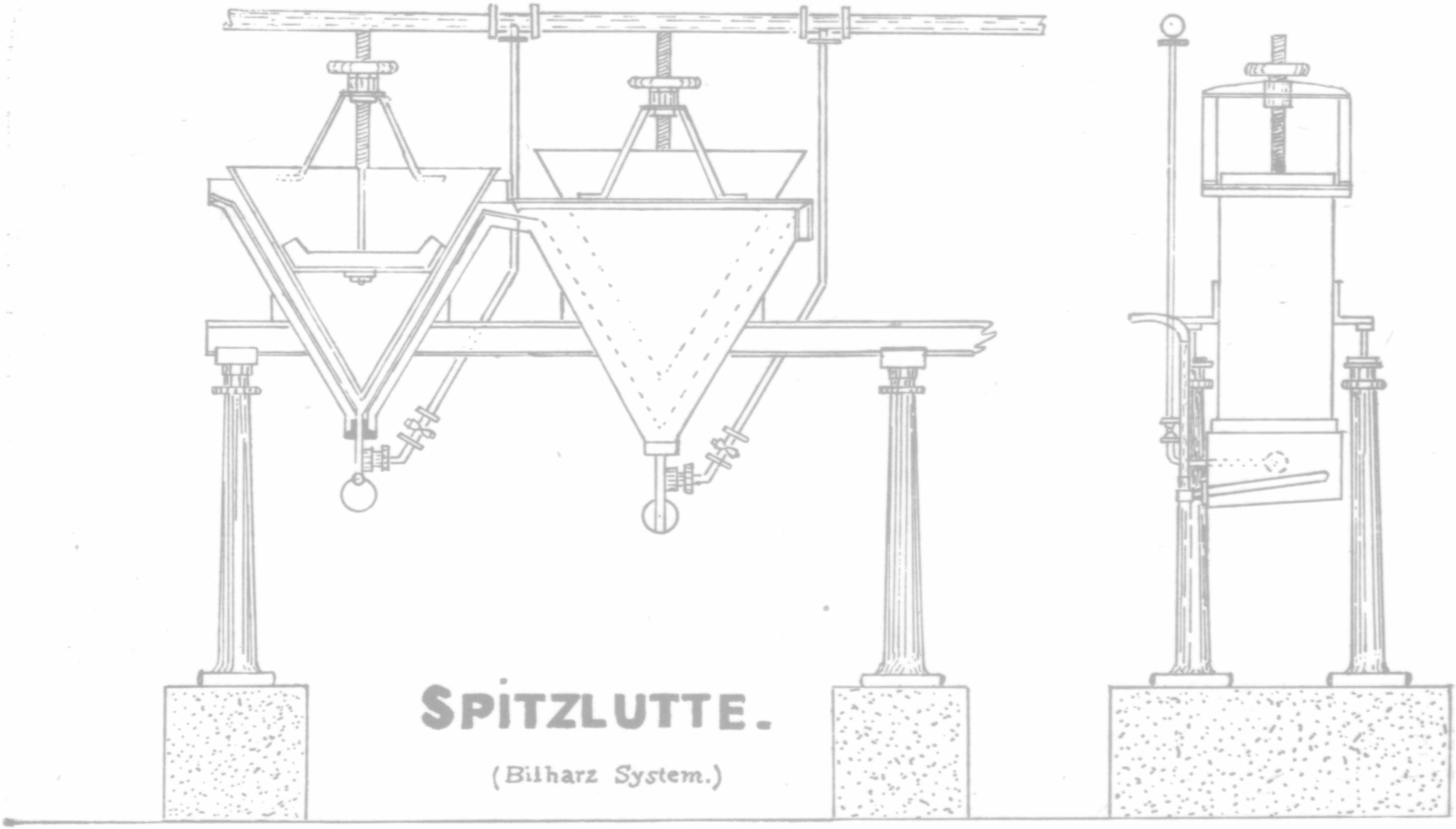

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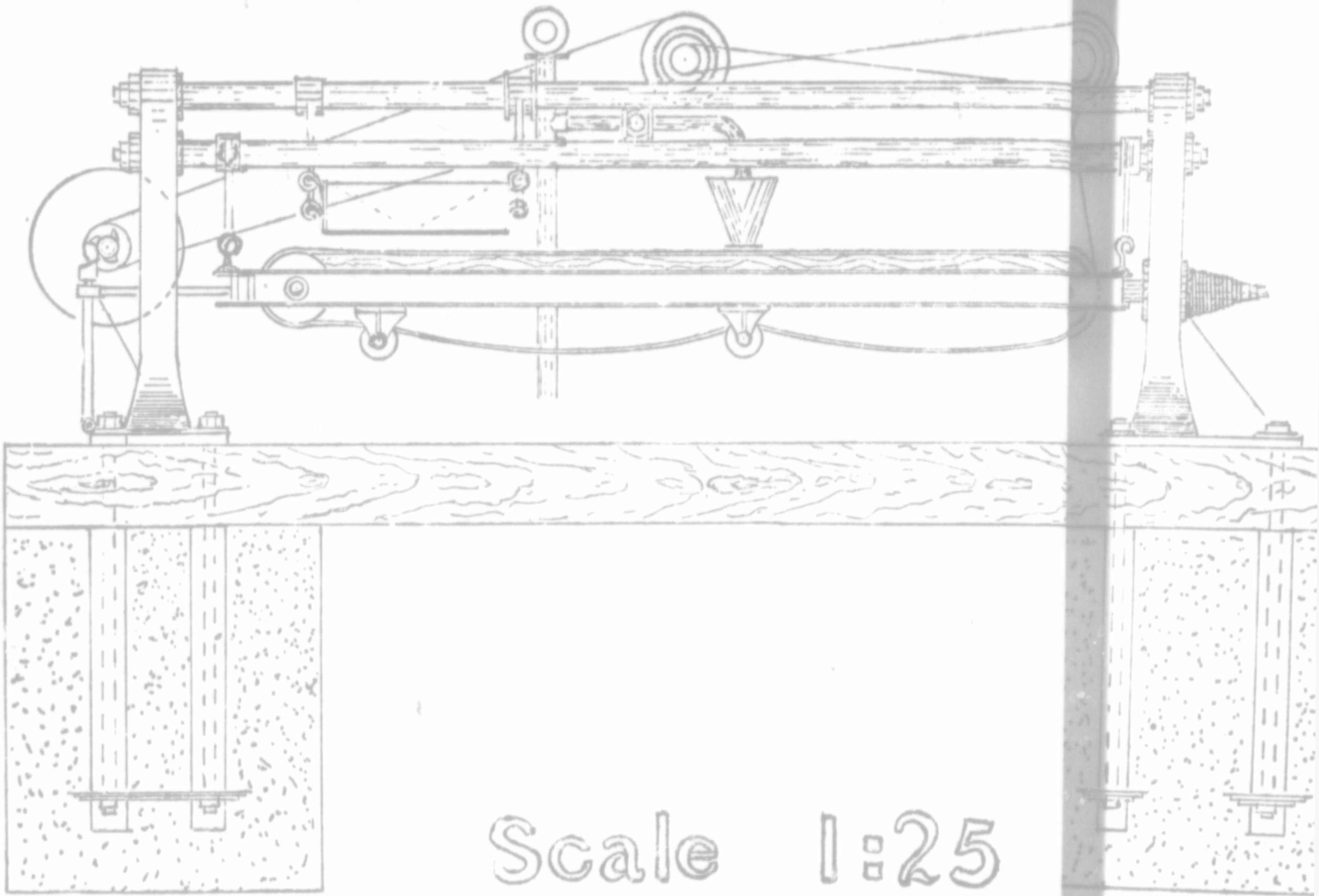
(Bilharz System.)

SPITZLUTTE.

(Bilharz System.)



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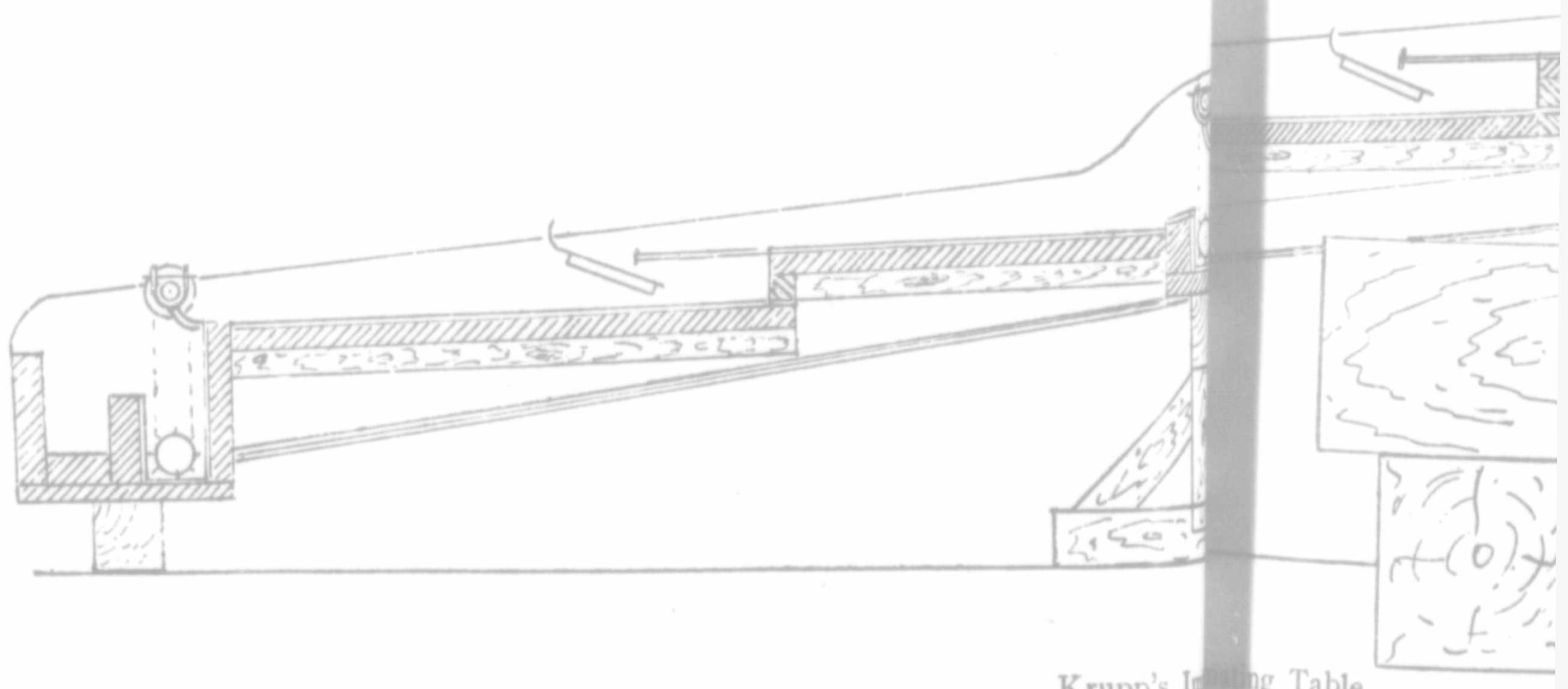

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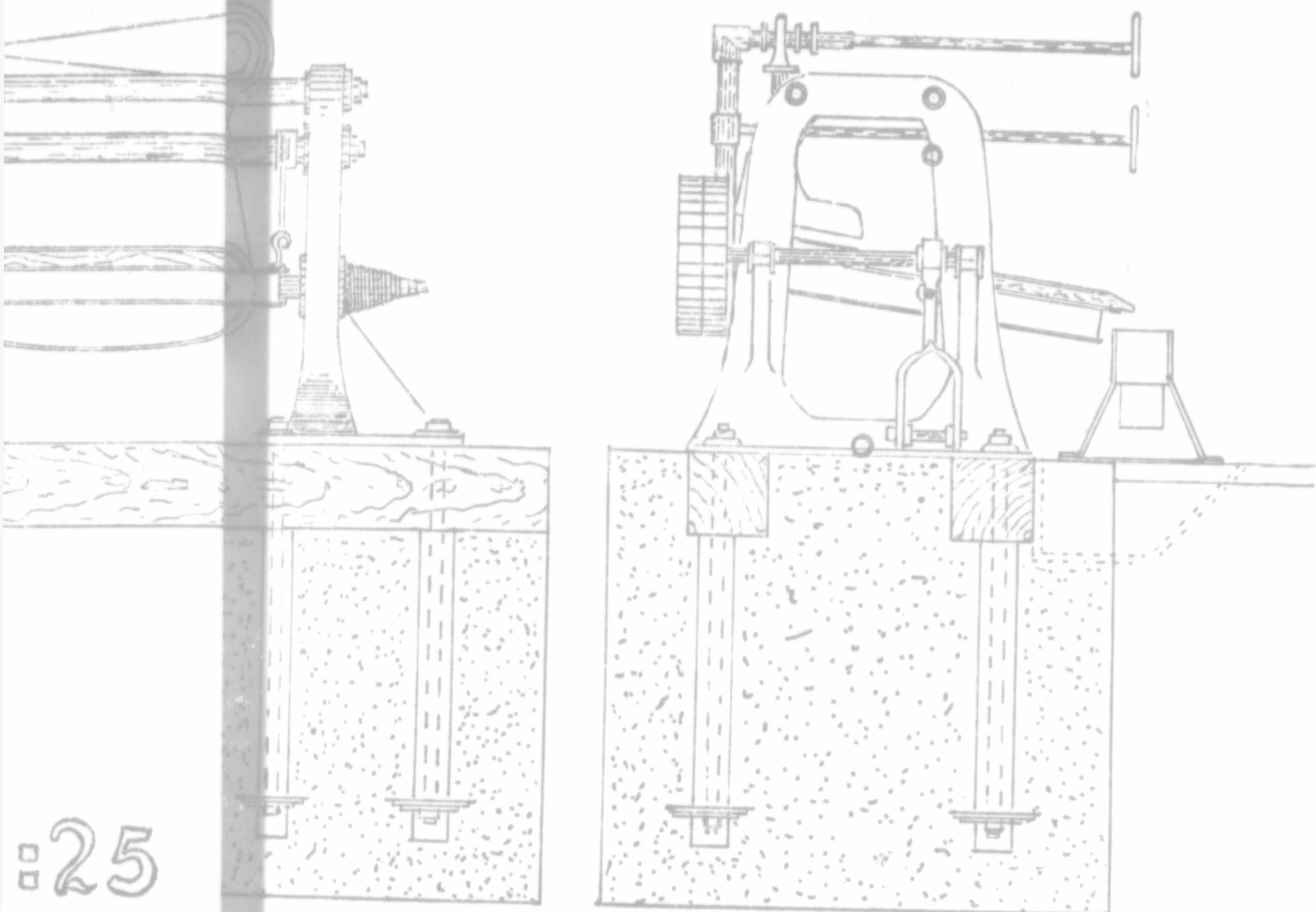

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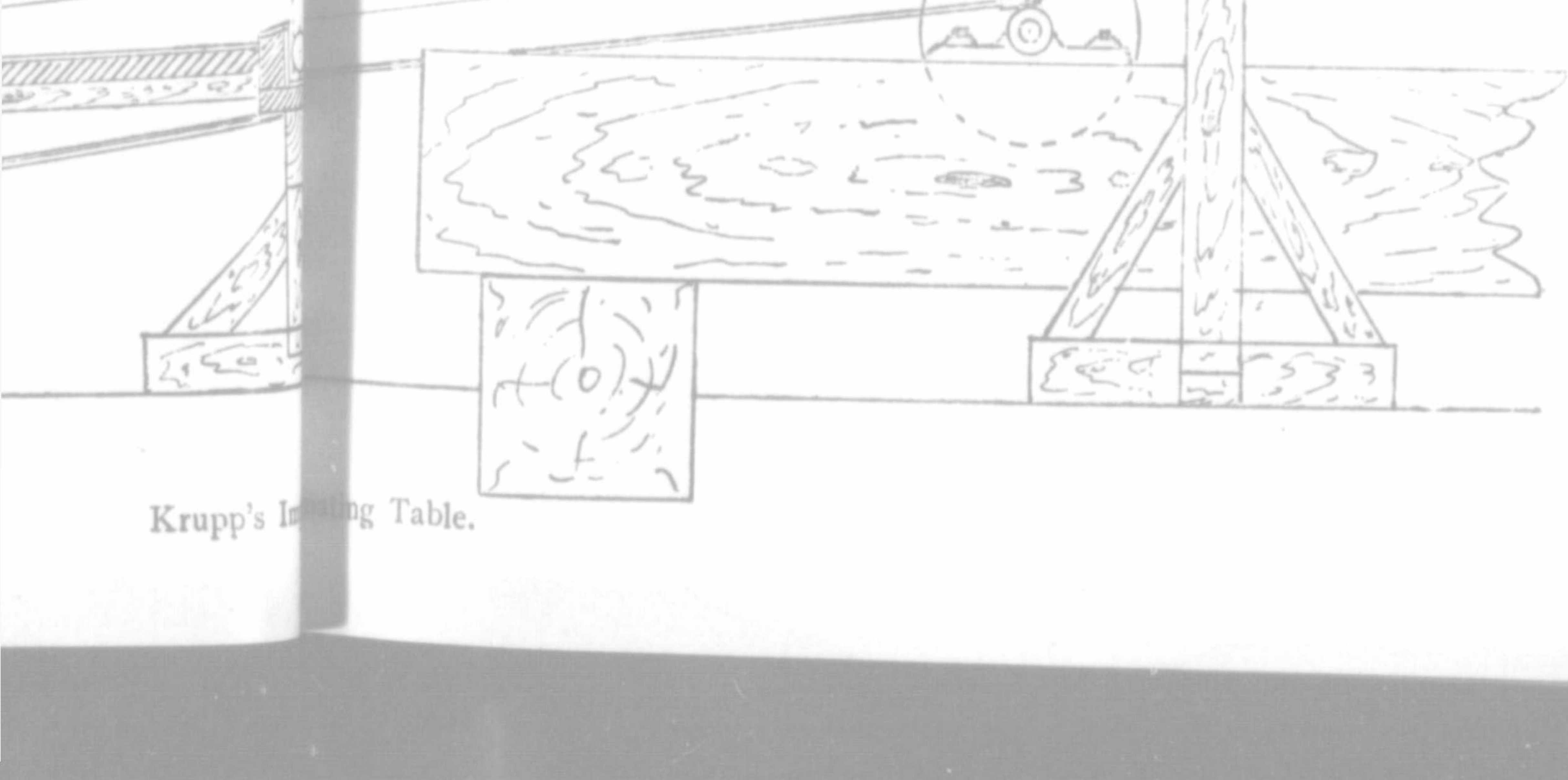

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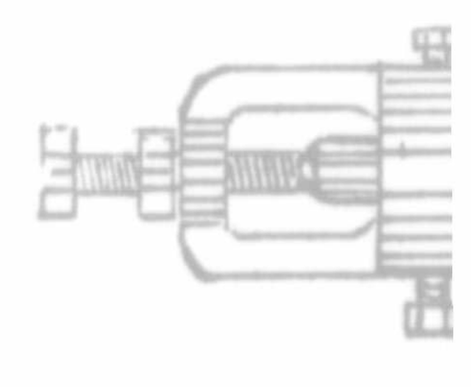
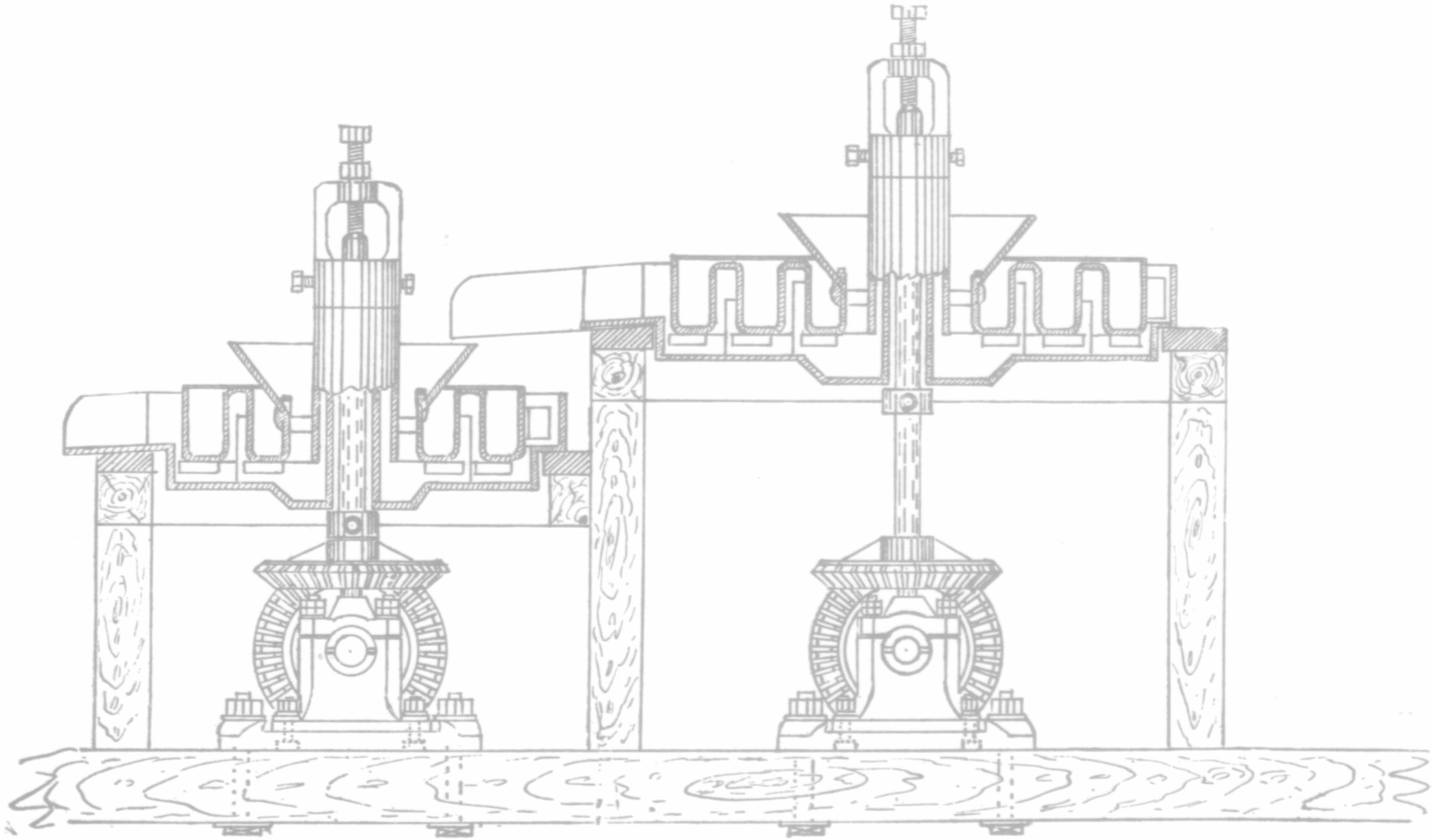
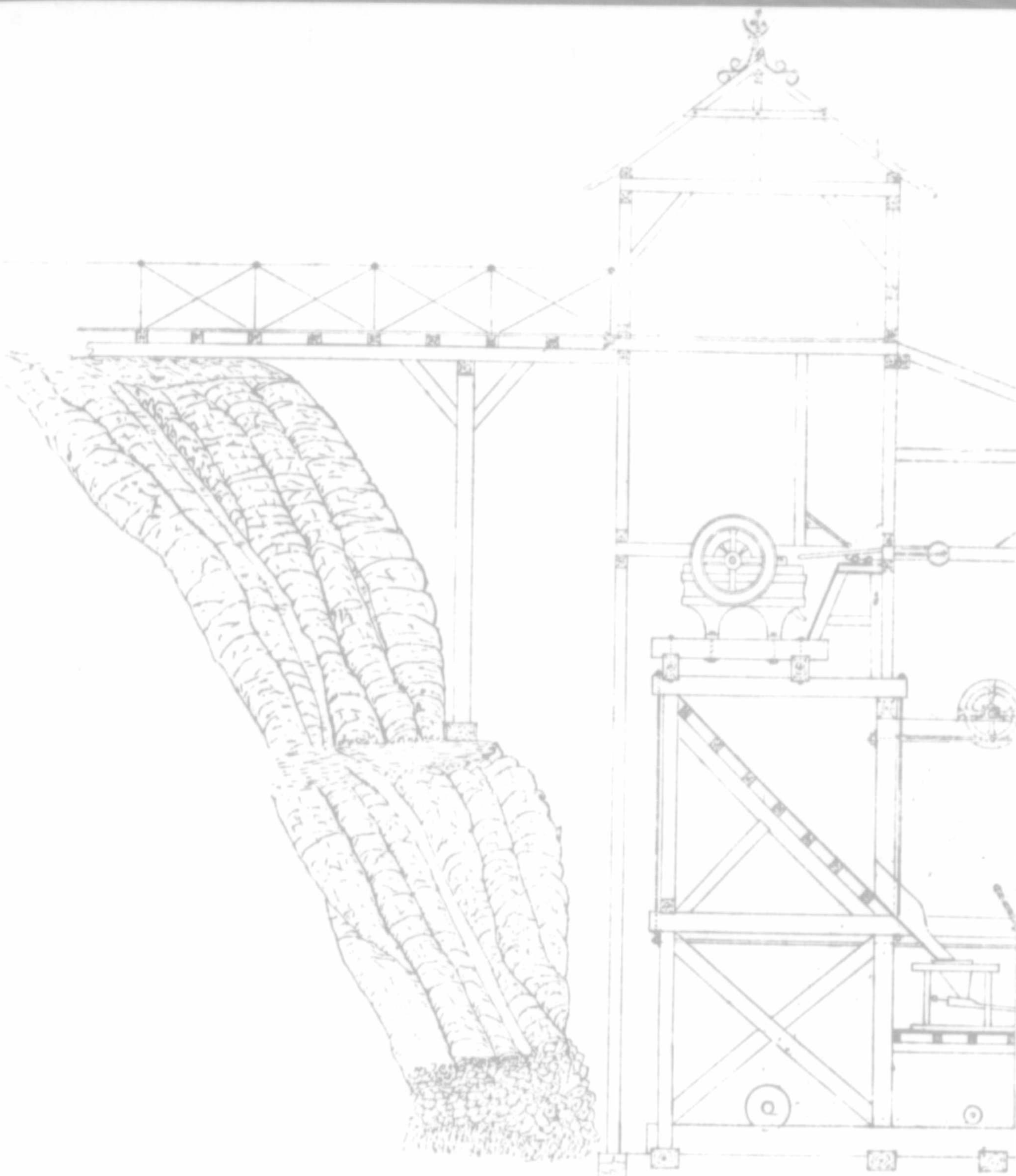




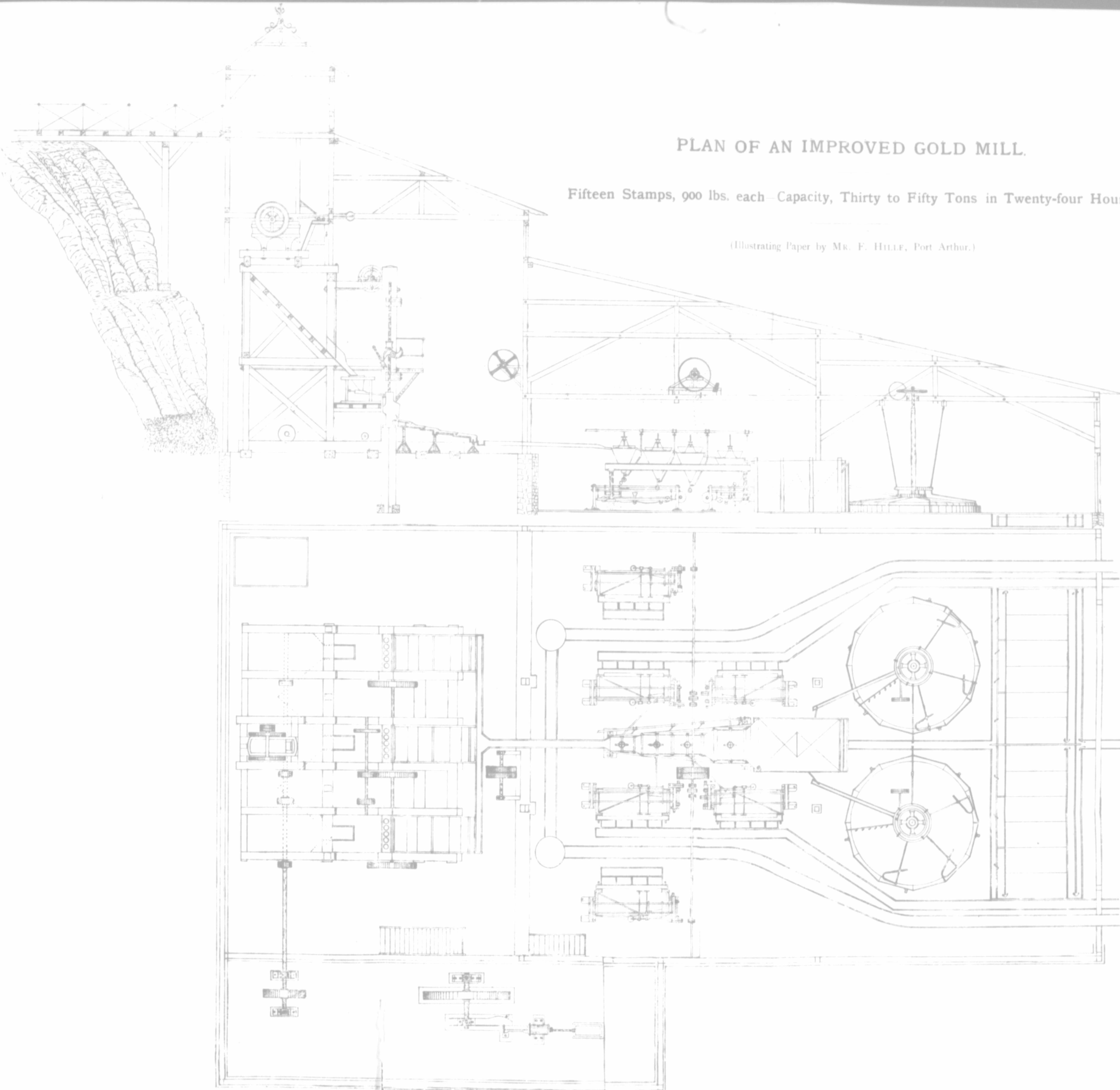
Laszlo Amalgamator.



PLAN OF AN IMPROVED GOLD MILL.

Fifteen Stamps, 900 lbs. each—Capacity, Thirty to Fifty Tons in Twenty-four Hours

(Illustrating Paper by MR. F. HILLE, Port Arthur.)



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heavier stamp with its lower and faster drop and lower discharge, of which the shoe in some of the mills does not rise over the water at all, exerts by its quick up and down movement, I might say, a wave like motion of the water, and by this action keeping the finer and lighter particles of ore more afloat and more from the die before the crushing moment is reached. It is obvious that we gain by these conditions a less production of fine slimes, and a regular discharge. Another reason which urged me to adopt heavy stamps was, that in passing the oxidation zone of our mines we find the sulphurets increasing and the free gold decreasing, therefore mortar amalgamation does not play in our country, in many of the mines to be opened, so important a part as many might think; then undoubtedly the longest period of our mines' existence will be the one while mining unaltered ore.

I come now to the amalgamating table. For a better understanding of its construction and *modus operandi*, I show it also here in a larger sketch, by which you will observe, that as soon as the stream of the slimes leaves the feeding-board, it runs against an obstruction, which not only causes the fine, light particles of slime to stay more suspended in the water, but also helps drowning the float gold. The water runs now down and back partly underneath the feeding board over a copper plate. After it has overcome its momentum it flows forward again, and falls upon and runs over a second plate until it finds another obstruction, makes the same back and forward movement as before, and drops then in a little launder which is lined with amalgamated copper plates. For preventing a settling of the sands and minerals, a stirrer keeps the ore pulp in motion, which is discharged over the front side of the box, being somewhat lower than the back part. The slimes in their forward course repeat the same play as before until they are discharged from a launder into the sluices, whence they enter the hydraulic classifiers.

I think it is hardly necessary to comment on this table, as it is easily comprehended that through the frequent interruption which the current finds on its way over the table that the light fine slime particles are not given time to settle so tenaciously on the copper plates, as it is the case on those tables which we have usually in use here. The area of the copper plates on a table of the size shown in the plan—56 x 122 in., without frame, is 61½ square feet, has therefore considerably more amalgamating area than our smooth tables, besides taking less space for placing them.

We come now to the classifiers in which the slimes enter at their smallest side. The little sketch shows that they consist of two prisms, made of sheet iron, sitting one in another, and can by means of a hand-screw be set apart as far as desired. Overhead runs a water pipe from which connections are made to the bottom of the outer prism, pressing a stream of clean water upwards, which holds the floating slimes in equilibrium, except those sands and minerals which resist, or better to say, which are heavier than the force of that pressure. These fall to the bottom of the Spitzlutten, and are discharged through a spigot bent upwards to nearly the middle of the apparatus. The still suspended slime particles flow on into the second classifier, where the prisms are sitting farther apart and lose here the next heavier grains of the ore. And so the process is going on, until all the coarser grains of the sands and heavier mineral particles are separated from the finer slimes. On considering the construction of these classifiers we see at a glance that the presence of the inner prism is a considerable improvement over those where they do not exist, because we are enabled thereby to regulate the weight of the water column standing above the water pressure from below, I might say, so sensitively, that we can grade the different ore particles in their exact weight and size as they exist in the travelling ore pulp. The finest slimes flow now into a Spitz-kasten, which acts merely as a settling box, over which a horizontal current of water passes, out of which the suspended ore particles fall into the pointed, funnel-shaped bottom of each compartment, and are discharged in the same way upon the buddles, as the coarser from the Spitzlutten on the concentrators. The water with the light muddy slimes contain usually only such a small amount of the precious metal and other metallic components of the ore, that they can be allowed to flow out of the mill, but should there be still an appreciable amount of gold or other valuable minerals suspended in it, then it is directed into settling pits, and the settled fine sands and slimes treated on the buddles.

Now we have seen that we receive in these classifiers graded products, that is, coarser sands besides finer mineral particles whose physical conditions differ greatly and when brought upon the table are naturally not only through their different specific weight, but also through their difference in volume, quickly separated. We have to consider that the stream of water on the vanners exerts always one certain pressure, therefore when I regulate that force so that it will act only on the specific lighter, but more voluminous, or more surface-offering gangue grains, so do we receive under all circumstances cleaner concentrates and also cleaner tailings. Charging these classified products on a Frue vanner we can expect better work from them.

But the concentrators shown here—an improvement on the Rittinger table—are quite a departure from the foregoing, they not only separate the gangue from the minerals quickly and cleanly, as soon as they are brought on the tables, but separate also the freed minerals from each other, as far as their specific gravity will allow it. The separation is fast and sharp, the quartz leaves the tables as soon as it is fed from the board and falls into compartment I., the second product, the blende, into compartment II.; the third, the pyrites, go into compartment III.; and the last in order, the galena, will occupy compartment IV. of a launder and boxes in front of the table. We learn by the little sketch that this concentrator does not discharge at the ends, as is the case with the Frue vanner, but sidewards, to which it can be inclined at any desired angle. The classified pulp is fed diagonally upon a rubber belt which travels against the feed of the ore, and moves over two rollers situated on both ends, of which one of them furnishes the forward movement. It is resting on a table in which grooves are cut, and little streams of water forced through them forming thereby a cushion which hinders wear and tear of the belt. On account of this, the latter is always smooth and level, no sacking occurs, as with the Frue vanner after it is used for some time. This arrangement rests in a stout iron frame which is suspended on two arms on an iron rod, allowing any desired inclination. It receives about 150 percussions per minute by a cam and spring, situated at the opposite ends of the machine; at the same time the belt travels nearly 165 inches, or 2¾ inches per second. By these motions the table is enabled to separate by specific gravity. This is different in the case of the Frue vanner, it receives lateral vibrations, and separation of the gangue and minerals takes place on both ends of the table, that is, the gangue is discharged on the lower, the mixed and heavier minerals, with a certain amount of gangue carried up to the higher end of the table or belt and there discharged. Should different minerals on above described table touch, or run together somewhat near the lines of their discharge these are caught, and kept extra for further treatment on the reserve tables, of which I intended to have two in the mill. They are built of iron, and have a capacity of about eight tons, if the ore is well classified.

The advantages which accrue from the separation of the components of our ores are so obvious that it would hardly be necessary to detail them here. But I would like to draw your attention to these facts emphatically once more, as they are of vital importance for many of our mines.

In most cases the gold in our ores is combined with the pyrites, seldom with galena or blende. Now what an advantage it is if I can send my gold concentrates so enormously reduced in bulk to the reduction works, or if, as we have intended, to give them to the chlorination works. What a saving of expenses in haulage, in space, in roasting, in chlorine! Further, if we save the galena and zincblende, and sell the first mineral which is usually rich in silver, and also the latter, to the one who wants them, we can pay in many cases our milling, if not also our mining expenses with the proceeds therefrom.

Mr. T. A. Rickard, the well known mining engineer and mill expert, speaks in regard to the foregoing: "In the actual pattern of the concentrating mills themselves there is no noteworthy change. The plant of the Smuggler Mining Company at Aspen is designed on the lines of German practice and is probably the most complete establishment of its kind in Colorado. The reproduction of European methods, while it may tend to technical perfection, is, however, rarely desirable, because local conditions do not often render it profitable to turn out a variety of products, such as would find a ready sale in the Old World. While the copying outright of mills of German design is not to be commended, there is no doubt that the best thing the western mill men can do just now, is to pay more attention to that one factor in successful concentration which the Germans have done so much to perfect. I refer to proper sizing before jigging. Indifference on this score has been a serious stumbling block to the attainment of good results in mills which were otherwise excellently designed."

But, gentlemen, even if we should not find here a ready market for the different products, for instance, for the zincblende and galena, so is it undoubtedly of vital importance for us here with our poor communications to the market, to reduce the bulk of our shipping ore, or those products which contain the principal value of our ores, as much as possible. Further, we reduce the reduction expenses considerably, first to the smaller bulk, second through the diminishing of the percentage of blende. I have seen in the veins, and have had in my laboratory very high grade of gold ores, having over 4 per cent. zinc, equal to about 6 per cent. blende, which concentrated to 14 to 16 per cent. zinc, for which we had to pay $3 and $4 extra reduction expenses, allowing 8 per cent and taking the plus units at 50 cents per unit. Do you not consider this a big item? Yes, I had lately average samples from a very rich vein which contained over 9 per cent. zinc, and still more lead, and the gold was only in the pyrites. And if we can increase the percentage of the copper in our gold ores, by getting rid as much as possible of the two former minerals, we increase also our receipts therefrom, being $1 per unit. Is this not also a matter of serious consideration? And everyone of us knows how eagerly the smelters are looking for argentiferous galena for flux; would not this mineral find a ready market? Surely it would, and would also contribute to the paying of expenses. And what is true of charging the jigs with classified pulp is true also to all kinds of vanners. Now in fact the jigs act, I might say, on the same principle as the percussion table above described, they separate also by the difference of specific gravity of the gangue and different minerals.

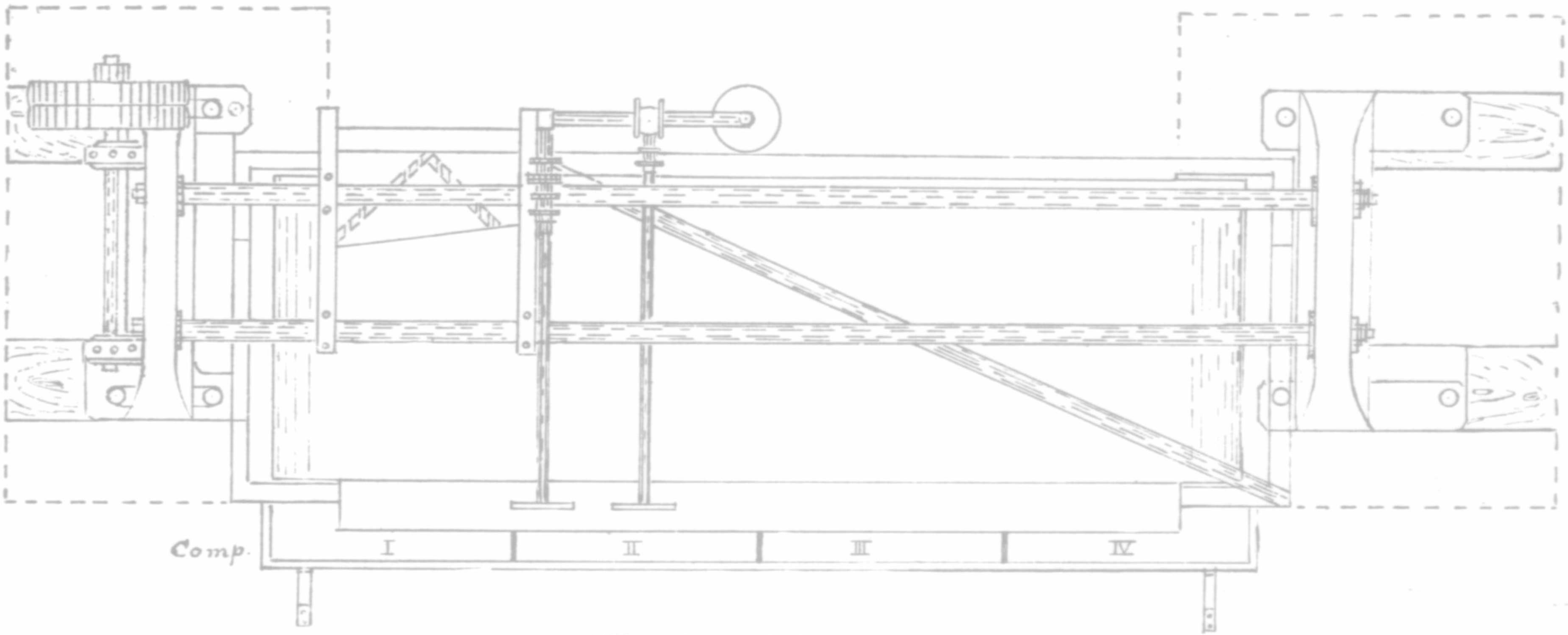
The treatment of the fine slimes, which is so often considered superfluous in our mills, is an essential feature in the German system, and indeed it must be an annoying fact to the millman to know his tailings assay high in gold, silver or any other metal. With the buddles shown here this is greatly avoided, as they concentrate very close, and the tailings show hardly enough minerals to be worth re-handling; they take the place of the blankets in the California mills. This apparatus furnishes the products similar to the percussion tables, the headings are washed into separate boxes, from those of the middlings which are re-washed on the same tables. These machines are built of iron, the upper part of the table covered by a layer of cement, inclining towards the periphery. The slimes are fed against a cone, or ring in the centre of the buddle, and washed by a number of water jets.

Now we have seen that from the time the slimes leave the mortars of the stamps, they flow continuously from apparatus to apparatus, as long as they do not form a ready product, even the clean sands from the vanners and buddles are washed through sluices outside the mill. Only the separated metallic minerals, and middlings are handled and carried on a tramway to the store-rooms or the latter back to the machines. The muddy slimes, which really constitute the tailings and come from the Spitz-kasten, represent no larger volume than perhaps a quarter of a pound in a cubic yard of water. But should they still have a certain value they are directed into settling pits as I showed in the plan, and also those yet recovered. We see these tailings do not consist, as in the American system, of an immense bulk, but of such a small amount that their after-treatment will cost only a trifle. Fifty per cent. of the water which comes from the concentrators can be used right over again without intermitting settling tanks.

By the arrangement of this mill manual labor is reduced to a minimum, consequently also the expenses A few men only are necessary to watch the work of the machines, and the number of those carrying the products to the dryers, or store-rooms, depends on the proportion of the metallic minerals in the ore. I could have made the whole operation in this mill automatic, by flushing the ready products through sluices in the storing room, where they had to be unwatered by a suitable arrangement. Also the middlings could have been fed automatically on the reserve tables. In a country like ours, where water is plentiful almost everywhere, it would have saved a considerable expense, but I omitted here and showed the hauling of the products by a tram-road.

Gentlemen, before concluding this paper, permit me to occupy your attention for a few minutes longer for the purpose of describing to you an amalgamator, which may interest you not only through its ingenuity, but also on account of its efficiency, because where it is in use it has proved to amalgamate from 20 to 40 per cent more gold from the slimes than any other apparatus so far in practical use. It is known as the Laszlo amalgamator, and consists of an iron dish contracted at the bottom. On top of it, fastened to a vertical shaft, rotates free of the former an iron casting with a hopper and open circular rings, three on the larger, and two on the smaller apparatus. Between these stand two, respectively, one iron ring, and at the lower ends are fastened a number of scrapers. When the apparatus are in operation and the ore fed into the hopper the little scrapers move the pulp very closely and in ever-growing circles over the quicksilver toward the periphery and bring so the free gold particles in contact with the former. Through the frequent revolving of the ore pulp in the dish over the quicksilver, we see that the gold passes over a much larger area of mercury than is the case on the tables. Through this action it is hardly possible that a gold particle should escape amalgamation, unless they are surrounded by films of an oxydation product of any element with which they were combined. The rings standing in the lower dish, and dividing it into different compartments, are for the purpose of making the ore climb over them, and retaining thereby the quicksilver or amalgam which should have been stirred up, by simply falling back again into its former place. These amalgamators, which are always in sets of two, have a capacity of about two tons in twenty-four hours; they have not only the advantage of saving a greater amount of gold, but also of saving considerable labor, compared with the tables, as they do not need to be cleaned and re-charged more than from once to four times a month, which of course depends on the richness of the ore. They can be kept under lock and key so that a meddling with the amalgam is prevented.

Now, gentlemen, I would be very glad if I should have succeeded by the description of the machines shown in the plan before you, to convince you that we can improve the conditions in our gold or other dressing works considerably. If so, and if it should bear fruit to the benefit of the country in general, and the mining industry in particular, I would be highly rewarded for my endeavor.



Bilharz Automatic Percussion Table.

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The Value of Careful and Complete Analysis of Rocks and Minerals.

By Dr. W. L. Goodwin, Kingston, Ont.

This short paper is a plea for an extension of this laborious work, engaged in by too few chemists, mineralogists, and lithologists—too few, because the field of investigation is so vast and the labor involved is so enormous that a large army of enthusiastic, patient toilers is required to carry it on.

I am using the words "rocks" and "minerals" in their scientific sense, a *rock* being defined as the material composing a layer, vein or other distinct part of the earth's crust, and a *mineral* as a more or less distinct chemical species found as a constituent of rocks. In the analysis of rocks it is possible, by taking advantage of differences in specific gravity, to separate the constituent minerals from each other before submitting them to chemical analysis. The minerals composing a rock can also be identified by examining thin sections under the microscope. The identification is aided by characteristic changes in appearance produced by addition of chemical reagents. Valuable information can be obtained by these and similar methods, the object of which is the identification of the minerals composing a rock; but this information must be supplemented by complete qualitative and quantitative analysis of the rock in order that our knowledge of its character may be complete. Such analysis involves an amount of labor which deters, no doubt, most chemists and mineralogists from devoting themselves to its pursuit. A man cannot do very many of them in a year. It may take the analyst six months to complete a research the results of which can be stated in a few lines of print.

I shall attempt briefly to show that such work pays both commercially and scientifically. The economic importance of minute chemical analysis of iron ores and fluxes is recognized by those engaged in the manufacture of iron and steel The properties of iron are so profoundly affected by even very small quantities of sulphur, phosphorus, manganese, chromium, &c., that the proportions of these elements in the ores must be known before their reduction is undertaken. The iron industry has been revolutionized during the past fifty years by the labors of chemists and metallurgists directed toward discovering the influence on the properties of iron of minute proportions of various elements. An English writer has recently pointed out that Great Britain has fallen behind Germany in many chemical and metallurgical industries. This he ascribes to greater generosity of the German Government in supporting technical schools. In and about these schools an army of investigators is constantly at work on scientific problems. The spirit of research pervades the land. The Germans understand the economic value of scientific research.

As data are accumulated we may expect exploration for valuable minerals to be aided by systematic and minute chemical analysis of rocks. For example, careful examination of talc found in eastern Ontario shows that it carries a very small quantity of nickel. This recalls the serious competition felt by our Sudbury nickel producers owing to the greater ease with which the metal is reduced from the New Caledonia ore, *garnierite*. Garnierite is, doubtless, talc changed by the infiltration of nickel compounds. At least its composition and physical properties admit of that explanation of its origin. It is at least within the range of possibility that the same process may have produced garnierite somewhere in Eastern Ontario. Nickel is found in small quantities in some of the commonest rocks of this district.

Careful and complete analysis of rocks and minerals may also bring to light the existence of paying quantities of those rare substances, at one time exclusively subjects of scientific investigation, but sooner or later finding their place in manufacturing industry. The manufacturers of the Auer gas burners pay at the rate of from $100 to $150 a ton for the monazite sand, from which is extracted part of the material for the incandescent mantles. The discovery of a considerable mass of material containing a small per cent. of "thorium," the oxide of which enters into the composition of these mantles, would be a very fortunate one. And yet, in an incomplete analysis, it would be very easy to pass over such a quantity of so rare an element. New elements have been discovered because careful determination of all known constituents of a mineral did not add up to one hundred per cent., but fell considerably short of it.

Nearly a hundred years ago the great analyist Klaproth, during an extended research into gold ores, discovered the element "tellurium," which has since been recognized as the cause of serious loss in the extraction of the precious metal. It might be useful for some Canadian chemist to examine a large number of Canadian gold ores for tellurium. He might be lucky enough to discover a new element.

I think I have made out my case for the economic importance of careful analytical research, and will add just another instance which has come under my own observation. A complete analysis of a basaltic rock found near Kingston has shown that it carries over one-half per cent. of nickel. When nickel ores become scarce, this rock, extending for miles through this part of Ontario, may become important. From its appearance no one would suspect it of being a nickel ore.

From the scientific standpoint argument is easier. Rock and mineral analysis, although so tedious, is full of interest, because it is full of surprises. I have just heard from one of my friends working in Leipsic that an odd-looking mineral picked up near Stoney lake turns out to be a new species. This fact was revealed by a fairly complete analysis which fell some fifteen per cent. short of the hundred, when all the constituents commonly determined were added up. The wide diffusion of the elements receives fresh confirmation from the patient labors of the analyst. Such important laws as the regular variation in the proportion of acidic to basic constituents in crossing an eruptive mass have been made out in this way.

W. F. Hillebrand, in a paper read before the American Chemical Society (Journal, 1894, p. 90) urges "greater completeness in chemical rock analysis," as follows:—"The valuelessness to the mineralogist and geologist of many of the analyses of mineral substances made in earlier times is a fact too well known to need substantiation. Defective methods of analysis, the difficulty of procuring pure reagents, and want of time for exhaustive examination have been largely responsible for this condition, but lack of appreciation of the fact, now so well established, that substances present in small amount may have an important bearing on the discussion of results, has no doubt contributed in no small measure to it. . . . Enough instances of totally inaccurate conclusions to be drawn from them (incomplete analyses) have fallen under my own observation to fully justify this plea in favor of greater completeness in rock and mineral analyses for purely scientific purposes."

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A Newfoundland Iron Deposit.

By R. E. Chambers, B.A., M.E., New Glasgow.

In Conception Bay, Newfoundland, about midway between its entrance and its head is situated Bell Island.

This island is eight miles long by two wide, and is about 35 miles by water from St. Johns. Upon its northern shore are stratified beds of hematite, which, on account of accessibility, quality, and ease of mining, are likely to come into prominence during the next few years.

Geology.

The measures containing these beds consist of shales and hard sandstones, and are said by the government geologists of Newfoundland to be of silurian age. The underlying measures are seen on Little Bell island, Kelley's island, and upon the shore of the bay at Topsail, where the lowest beds consist of limestones reposing at a high angle upon the Huronian and Laurentian formations of Avalon peninsula

The beds containing the iron ore are even and unbroken, and lie at an easy dip to the northward.

Beneath is a great thickness of white sandstone, while in the immediate neighborhood of the ore are several thick shaley bands of dark color.

Different Beds.

There are in all five beds of ore exposed in the cliffs upon the northern side of Bell island.

Three of these extend over so small an area, and are so thin that they are not of commercial value, and for this reason will not be here again referred to.

The two lower beds are of larger size and extend over wider areas.

The Lower Bed.

The outcrop of this bed is seen in the cliffs on the north side of the island, its western extremity being at Ochre cove, and its eastern near Gull island head.

It is first met upon the tramway at a distance of 8,600 feet from the pier. From this point the distance is one mile to the eastern end of the outcrop, and two and one-half miles to the western end. At the open cut near the tramway the section shows ten feet of clean ore. At Gull island head the bed is eight feet thick and at Ochre cove seven feet, the average of the whole bed being probably eight feet.

At the western end the dip is N. 19° E. 7°. This increases a few degrees going east, and the dip changes towards the north. Along this outcrop of 3½ miles not any dislocation of the strata has been found, and the ore is exposed over most of its extent. This gives unusual facilities for open-cut working. There is little doubt but that 200 feet of this outcrop can be mined open-cut over the greater part of this distance, giving 2,000,000 to 3,000,000 tons of ore. When this is worked out many times that amount can be mined underground with natural drainage.

From the open cut near the tramway 3,000 tons have been shipped to the Ferrona furnace of the Nova Scotia Steel Company, giving entire satisfaction in the manufacture of foundry pig iron.

From about 100 analyses made during the past year the composition of this ore is found to be:—

	%	%
Metallic Iron	54.000 to	59.000
Silica	5.000 to	12.000
Alumina	2.000 to	4.000
Phosphorus	.500 to	700
Sulphur	Trace to	.012
Carbonate of Lime	3.000 to	5.000
Oxide of Manganese	Trace to	.400

THE UPPER BED.

At Station 101 on the tramway the outcrop of another bed of ore appears, overlying the first in stratification and six feet in thickness, the ore is fully equal to the lower bed, the average of eleven analyses from widely separate points giving 57% in metallic iron While not extending over so large an area as the lower bed its boundaries are equally well defined, leaving no doubt as to the quantity of ore it contains. The exposure in the cliffs is quite regular at both the east and west ends, and the ore has been test-pitted along the outcrop between.

Over a great part of its extent this bed is denuded of the overlying strata making it accessible over large areas for open-cut mining.

Quantity of Ore.

The area of the lower bed upon Bell island is 817½ acres. Counting 10 cubic feet of ore to the ton and considering the bed 8 feet thick, which is a fair average.

$$\frac{817.5 \times 43560 \times 8}{10} \quad 28{,}488{,}240 \text{ tons.}$$

The area of the upper bed is 240 acres and its thickness 6 feet.

$$\frac{240 \times 43560 \times 6}{10} \quad 6{,}272{,}640 \text{ tons.}$$

This gives a total upon the island of 34,760,880 tons.

As will be seen from the sketch of the outcrop this quantity can be legitimately considered to be in sight.

The outcrop inland and the exposures in the cliffs give access to the beds from all sides.

Shipping Facilities.

Conception Bay, to the north-east of Bell Island, opens gradually towards its mouth into the Atlantic ocean, so that with northerly winds the side of the islands on which the ore is situated could not be used for shipping purposes, consequently shipping has to be done on the south side. A small beach near the east end and the situation of the island itself form a perfect shelter from northerly winds, and the mainland being close to hand on the south and east no ocean swell is to be feared from that direction; consequently the pier is so situated as to be perfectly safe with the wind from almost any quarter of the compass.

The waters of the bay are deep and free from rocks and shoals, the bottom being mud near the pier affords admirable anchorage.

Near the island the admiralty charts show from 8 to 14 fathoms of water on the southern and from 6 to 20 fathoms on the northern shore.

The bay is navigable from 8 to 9 months in the year.

Equipment.

The ore being obtained by open cut work from the outcrop an elaborate mining plant is not necessary. Two systems are employed for excavation. In the first the cars are run by gravity along a track of 2 ft. gauge to the working face, whence, after being loaded, they run, still by gravity, to the main tramway. This is made possible by a switch for empties being at the top while the switch for loaded cars is at the foot of a 10 per cent. grade. The track is shifted laterally to keep within loading distance of the receding face.

Another part of the outcrop is worked by a double travelling cable hoist of 300 ft. span. One span is used for stripping the surface, the other for excavating the ore. The towers with boilers and double drum engine are upon trolleys capable of being moved in a direction parallel to the strike as the excavation proceeds. As before the empties are switched from the main tramway at the top of a grade and dropped by gravity beneath the cable. They are then conveyed by the cable carriage to any part of the working face, whence after loading they are again hoisted and placed in the full track leading to the main tramway. Upon any part of the ore being excavated the whole plant is moved upon the supporting tracks to new ground. The accompanying illustration will give a clearer idea of this part of the plant.

TRAMWAY.

From the mine the ore is conveyed over a double track tramway of 2 ft gauge and two miles in length to the shipping pier; this is operated by an endless steel cable, 1⅝ in. in diameter, four miles in length. The alignment is perfectly straight and the profile is shown in the sketch. The cable is supported by wooden rollers 25 ft. apart, while at the apices of the grades iron pulleys 2 ft. in diameter are placed. The cable is kept in proper tension by counterbalance weights. The power house contains two upright tubular boilers and a double cylinder stationary engine geared 1 to 20 to two 6 ft. 6 in. bull wheels. One of these operates the cable for the line now working, the other is spare, for any road it may be found necessary to construct. At present the tramway has a capacity of hauling 500 tons to the pier in 10 hours and by increasing the rolling stock 1,000 tons could easily be shipped in the same time.

PIER.

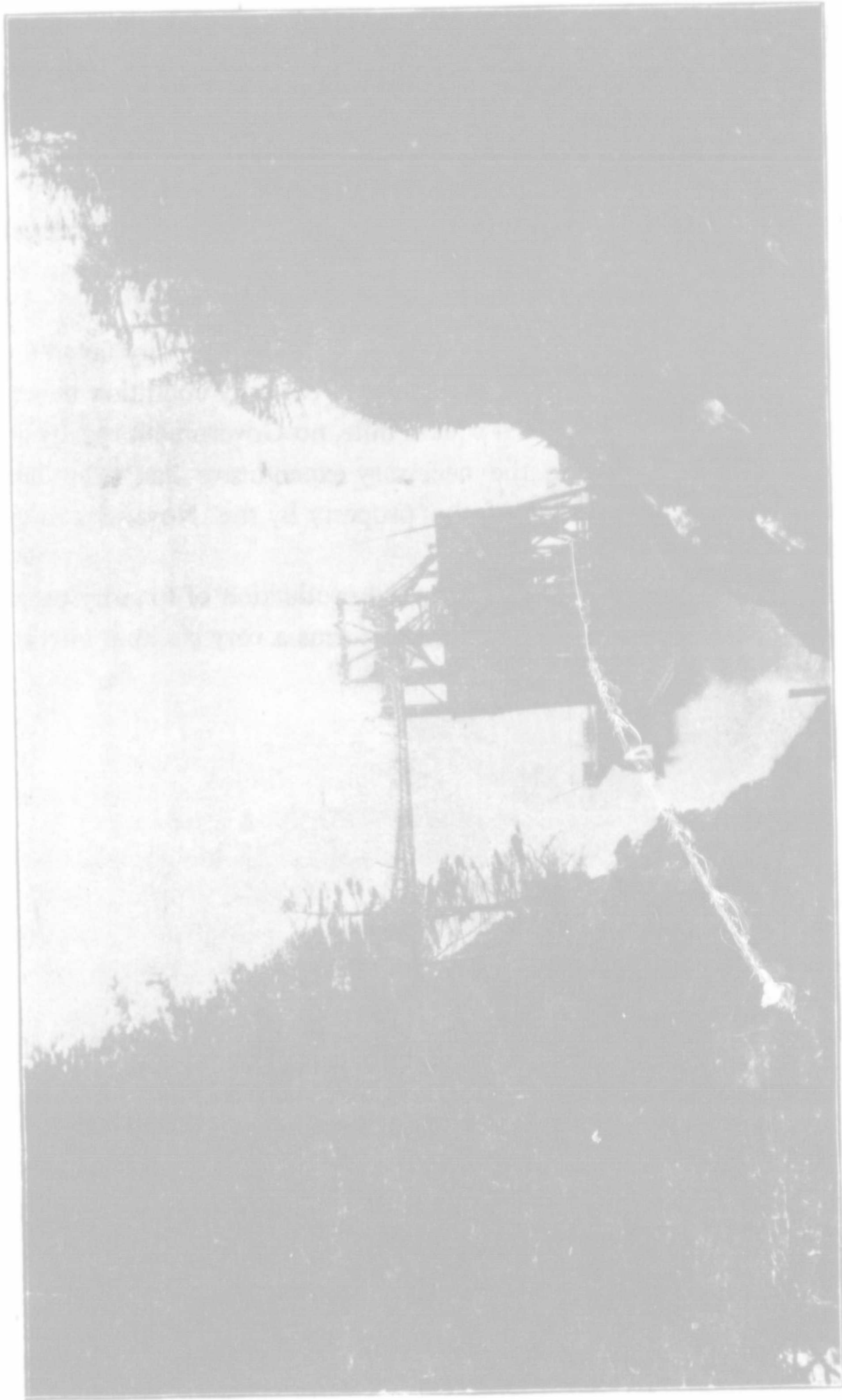
The pier is 45 ft. x 65 ft. and 90 ft. high, constructed of southern pine; it is supported upon 190 bearing piles surrounded by a cribwork of heavy timber filled with stone. There are ten pockets of 200 tons capacity each at a height sufficient to discharge into a steamer by gravity. The shutes for this purpose descend at an angle of 40° and are moved by a counterbalanced winch easily operated by one man. The cars are dumped by an automatic tipple, upset by the weight of the loaded ore, and returned to an upright position by cast iron counterbalance weights hung upon a shaft beneath the floor. In loading a steamer 200 tons have been discharged from one pocket in 10 minutes.

The depth of water at the pier is 24 feet at low tide increasing rapidly away from the shore. The access is easy, unobstructed by rocks or shoals.

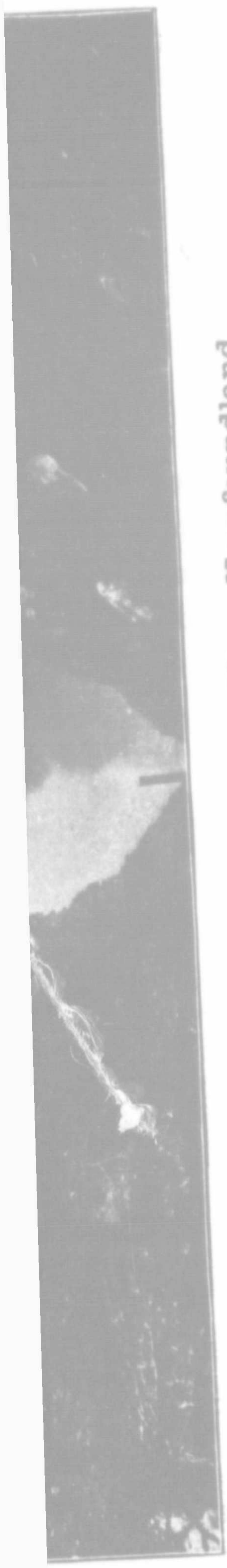
The terms of the Newfoundland mineral act are very favorable to the operators in regard to security of title, the only condition being the expenditure of $6,000 for each square mile, no Government royalty being demanded. In this case the necessary expenditure has been largely exceeded in the equipment of the property by the Nova Scotia Steel Company who control it.

This ore will be largely used for the production of foundry pig iron.

The Nova Scotia brown hematite forms a very suitable mixture in connection with it.

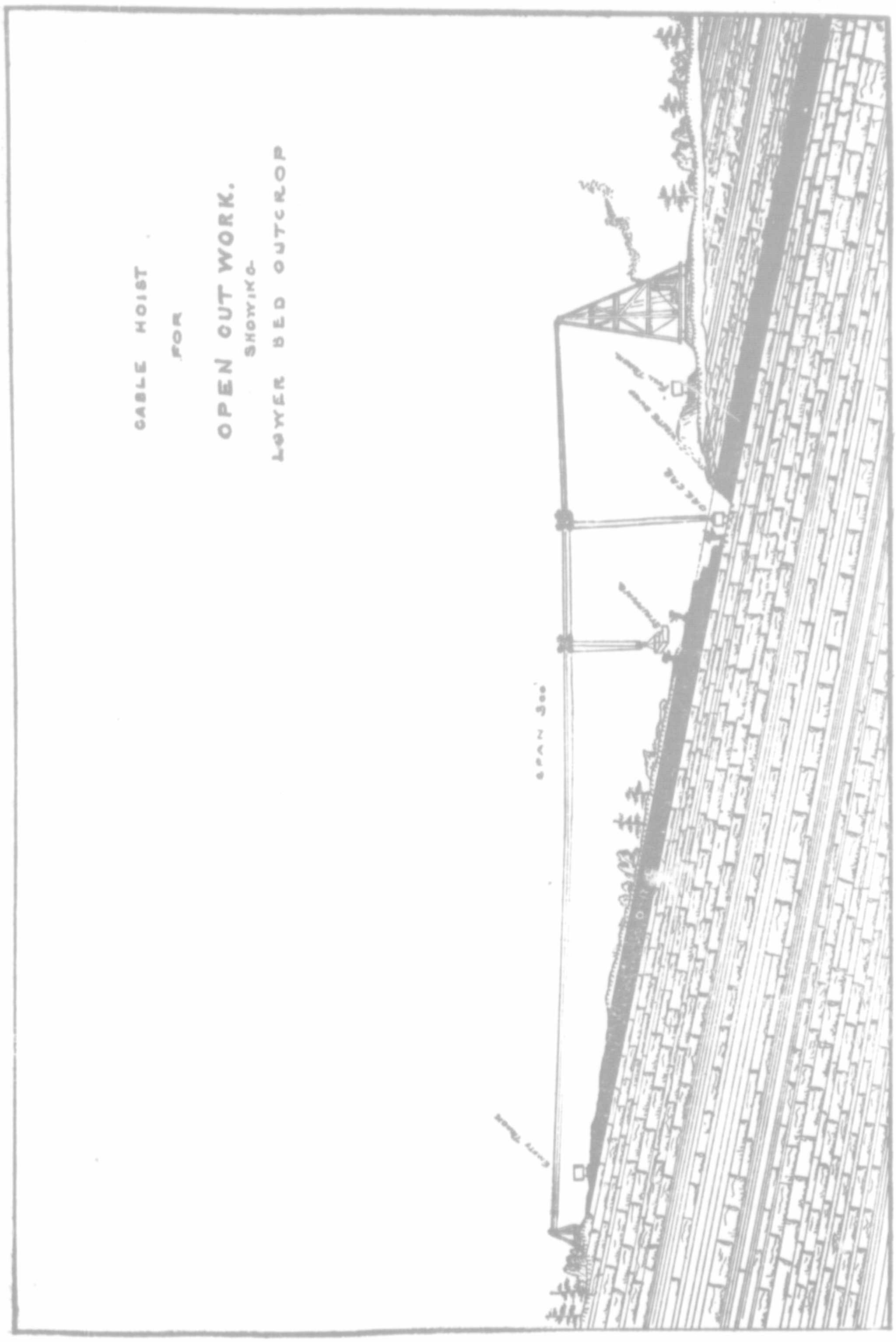


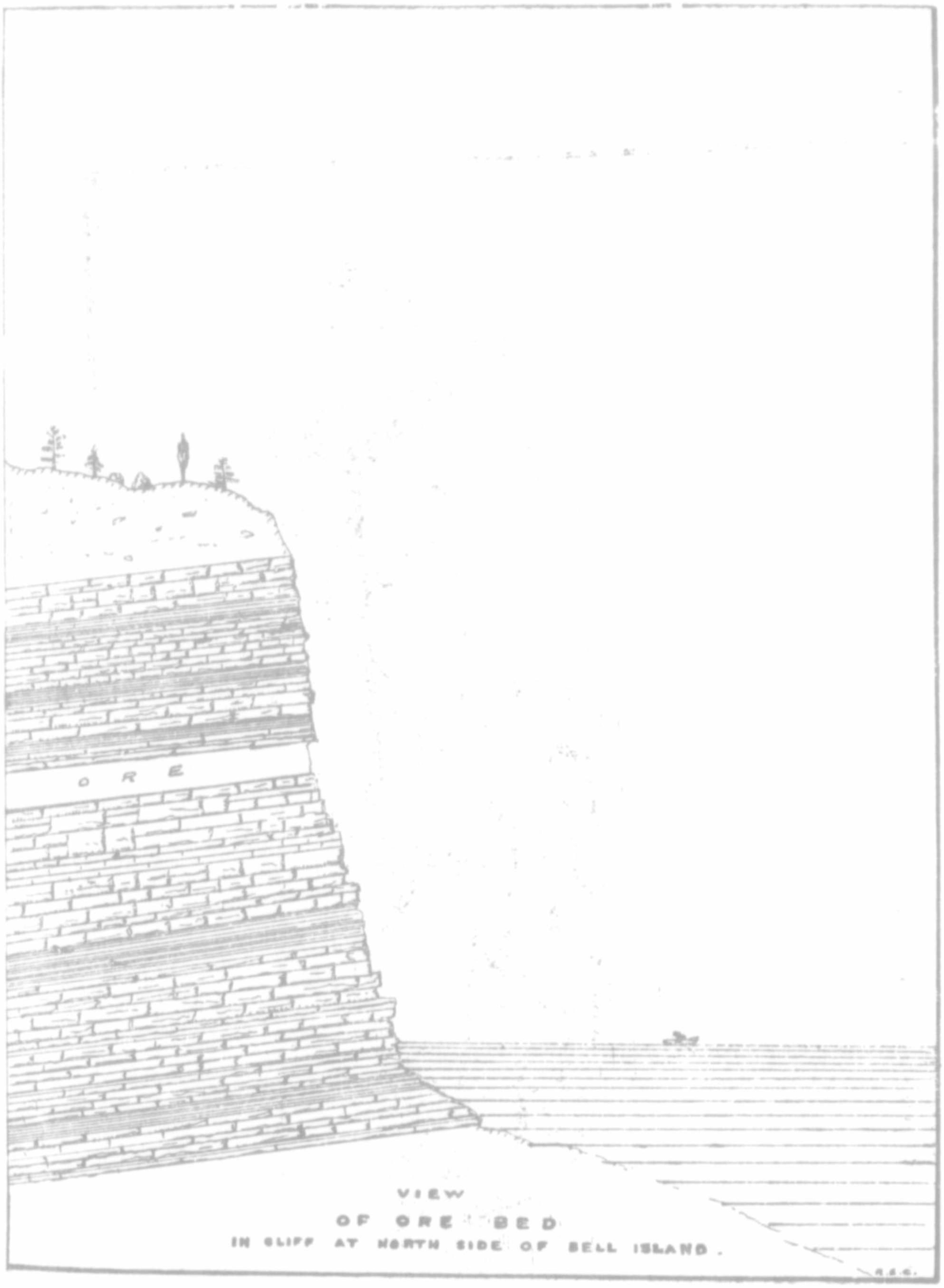
Shipping Pier, Bell Island Iron Mine, Newfoundland.



Shipping Pier, Bell Island Iron Mine, Newfoundland.

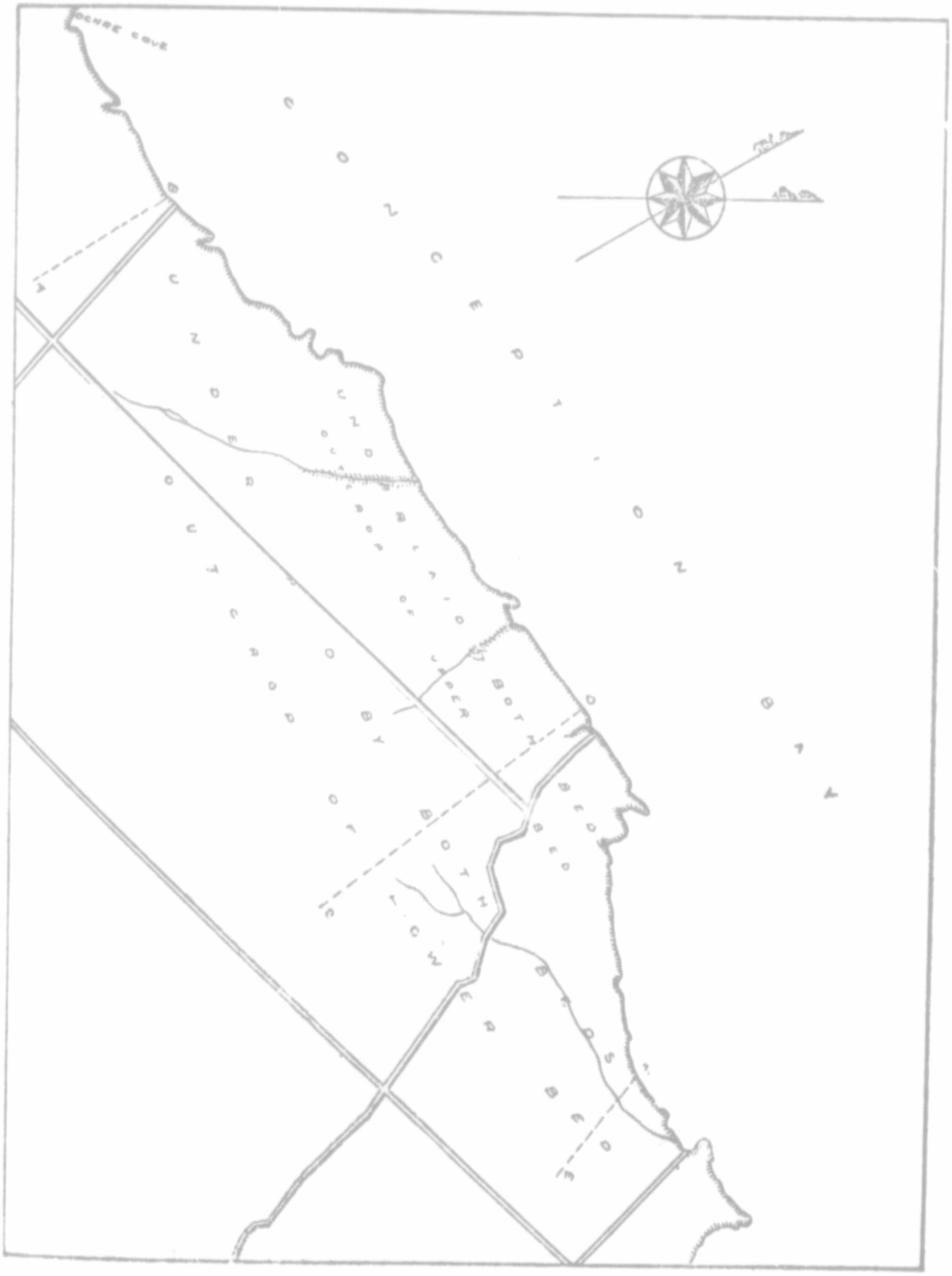
SECTION CD


CABLE HOIST
FOR
OPEN CUT WORK.
SHOWING
LOWER BED OUTCROP
SPAN 300



VIEW
OF ORE BED
IN CLIFF AT NORTH SIDE OF BELL ISLAND.


GREAT BELL ISLAND.
SHOWING
PIER, TRAMWAY AND ORE OUTCROPS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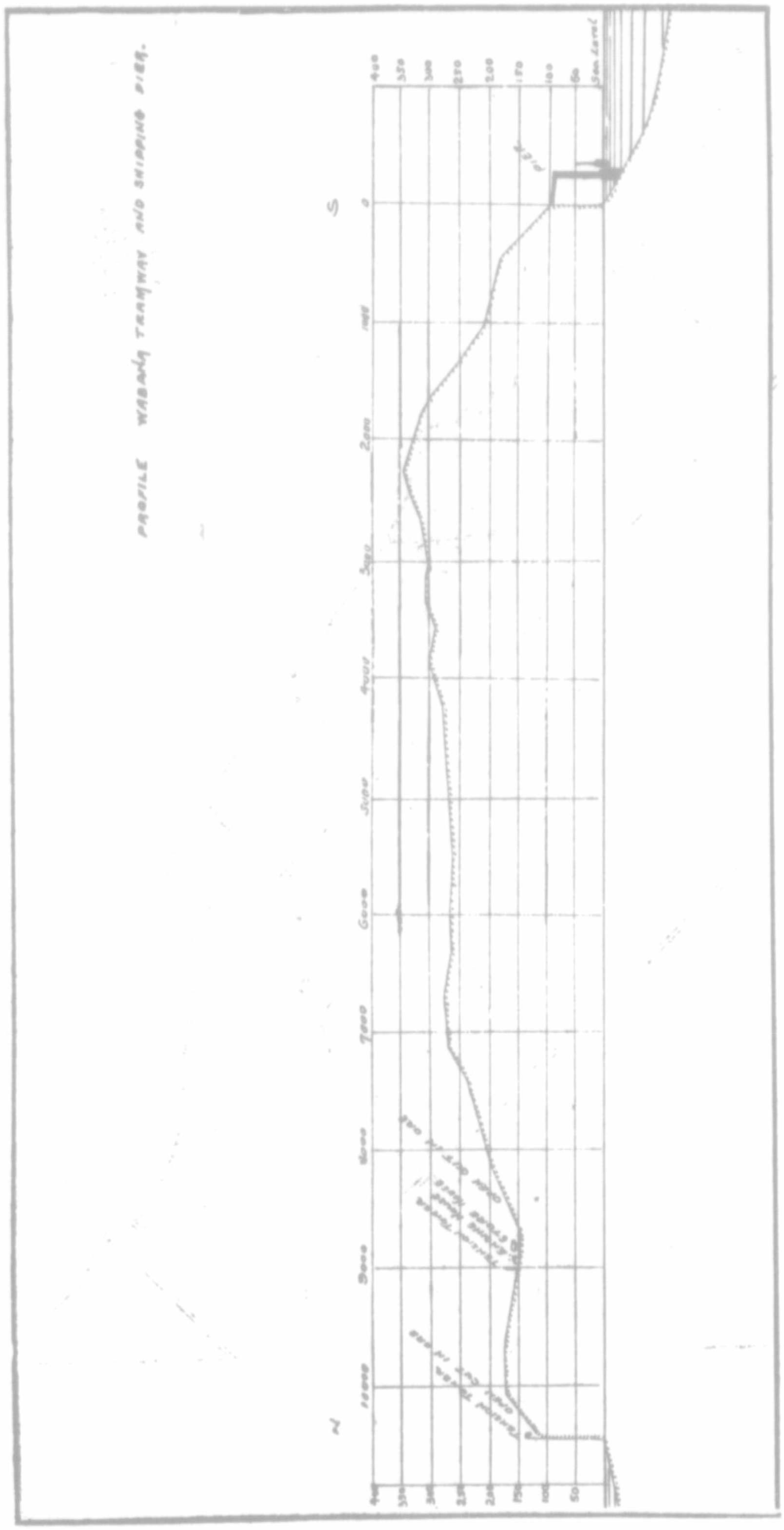
PROFILE WABANA TRAMWAY AND SHIPPING PIER.

Compressed Air at Sydney Mines, Cape Breton.

By R. H. Brown, M.E., Sydney Mines, C.B.

There being two accumulations of water in the workings at this colliery—one of several millions of gallons lying in the workings at 3,590 ft. distant from the shaft bottom and at a level of 209 $\frac{9}{10}$ ft. below it; the other a much smaller quantity, lying at or near the face of the north engine deeps at a distance of 1,700 ft. from the other body of water and at a level of 155 ft. below it—the determination was come to of pumping these two bodies of water to the shaft bottom by using compressed air as a motive power.

One Ingersoll-Sergeant, Class A., straight-line piston inlet air compressor, having steam cylinder 14 in. diameter, air cylinder 14¼ in. diameter, and stroke 18 in., was erected on the surface at 104 ft. from the pit mouth, and one steel tubular boiler, 14 ft. long by 54 in. diameter, having 54 tubes of 3½ in. diameter, and built by I. Matheson & Co., of New Glasgow, was set beside the compressor to supply steam thereto. A steel air receiver, 10 ft. long by 30 in. diameter, was placed on end outside of the compressor house, and was connected with the compressor by a short pipe of 3½ in. diameter.

A small water reservoir, 24 ft. square, was constructed at a distance of about 100 ft. from the compressor, and two sets of 4 in. pipe laid therefrom to the compressor house; these pipes are buried beneath the surface of the ground. One set, 110 ft. in length, leads the water direct to the compressor house, where it is received by a small duplex Blake pump, having 3 in. steam cylinders, 2 in. water plungers and 3 in. stroke, which elevates it to an iron tank placed over the compressor; the bottom of the tank stands 9 ft. 10 in. above the centre line of the air cylinder of the compressor. The water from this tank supplies feed for the boiler, and cooling water for the jacket which surrounds the air cylinder. The other set of pipes, 240 ft. in length, takes this cooling water by a circuitous course back to the reservoir. The water is thus kept circulating, being cooled by its journey through the pipes under the ground.

The intake air enters the compressor through a short length of pipe 4 in. diameter, projecting through the end of the building into the external air. To prevent dust and foreign substances being drawn into the compressor, we built a wooden box or shaft, 22 in. by 12 in. in section, and 16 ft. in height, against the end of the building and enclosing the end of the intake air pipe. The air being thus drawn from a point above the roof of the building, is free from dust and smoke.

The compressed air is conveyed from the air receiver down the shaft and into the workings by wrought iron pipes; these pipes are 6 in. diameter from the receiver for a length of 2,467 ft; thence they are 5 in. diameter for 1,152 ft. farther; thence 4 in. diameter for the next 860 ft., to air receiver No. 2. This receiver, made of steel plates, is 8 ft. long by 30 inches diameter, and near it stands pump No 1. The pump, situated at 4,479 ft. from the air compressor, is a Northey duplex, having 7½ in. air (or steam) cylinders, 4½ in. plungers and 10 in stroke; it works at the average 100 strokes per minute, forcing the water to an elevation of 209$\frac{8}{10}$ ft. through 3,590 ft. of delivery pipe of 5 in. diameter. The water delivered, deducting 5 per cent. from the calculated delivery for slip of pump, is 54$\frac{4}{10}$ imperial galls. per minute.

From air receiver No. 2, the pipes are continued of 4 in. diameter for 1,150 ft. down the engine plane; thence they are only 3 in. diameter for 400 ft farther to air receiver No. 3. This receiver is of same dimensions as receiver No. 2, and from it the 3 in. air pipes are continued 120 ft. farther, to pump No. 2. This is a Worthington duplex pump, having 4½ in. air (or steam) cylinders, 2¾ in. plungers, and 4 in. stroke. This pump, situated at 6,149 ft. from the source of the motive power, works at 90 strokes per minute, forcing 7$\frac{3}{10}$ galls. of water per minute to an elevation of 155 ft. through 1,700 ft. of delivery pipes, of 2½ in. diameter; it delivers its water to pump No. 1, which forwards it to the shaft bottom.

It was determined to apply the compressed air taken in bye to such a distance, to the operation of two coal cutting machines, and a winch to assist the underground haulage; as well as to working the two pumps above described. The winch having two cylinders, each 7 in. diameter by 12 in. stroke, was fitted with a drum of 26 in. diameter, on the second motion of 5½ to 1, and was set up in the vicinity of pump No. 2. The wire rope by which this winch hauls 4 or 5 boxes of coal at a trip up an incline of 1 in 6, is only ⅜ in. diameter, of crucible cast steel, made by the Dominion Wire Rope Co. The coal is drawn from distances of 500 ft. to 800 ft. from the faces of the deeps to the engine plane, and the winch takes the place of four horses or more.

The two coal cutting machines are an Ingersoll-Sergeant and a Harrison, our compressor supplying sufficient air to operate them both successfully. They work at the coal faces, about 500 ft. from pump No. 2, the air being led to them from that station through pipes of 1½ in. diameter.

It has been often stated that compressed air is a wasteful power and shows a low percentage of useful efficiency. I can hardly think that such would be found to be the case with our plant. I have not had time to make any calculation of the horse power applied, and the useful horse power obtained in our case. I only know that our compressor is a small affair, but does a big amount of work, considering the great distances between the source of the motive power and its points of application.

In the matter of air used, I should like to say that our No. 1 pump uses 70 cubic feet of free air per minute; the air winch at full work uses 668 cub. ft.; and the two coal cutters, working at 200 strokes each per minute, use 157 cub. ft.; a total of 895 cub. ft. per minute. As the Ingersoll catalogue only claims that our compressor should compress 398 cub. ft. per minute, it appears that the compressor is well up to its work. Of course the delivery of 895 cub. ft. per minute cannot long be maintained, but it can be depended on for a "spurt" when desirable.

The question of pressures is interesting. With a steam pressure of 62 lbs. at the boiler, and the engine going at 83 revolutions per minute, we get a pressure of 80 lbs. of air in the receivers at the compressor, and from 81 to 82 lbs. of air in the receiver at No. 1 pump; and practically 80 lbs. at No. 2 pump, 6,149 ft. distant from the compressor.

With a temperature of 28° Fah., at the intake on surface, 43° in the air at pit bottom, and 51° at No. 1 pump, we find the exhaust from that pump to be 30° at the distance of 12 inches from its exit, and 2° below zero at 2 inches from the exit.

I may add that the consumption of fuel by the boiler which actuates the compressor averages 248 lbs. of slack coal per hour worked.

Pumping with Compressed Air.

By H. S Poole, M.A., A.R.S.M., F.G.S.

The use of compressed air as the motive power in mine pumps is rapidly extending in Nova Scotia, and as a general thing the users are content with the advantage gained by the substitution of air for steam in the pumps already at work in the mines. The objections to the use of steam underground—loss in transit by condensation, objectionable heat, crumbling of roof or walls through steam escaping, and trouble occasioned by the expansion and contraction of the piping on long inclines when the steam is on and off,—need not here be further dwelt on. The point that is submitted for consideration is this:— "Is full advantage taken of the compressed air as at present generally applied?" Judging by my own experience, I should say, far from it.

Having decided some three years ago to substitute air for steam at the bottom of a long incline, a point 4,000 feet away from the boilers, pump-makers were asked what make of pump they recommended. Invariably they answered, "You cannot do better than use OUR direct acting steam pump." Enquiry of compressor men obtained only indifferent replies. Those asked evidently did not know anything about the *use* of air, or if they did, did not care whether or not the air was used to advantage. All they seemed to know or care was that their particular make of compressor should be adopted.

In this respect surely a great mistake is made, for it certainly would appear to the interest of compressor makers to shew how to use air to the best advantage, as it evidently is to the makers of cotteline to shew consumers how best to use their goods. However, by enquiry and some experience, I am now satisfied that the majority of users of air in Nova Scotia are more wasteful than they suppose, and that a consideration of the question cannot but be beneficial.

1. It is evident that the clearance in the cylinders of direct acting steam pumps, often 12 per cent. of the stroke, represents a large loss.

2. It is very possible the ports also are unnecessarily large.

3. It may be that where the mine water has a temperature above 60° Fahr., as in deep coal pits, a water jacket would raise the mean temperature of the cylinder and reduce the tendency to make ice in the cylinder and ports.

4. Then if the air cylinder and the water plunger be not proportioned to the work to be done, and the air has to be throttled down to the required pressure, it is clear there is a loss in conseqence of the cooling of the air, unless the throttling is done at such a distance from the pump that the compressed air can recover from the surrounding air the heat which it has lost.

5. The prints in catalogues of compressors seldom show (I have yet to see one that does show) the inlet taking air otherwise than from the compressor house, and yet as the air in the house is always warmer, and generally also more moist than the external air, the loss incurred from so taking the air is well worth looking after. At 60° Fah. a difference of 5° is equal to 1 per cent. of the coal consumption, while the actual difference on the mean of the year cannot be less than 20°, or equal to no less than 4 per cent of the fuel consumption in favor of taking in air through a properly constructed duct free of dust.

Experience with Air Compressing at Drummond Colliery, N.S.

—

By Charles Fergie, M.E., Westville.

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The underground pumps at this colliery until quite recently were driven by steam taken from the surface along an incline having a pitch of 16 degrees and some 4,200 ft. in length.

In consequence, however, of the loss of power in carrying steam that long distance, the great heat produced in the pipe road and pump room, the latter 110 F., the bad effect of heat and moisture on the roof and sides of the roads, and consequent expense of maintaining the same in a safe and satisfactory condition, the interference of heat with the ventilating currents, and the many other sources of trouble due to the use of steam underground led the management to substitute compressed air for steam as the motive power at the pumps.

The compressor used is a duplex, 14 in. x 22 in., built by the Canadian Rand Drill Co., Sherbrooke, Que., has steam expansive cut off, Halsey's positive air valve motion, the air cylinders are water jacketed, The boiler pressure is 110 lbs. and steam is cut off in the cylinder at ¼ stroke. The air supplied to compressors is taken from outside the compressor house.

The compressors were purchased with a guarantee to drive two separate pumps at the same time, and each capable of throwing 40,000 gallons in a shift of eight hours, one against a vertical head of 600 ft. the other against a head of 300 ft.

The then existing steam pumps were to be used and consisted of one, the No. 9, duplex compound straight line plunger pump, cylinders 8 and 14 in. x 18 in. stroke; clearance ½ in. at each end; plungers 4½ in. This pump has the 600 ft. head to force against. The second, or No. 11 pump, is a single straight line plunger pump, 14 in cylinders by 12 in. stroke; clearance ½ in., and plungers 5 inches. This works against the vertical head of 300 ft.

The old steam mains are used for the air, are 5 in. diameter for one-fourth the distance and 4 in. the remainder.

The first trial of the air was made on the No. 9 or compound pump, but using the low pressure cylinders only; the pump was set at a speed of 60 ft. per minute, the air pressure was 95 lbs. and the pump did its work satisfactorily. In consequence of the cylinders being out of proportion to the water ends at that pressure the air had to be wire drawn.

The No. 11 pump was then started up to work at the same time as the No. 9, but a sufficient speed to throw the stipulated quantity of water could not be maintained, and the pressure fell from 95 lbs. to 36 lbs. at this pump and to 43 lbs. at the No. 9; the pressure at the surface falling to 40 lbs., the speed of the compressors remaining at 85 revolutions.

So far no difficulty was experienced with freezing. This we attributed to the high temperature of the pipe road, and which had not had time to sufficiently cool down after the use of steam. No receiver had been placed underground up to this time.

The two pumps were run together as above for three or four days, but the work was far from satisfactory as it took 16 instead of 8 hours to pump out the water, and considerable difficulty with freezing was now being experienced.

To overcome the difficulty of freezing receivers were placed, one close to each pump, and this considerably improved matters, but did not altogether prevent the same.

The experiment was then made by running the No. 9 pump alone and maintaining a steady pressure at surface of 85 lbs., but wire-drawing the air at a point some 300 ft. above the pump receiver, with a view to allowing the moisture to drop before reaching the pump. This proved satisfactory and entirely prevented freezing. Indicator diagrams were now taken which showed that the compressor engines were developing 128.49 h. p. as against 16.45 h. p. at the pump, which gives a useful effect of 12½ per cent. only.

A similar test was then made with the No. 11 pump running alone, and here no difficulty with freezing was experienced. The indicated h. p. at compressor engines was 82.13 and at the pump 10.77, showing a useful effect of 13.11.

Having got over the difficulty of freezing, attention was then turned to the more economic problem of finding out by what means the two pumps could be run at the same time and the water taken out in the stipulated eight hours, and without making any change in the cylinders of the pumps, and which are out of all proportion to their work when using air, having been built for low pressure steam. To do this it was decided to try compounding with the No. 9 pump. This, however, was not successful as a steady pressure of 75 lbs. with 90 revolutions of compressors could not be maintained and indicator cards showed that though there was an average pressure of 62 lbs. in the high pressure cylinder, after release it fell to an average of 6.28 lbs. in the low pressure. The effect of introducing "live" air into the exhaust chamber connecting the high and low pressure cylinders, was then tried and proved successful, notwithstanding that by so doing considerable back pressure was thrown on the high pressure cylinders. This also gave a more uniform stroke of the pumps.

Indicator diagrams were then taken both at the compressors and pumps, and showed that the useful effect by the above change had been increased from 12¾ per cent. to 25.93 per cent.

There is no question that this useful effect can be considerably further increased by making use of pumps properly proportioned to their work and expressly designed for the use of compressed air, and of the rotary type. The exhaust ports should be large and as straight as possible and the air should be exhausted above and below.

An interesting feature observed by admitting "live" air into the exhaust passages as mentioned above is that all traces of frost around the exhaust passages disappear. This is no doubt due to the expanding air taking up heat from this "live" air introduced.

Speaking of freezing at the motor it may be mentioned that glycerine has a most beneficial effect in its prevention.

The great objection to the use of straight line pumps is in the large amount of clearance to be found in the cylinders ; also that such a pump seldom makes two consecutive strokes alike, and that it is impossible to make use of any expansive force there may be in the air and cut-off before the end of the stroke. In the No. 9 pump above referred to the length of the stroke varies all the way from 16¾ inches to 18 inches, according to the conditions under which it is working. Considering these imperfect conditions is it any wonder so small a percentage of useful effect is found in mine pumps using compressed air.

The question may be asked is the air as economical as was steam, considering that only 25¾ per cent. of the work developed in the compressor engines can be shown at the pumps. In this particular case it certainly is, and as a matter of fact 1 ton 8 cwt. less coal is now being consumed in 24 hours than was the case with steam to do precisely the same work.

There is also the beneficial effect of introducing cool air into the mine and the saving of expense in repairs due to the injurious effects of steam on the roads, etc. The pipe line is not nearly so costly to maintain as with steam, and so much steam sent into the mine means so much extra water to be pumped.

Another important advantage gained at the "Drummond" by introducing compressed air is that the total volume of air circulating through the mine has been increased by 16,800 cubic feet per minute.

This increase is not due to the amount of air delivered by the compressors, but from the fact that when using steam the No. 2 slope could not be used as an intake, whereas now both Nos. 1 and 2 slopes are intakes.

DISCUSSION.

In the discussion on these papers Mr. Brown remarked that while the steam and air cylinders were of the same size, a steam pressure of 62 lbs. gave an air pressure of 80 lbs.; adding that as the hoisting engine only worked intermittently he was enabled with the aid of the receivers and only a 14 inch compressor to work engines that in the aggregate would require 898 ft. of free air.

Mr. Poole and Mr. Fergie also showed how it was that Mr. Brown was able at Sydney mines to get a more useful effect than they were at Westville, where, on account of gas, they were unable to re-heat the air before using it below, and then their pumps having heavier heads of water to work against, had to contend with the formation of ice in the cylinders and ports.

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How an Abandoned Mine Became a Paying One.

By W. L. LIBBEY, Brookfield, N.S.

A few days ago I received a letter from our Secretary, suggesting a paper something in line with the above heading. Now the emotions called forth by his modest and courteous invitation, were not only varied, but they gave rise to a train of thought and consideration.

In the first place, it was a fact impossible to disguise from myself that my time had never been devoted to writing "papers," therefore the chances were largely in favor of my being found lacking, if I attempted to perpetrate one on a society which contains in its make up so much more than the average of brain adaptability, all around ingenuity and fertility, as I believe the Mining Society of Nova Scotia to contain. With the reminder that "You'd scarce expect one of my age to appear in public on the stage," I will cease to apologize for my appearance, omitting entirely the usual flattering references to the entertaining qualities and abilities of those who have preceded me and those who are yet to be heard.

One remark in particular in the letter of Mr. Wylde, making his request for a paper, has frequently recurred to me. It is simply this :— "It is very hard to get anything from the gold miners." The question as to why it is so naturally presents itself. In drawing a conclusion, comparisons (always odious) will be avoided as far as possible.

From my limited opportunity for observation it seems to me that the coal mining industry of the province has drawn freely on the best trained practical and technical ability of the world in making up its engineering and executive staff. The results are becoming so plainly apparent as to need no criticism from the writer. But how is it with the industry of gold mining, which should and yet will be regarded as one of the legitimate industries of the province. Have not a large proportion of the investors in and managers of mines been, like the writer, men who from various inducements, have taken little "flyers" in gold mines much as they would take a share in a guess cake at a church fair with little care to the conducting of the enterprise? and would not technical training and methodical attention to business details applied to gold mining make our industry rank with the first of the province? The writer has great confidence that a strict attention to the economical management of the business would have resulted in many mines being kept in operation that are now closed down, and that attention alone in many cases, without more technical or geological knowledge than an ordinary education and an average clear mind would give in addition. This line of criticism, however, may well give place at this time to a brief resume of the preparation for, and the experience of the writer in making an abandoned gold mine pay. And if the relation proves even of passing interest, repayment for the pains will be ample.

From the age of 17 until 31, his life was spent in the American and English Merchant Marine, with about the usual result — experience. The next ten years his faculties received training in the real estate and building business, resulting, of course, with more experience, and among other things, with an interest in the Brookfield mine figuring among his assets—or liabilities, some might have classed it at the time. Now, right here attention may be called to the somewhat common desire to get something for nothing or as near to it as possible, and the result of an attempt noted.

After some consideration it was decided to start operations at Brookfield. There were, and still are, over 6,000 tons of tailings, on the dump, which assay high. Just as active operations were decided on, one Professor Kendall, of New York, backed by Erastus Wiman (at that time in good commercial standing) and others, were attempting to introduce to the mining world, his version of the "cyanide process," that is what he said anyhow—but my own belief is that he was only skinning Wiman and other flats he could catch in New York. However, he was sent a half ton of tailings to test. Glittering returns were received from the test and fat profits were just in sight; and best of all, less than $2,000 to be expended, was to divert the golden stream into our yawning pockets. The necessary ducats were promptly and cheerfully produced and a start was made for Nova Scotia in August 1893. The writer does not believe in ploughing graveyards, or he would tell you the size of the dividends that would be declared every few days, and he would also tell you, how in the style that must be familiar to many in the audience who have seen the capers of gold miners for past years in this province, he, instead of coming here and paying attention to business, took his wife (the only excusable part of the performance) and went to Chicago to the Fair, but it would be too harrowing.

By November, when the writer did get here, it was found that Kendall and his fellow swindlers of the Mechanical Gold Extractor Co knew nothing about their business. They fled in confusion. Further and expensive experiments with cyanide were conducted during the winter of '93 and '94, resulting, however, in failure, commercially speaking. Recently samples from the dump and other places have been submitted to the Cassel Gold Extracting Co. of Glasgow, who advertise that if samples will be sent them, that reports as to value, etc., will be returned. Several samples were sent, but no report definitely was made, except on one ore. This, the report said, contained absolutely *no gold or silver.* The samples of this ore were taken from a 40 ton lot the writer had milled over hungry copper plates at Molega, and there were recovered over $4.00 per ton in gold from the lot.

Finally in June, '94, it was decided to pump out the old workings and go to mining; and by this time it may be remarked that kite-flying had entirely ceased, and work was being conducted with as much regard to economy as is displayed on any hen farm. The history of the mine showed that the lead was a true fissure vein that was opened up and worked in the years 1886-7 and 8 by the methods then in vogue; first, by making a hog-wallow or open cut on the lead, to rob out all surface ore, and finally by sinking shafts every 75 ft. or so on the lead, underhand stoping, shovelling from stopes to shafts and hoisting to surface in tubs, was the underground system; that is, by main strength and stupidity. Finally, a break in the formation was, in the course of time, encountered, the ore pinched out and the mine ceased to pay, and was shut down and allowed to fill up with water. Now the writer has been reminded several times by and through old miners down in Queen's county, that he was a tenderfoot, and he cheerfully admits that previous to his landing here, the only mining education he had was a common school education, five or six months in Colorado and an occasional visit to coal mines; but during this experience he had never heard of any one who had seen the bottom of a fissure vein, and it did not seem credible that the little pod of gold bearing ore contained in a block 240 ft. x 200 ft. x 14 in., was all that the mighty forces of nature had put in the vein. Consequently, when the water was out, work was pushed past the break in the formation, which soon resulted in a showing of good ore. A careful survey and plans of the underground workings were made by Walter H. Prest, proving what was already believed, that a well defined pay chute existed. Information as to the expense of mining and milling during 1886-7-8 shows the cost to have been about $9.00 per ton; and it was easy for one experienced in the handling of heavy cargoes and in surface earth work to see that the method of work was radically wrong. Therefore, as soon as circumstances would permit, an incline was made from the surface undercutting the pay chute, equipped with tramway and ore skips, tramways and ore shoots put in where they would facilitate work underground, and the system of mining changed from underhand to breast stoping. Prompt obedience is demanded of employees, and no one loafs below or above ground but the writer. As a result, $4.00 per ton pays every expense in connection with running the mine, not, of course, including additions to plant, etc. This by hand work on a 14 in. lead.

It is hoped that this sketch of "How an abandoned mine became a paying one," will be interesting to the Mining Society of Nova Scotia, and, perchance, encouraging to tenderfeet.

Notes on the Grand Lake Coal Field of New Brunswick.

By R. G. E. Leckie, B. Sc., Torbrook, N.S.

The Grand Lake coal-field is situated about seventy miles north of St. John city, and in a direct line between Fredericton and Moncton, twenty miles east of the former town, and fifty miles west of the latter. It is thus the nearest coal field to the Province of Quebec, being four hundred and eighty-four miles from Montreal by rail, (25 miles of which, between Grand Lake and Fredericton, have not yet been constructed) or more than 200 miles nearer than the nearest Nova Scotian coal field. The distance by rail to St. John, *via* Fredericton by C.P.R., is 90 miles, and the distance by water 80. To Fredericton, the distance by river is the same as to St. John ; the river and lake being navigable for boats drawing under nine feet of water.

The coal field lies to the north of Grand lake, extending inland from the shore about 10 miles.

Grand lake, 25 miles long, and from 4 to 7 miles wide, is a navigable arm of the river St. John, and into which flow several large streams.

The coal-field extends from Coal creek on the east, to Little river on the west, while through it run the Newcastle and Salmon rivers. The southern boundary is the lake shore, while the northern limit has not yet been absolutely determined, owing to the existence of extensive bogs, out of which the rivers mentioned take their rise.

The area thus bounded contains about 100 square miles, and comprises the operative, or workable field, the most productive section of which, is that portion west of the Newcastle river, and known as the Newcastle field. Workable coal has recently been discovered west of Little river, which I think may prove of importance, owing to its proximity to Fredericton in comparison to the rest of the field, but its extent has not yet yet been determined. The strata in this district lie almost flat, rising gently from the lake shore inland in a north-westerly direction. The dip seldom exceeds four or five degrees. The undulations are gentle and in no case abrupt, the surface generally conforming to the folds of the strata.

Prof. L. W. Bailey and Mr. G. F. Mathew, in their report for the Geological Survey of Canada, (Report of Progress 1872-73) divide the carboniferous formation of Central New Brunswick somewhat as follows :—

Lower Carboniferous, composed of red conglomerates and sandstones, red shales and purplish doleritic rocks containing zeolites.

Middle Carboniferous, sub-divided as follows :—

> BARREN MEASURES: Resembling the millstone grit of Nova Scotia—consisting of grey conglomerates, coarse grey grits and sandstones, and grey sandy shales. Thickness, 200 feet.
>
> PRODUCTIVE MEASURES: Corresponding to the lower productive measures of Nova Scotia—consisting of finer grey sandstones, fossiliferous shales, fire-clays and coal seams. Thickness, 200 ft.

Upper Carboniferous, consisting of purple sandstones and shales. Thickness, 200 ft.

The only coal seam in the Grand lake coal-field known to be of economic value is the "surface seam." This seam consists of very clean coal, of an average thickness of 2 ft., but varying in places from 1½ to 3 ft It is generally accompanied by a smaller seam, from 5 to 8 inches in thickness, which occurs either above or below it, in different localities, and is separated from the larger seam by a few inches of fire-clay. The "surface seam" has been found to underlie continuously the whole coal field, save where it has been eroded in the localities where the streams cut through the bed.

The term "Newcastle coal" has been applied to the coal mined in the vicinity of the Newcastle river, and in the district between the Newcastle and Little rivers. In this district the seam is thicker, and of much better quality than in the eastern portion of the coal field, where coal mining operations were first pursued.

The Grand lake coal was first discovered by the French about 200 years ago, near the mouth of the Salmon river, where the seam is about 20 in thick, and of rather poor quality. With the belief that thicker beds of coal existed below the surface seam, boring operations were commenced in 1837 by a private company organized for the purpose. The iforming to the

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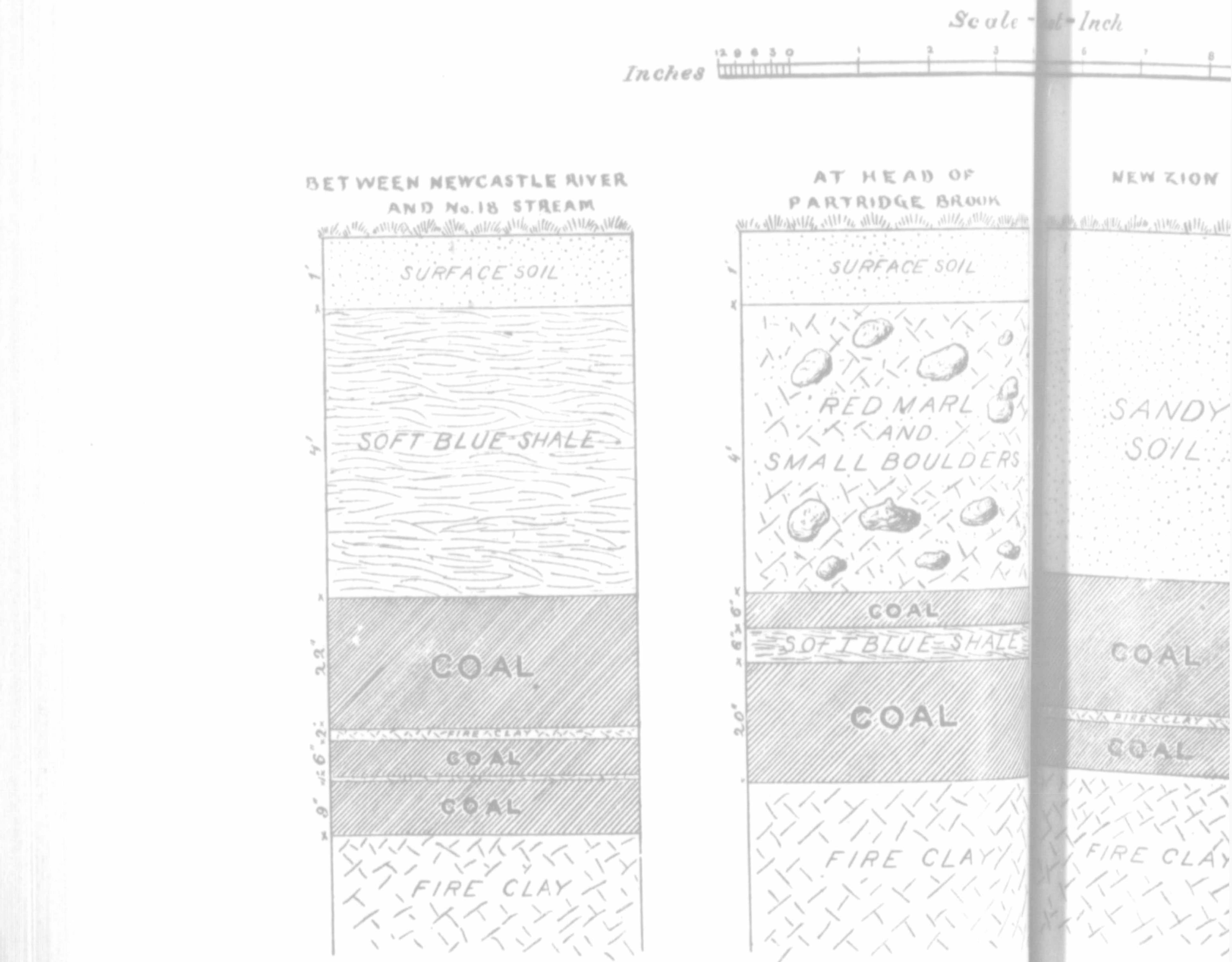

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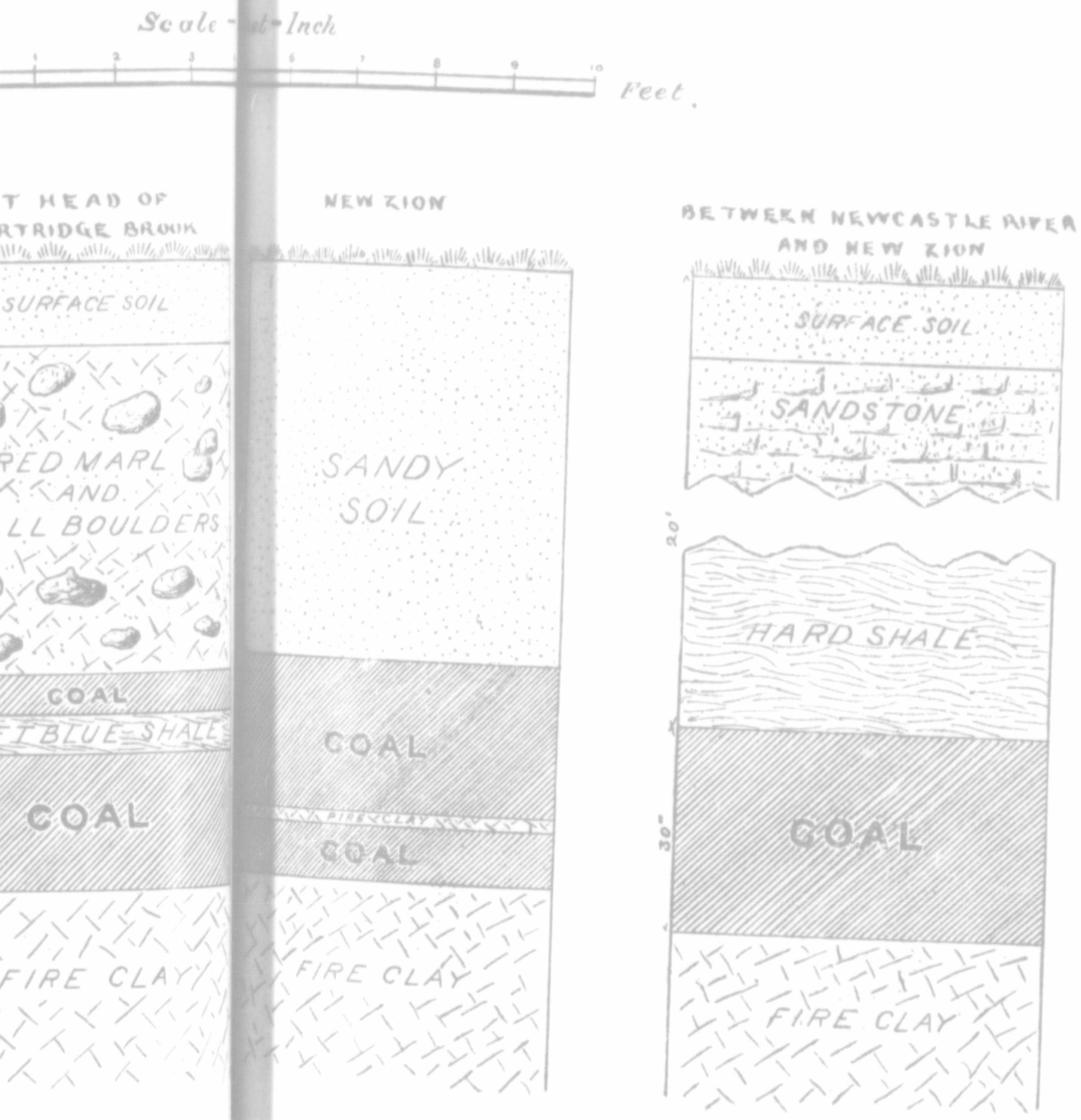

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first bore-hole was put down near the mouth of Salmon river, and a depth of 403 feet was reached. At 21 ft. the "surface seam" was encountered, 1 ft. 10 in. thick, and at a depth of 262 ft. a bed of bituminous shale and coal was struck, 8 ft. in thickness. The method of boring, however, was unsatisfactory, and on this account a second boring was made in 1866 on Coal creek, five miles west from the first, but was only carried to a depth of 96 ft., when the drill became jammed in the hole, and operations suspended. The surface seam was the only coal passed through.

Again in 1870, another boring on the Salmon river proved equally barren of satisfactory results. A seam of impure coal, 6 in. thick, was found at a depth of 96 ft. Disagreement between members of the company caused cessation of work, when a depth of 218 ft. had been attained.

In 1872-73 boring operations were conducted by the Local and Dominion Governments, near the Newcastle river, at a point 3 miles inland from the lake and 12 miles west of the old bore-holes. Mr. R. W. Ells superintended the work. Two holes were put down, 170 and 190 ft. respectively; but apart from the "surface seam" no coal was struck.

The same year (1873), at a point 3 miles south from the last holes, and half a mile from the lake shore, a bore-hole was sunk to a depth of 400 ft., the last 100 ft. of which appeared to be in a formation underlying the coal measures. No coal was reported from this boring.

Taking the result of these bore-holes, and considering the careful explorations conducted in this district by Prof. Bailey and Mr. Mathew, we may safely state, although possible, it is by no means probable, that there exist other seams of value underlying the "surface seam."

I have stated that the area of the Grand lake coal-field is about 100 square miles; but this does not include that portion of the district where the upper carboniferous overlies the productive measures.

A remarkable fact in connection with this coal seam is that in no place has the coal been found at a greater depth than 45 ft., and it is not probable that at any spot, in the Grand lake coal-field proper, it lies at a greater depth than 60 ft. below the surface. This fact, therefore, enables the coal to be mined at any point by sinking of shafts comparatively inexpensive and requiring no heavy machinery, but rather that of a portable nature, which could be moved from place to place as the coal became worked out.

Hundreds of acres have been proved by means of test pits, where the coal is merely covered with a few feet of alluvial, and would be won by the process of stripping. Steam shovels could be advantageously employed in this connection. The areas capable of being thus stripped occur mostly at or near the heads of the various brooks.

An important and valuable feature of this coal-field is that, from the position of the coal seam, it has a natural drainage by means of the streams which traverse it, cutting through the strata at a lower depth than the coal.

The coal obtained from the "surface seam" is bituminous and of the coking variety. The following are some of the analyses of Newcastle coal, made by Wm. Smail, B. A. Sc.:—

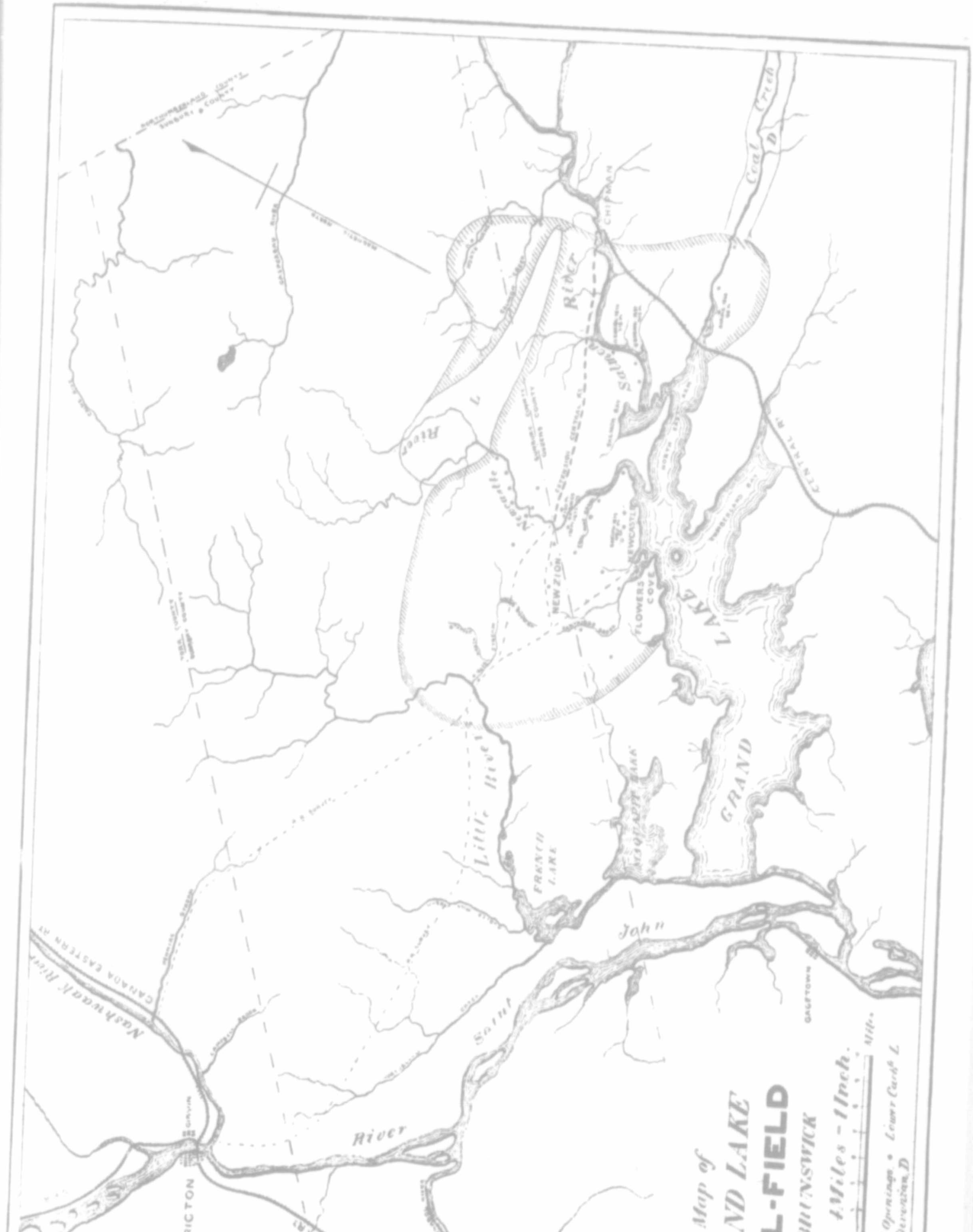
—	I. Newcastle River.	II. New Zion.	III. No. 18 Brook.
Volatile	37.30	35.25	37.10
Fixed carbon	59.35	55.80	61.10
Ash	3.35	4.20	1.80
Sulphur	2.66	1.68	1.98
Coke	62.72	60.00	62.90
Moisture	....	4.75	....

To show the similarity which exists between Grand lake and Cape Breton coals, I append the following average of the analyses of Cape Breton coals as given by the Geological Survey of Canada, and confirmed by a complete set of analyses made by Dr. Gilpin :—

Volatile	33.44
Fixed carbon	61.87
Ash	4.22
Sulphur	2.37

Grand Lake coal ignites quickly and burns with a bright flame. Screened Newcastle coal is an excellent house and steam coal, whereas the fine is well known as a blacksmith coal of superior quality.

The great difficulty heretofore in the way of obtaining the deserved place in the market for Newcastle coal, arises from the fact that farmers holding land in fee simple are allowed the privilege to mine the "surface seam" on their property, without the payment of royalty to the Govern-


Map of
GRAND LAKE
COAL-FIELD
NEW BRUNSWICK
Scale – 4 Miles – 1 Inch.
FREDERICTON
Saint John River
GRAND LAKE
FRENCH LAKE
Little River
Salmon River
Coal Creek
FLOWERS COVE
NEW ZION
CANADIAN PACIFIC R.
CANADA EASTERN R.
Nashwaak River
GAGETOWN

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ment. Each farmer having conditions favorable, therefore, mines coal on his own land. He usually lets the mining out by contract, paying the contractor so much per chaldron. The miner, if not very scrupulous, allows a certain percentage of shale, pyrites and poor coal to make up his chaldron, and the coal not being picked or screened generally goes to the market in a very bad state.

Dr. Gilpin, in writing of this coal, states, "when properly cleaned and handled it should furnish a good quality of coal, comparing well with other maritime coals."

In regard to quantity of coal available in the Newcastle field (that is the district between the Newcastle and Little rivers), we have 40 square miles of coal area. Assuming specific gravity of coal to be 1·26, or weight 78·75 lbs. per cubic foot, and taking 20 inches as average thickness of seam, we find that in an acre we have 2,552 tons; and for 40 square miles we have 65,331,200 tons. Allowing 20% for areas where the seam is eroded by streams, this gives us a balance of over 52 million tons available in this district. The Geological Survey report estimates the coal of the Grand lake coal field at not less than 154,948,000 tons.

Mining operations have been continued on a small scale for over thirty years, with an annual output of about 4,000 chaldrons. Not more than 125,000 tons have been mined in the district.

With the present limited output the coal costs the miner about 80 cents per ton, including timber, stores, etc.

The cost of teaming the coal to the lake shore (three to six miles) is from 45 to 70 cents per ton. Cost of shipment to St. John or Fredericton by wood-boats, 70 cents per ton. Total cost in St. John or Fredericton, $2.20 per ton.

Screened Newcastle coal, with proper facilities for mining, handling and transport, ought to be landed in the above named places for little more than half the present cost.

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Nova Scotia Coals as Steam Producers.

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By F. H. Mason, F.C.S., and W. G. Matheson.

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The object of this paper is to place on record some results obtained from an analysis of samples of coal from the various mines in Nova Scotia This was undertaken principally because of the fact that it is impossible in any books of reference known to the writers to get at any information as to the thermal value of the fuel we are compelled to use, and hence the difficulty of instituting a comparison between the duty of any steam plant using our own coal and those using coal mined elsewhere. It is not unusual to find full information concerning coals of other countries, and hence well known, while our own coal is all disposed of in one item, and that comparing by no means favorably. Of course this is entirely as regards coal as a fuel as being capable of evolving so much heat, of being able to evaporate so much water, of containing so many T. U. With its properties as a gas producer, or its value for coking we have nothing to do. Most of it is used for generating steam, and its value for this is what concerns us most. How many lbs. of water will one lb. of it evaporate? That is the question we wish to settle, for on this depends the comparison of one steam plant with another. We find that at such a place, for instance, one steam user is evaporating 6 or 7, or 8 lbs. of water per lb. of coal, while others are doing 9 or 10, or 11. Why the difference? Is it due to difference in design of generators, or difference in quality of fuel? Or if one manufacturer decides on testing his plant what about the result? for he knows nothing of what the fuel he is using is capable of doing, and hence the result is more or less valueless. If it is high he is probably satisfied, but if it is low or only fairly good, where does the fault lie? Is he using a generator that is wasteful or could he get better fuel for his money?

The only method of his satisfying himself on this point is by knowing the calorific value of the fuel, and to get at this value of the different coals in the province was the reason for instituting the tests herewith recorded.

NOVA SCOTIA COAL.

The method used for taking the calorific power of the various coals was a calorimetric one, and the instrument used was a modification of the Thompson calorimeter. In order to make the results the more comparable, the initial temperature of the water in each case was the same. The combustion of the coal was brought about by a mixture of 2 parts of chlorate of potash and 1 part of nitre. The formula by which the results were calculated was the usual one, namely:

$$x = \frac{(t'-t'')(w+cs)}{n}$$

n = weight of coal.
w = weight of water.
c = weight of copper in calorimeter.
s = specific heat of copper.
t'' = initial temperature of water.
t' = final temperature of water.

There also has to be a correction for the heat taken up by the glass. We consider that for a laboratory test which will give the truest calorific power of a coal the calorimetric test is in advance of any other method.

Attempts have recently been made to revive Berthier's method for estimating the calorific power of coal. This method consisted of placing a weighed quantity of finely divided coal thoroughly mixed with more than sufficient mon-oxide of lead to completely oxidize it, and calculating the calorific power from the resulting button of lead. A little thought will show that this method is not reliable, although at times it may closely approximate the true calorific power. It is an open question whether some of the more volatile matter of the coal will not become volatilized at a temperature below that required to reduce oxide of lead, but setting aside this by no means unimportant factor, there are other reasons which will render Berthier's method valueless.

There are three constituents of coal whose action on oxide of lead it is mainly necessary for us to study, namely, carbon, hydrogen and sulphur.

The final chemical action of these three substances on litharge may be expressed by the following equations:—

$$2\,PbO + C = 2\,Pb + CO_2$$
$$PbO + 2H = Pb + H_2O$$
$$2\,PbO + S = 2\,Pb + SO_2$$

Taking the atomic weight of lead as 207, oxygen as 16, hydrogen as 1, carbon as 12, and sulphur as 32, we get following equivalents of lead for each of the elementary component parts of coal under consideration :—

1 part of	carbon	= 34.5	parts of lead.
1 "	hydrogen	= 103.5	" "
1 "	sulphur	= 12.9	" "

We next have to consider the calorific power of each of these elements, for which purpose we propose to take the figures obtained by Sibbermann :

Carbon	= 8080 calories.
Hydrogen	= 34462 "
Sulphur	= 2216 "

It will thus be seen that while the calorific power of hydrogen is more than four times that of carbon, part for part hydrogen will reduce three times as much lead as carbon. As a set-off against this enormous source of error the whole of the oxygen contained in the coal in a free state will have to be satisfied with sufficient hydrogen to form water, before any lead becomes reduced.

Comparing sulphur to carbon it will be seen that the discrepancy is not so great, but a high percentage of sulphur will give by this method a calorific power higher than the truth.

The other method of taking the calorific power consists of first making an analysis of the coal, and then giving each component part its calorific power and adding the whole together ; the whole of the oxygen is satisfied with sufficient hydrogen to form water, and the calorific power of the surplus hydrogen only estimated.

The calorific power of a fuel taken by this method is open to the following sources of error : (1) In the combustion of the coal, iron pyrites is converted into ferric oxide and the sulphur into sulphurous anhydride ; in the presence of lime or other base this latter would remain behind with the ashes, and its calorific power would escape calculation. (2) The hydrogen in the water of combination which always exists in fire-clay (a very usual constituent of coal ash) would be calculated as hydrogen (3) In the event of a coal containing a carbonate—and many coals contain carbonate of lime, while some of our Nova Scotia coals contain carbonate of iron—the carbonic acid would be evolved in the combustion and be calculated as carbon. In general practice it is found that the calculated calorific power is greater than that obtained by the calorimetric method, while that obtained by the Berthier method is less.

The following (taken from the report on coals suited to the steam navy by De la Bache and Playfair) are the evaporative powers obtained by calculations and the actual practical results obtained in boilers of a few British coals:—

Locality.	Calculated Evaporative power of 1 lb. coal.	Practical Result of 1 lb. Coal.
Ebbn Vale	15.635 lbs. water.	10.21 lbs. water.
Mynydd Newydd	14 904 " "	9 52 " "
Porthmawr	12.811 " "	7.53 " "
Elgin Wallsend	13.422 " "	8.46 " "

Of course in actual practice a certain amount of the coal escapes complete combustion, which accounts to a great extent for the wide difference between theory and practice; and then a by no means inconsiderable amount of heat is lost up the chimney stack and by radiation.

Turning to the sulphur contained in coal, its mode of combination is a matter of no small importance. It may appropriately be described as volatile sulphur, fixed sulphur and sulphur in ash.

The first form is principally a matter of consideration for the gas manufacturer, as in the destructive distillation of coal, it will be evolved as either hydrogen sulphide or one of the sulphides of carbon. The fixed sulphur, or the sulphur contained in the coke, usually exists as a sulphide of iron, and is a matter of consideration to the iron manufacturer. The sulphur contained in the ash probably originally existed in the coal as a sulphate of sulphide of one of the alkalis or alkaline earths, or it may in the process of burning be taken from the sulphide of iron by an alkali or alkaline earth present in the coal. This last form of sulphur is not detrimental to the coal, whatever may be the use to which it is put. For steam and household purposes both the volatile and fixed sulphur are equally noxious.

Ashes of Coal—The consumer too often contents himself with a knowledge of the proportion of ash in a coal, while he utterly disregards its composition.

Much iron pyrites is very injurious to steam coal, for in the reducing atmosphere of the grate in which the coal is burned, the iron pyrites does not become oxidized, but remains in the ash, and falling to the bottom of the grate in a semi-liquid form, it comes in contact with the fire bars. Here it cuts off a considerable amount of the draught and stops its cooling effect on the fire bars, and they becoming heated are rapidly eaten away by the corrosive action of the sulphide. Similarly, when the composition of the ash is such that it sinters together, a clinker is formed on the fire bars, cutting off to a large extent the cooling effect of the draught, and consequently fire bars become heated and readily oxidized. It is exceedingly unusual to get an ash which is sufficiently fusible to run between the bars of the grate, unless it be mainly a sulphide of iron, which as we have already stated, is injurious to the fire bars. It is therefore advisable to try and select a coal with a difficultly fusible ash. Such an ash should be high in silica and may contain from 15 to 25 per cent. of alumina. It should be low in oxide of iron and very low in lime, magnesia and the fixed alkalies.

Many other forms of ash are of course equally infusible, for instance an ash mainly composed of an alkaline earth.

Provided the ash does not clinker, a comparatively high ash is rather beneficial in a steam coal than otherwise, for it holds the fire together and prevents it from too rapidly collapsing.

The physical as well as the chemical properties of a coal are a matter of considerable importance. Two coals may be obtained of approximately the same quantities of volatile matter, fixed carbon and ash, yet the one will coke and the other will not. The length and character of the flame is a matter of no small importance, as is also the character of the coke.

Samples.—The samples received from the various mines were for the most part in fairly small pieces and showed no signs of unfair picking.

In taking the samples for analyses the whole box was turned out, the larger pieces broken, the whole carefully mixed together. From this a sample of about 10 lbs. was taken and crushed through a 4 mesh sieve. This was again carefully mixed and a sample of one pound taken and ground through a 60 mesh sieve, and from this the analyses were made

METHODS OF ANALYSES.

Moisture—The powdered coal was heated in an oil oven at a temperature of 110° until the weight was constant and the loss taken as moisture.

Volatile Matter—The coal was heated in a closed crucible in a muffle in a reducing atmosphere, at a temperature below the melting point of gold and above the melting point of silver. The loss in weight, less the moisture, was taken as the volatile matter.

Fixed Carbon—The coke obtained from the previous experiment was heated in a muffle in an oxidizing atmosphere until oxidation was complete. The loss in weight gave the fixed carbon, while the residue gave the ash.

Sulphur—This was estimated by two and sometimes three different methods, all of which gave equally good results. For quickness the method in which the coal is mixed with about four times its weight of pure sodic carbonate, heated at first gently, and finally strongly, for fully an hour, the mass is turned into a crucible and digested with bromine water, then filtered, and the filtrate acidulated with hydrochloric acid, and the sulphur precipitated with baric chloride.

The second method was similar, only a mixture of two parts of pure magnesia and one part of sodic carbonate was used, instead of the sodic carbonate alone.

The third method, and one which gives very accurate results, consisted in heating the coal in a current of oxygen and passing the products of combustion through bromine water and hydrochloric acid and precipitating the sulphur as barium sulphate.

—	Caledonia.	Dominion No. 1.	Hub.	Old Bridgeport.	Sterling.	Reserve.
Moisture lost at 110° C.	0.93	0.92	0.90	1.25	1.60	1.12
Volatile matter	28.02	25.13	29.10	31.81	37.96	32.00
Fixed carbon	68.05	71.22	65.50	63.86	54.84	63.93
Ash	2.19	2.73	4.50	3.09	5.60	2.95
Total sulphur	1.72	1.10	3.29	1.33	4.03	1.33
Sulphur in ash	0.05	0.10	0.12	0.12	....	....
Calorific power	7623	7403	7458	7238	7403	7513
Color of ash	Buff	Whitish buff	Purple brown	Light buff	Purple brown	Whitish buff
Character of flame	Medium; very smoky.	Long; very smoky	Long; smoky	Long; slightly smoky.	Long; smoky	Very long; very smoky.
Character of coke	Light	Puffed up; light, tender.	Hard, metallic	Puffed; light	Puffed; light	Light; metallic

—	Victoria.	Old Sidney.	Joggins.	Springhill.	Drummond.	New Campbellton.
Moisture lost at 110° C.	2.00	1 05	1.64	3.17	1.10	4.58
Volatile matter.	34.65	34.65	30.08	28.28	24.55	32.07
Fixed carbon	58.42	57.67	60.42	65.30	66.65	56.86
Ash.	4.93	6.63	7.86	3.30	7.70	7.46
Total sulphur.	3.48	4.10	4.96	1.29	1.45	5.90
Sulphur in ash	....	0.14	....	0.08	Nil.	....
Calorific power.	7513	7623	6798	7898	6963	7073
Color of ash	Purple brown....	Purple brown....	Purple brown....	Buff	Buff	Purple brown.
Character of flame	Long ; very smoky	Long ; very smoky	Medium ; smoky..	Medium ; clear...	Long ; smoky....	Medium ; smoky.
Character of coke	Puffed up ; light..	Very puffed up ; light ; tender.	Hard, compact...	Hard, metallic...	Hard, metallic...	Light, fingery.

DISCUSSION.

MR. H. S. POOLE—How do they do in the admiralty in judging of the value of coals?

MR. F. H. MASON—They make actual tests as well.

MR. MATHESON—In taking the theoretical caloric power, if the test under the boiler does not come fairly near it, either the design of the boiler or the design of the setting is improper. Bad stoking will affect the caloric power of the coal. One stoker may not get steam at all; he may have his fire dead.

MR. C. FERGIE—Taking two coals, one of a higher caloric power than the other, fired by the same man, I have seen better results from the poorer coal. Some physical qualities come out in practice.

MR. H. S. POOLE—One coal will answer well enough in a locomotive and be perfectly valueless in a marine boiler.

MR. MATHESON—The idea was to get something by which you could make comparisons. As a general rule, coal that will give 14 to 15 pounds theoretically will give about 11 pounds in practice.

MR. F. H. MASON—With regard to the ashes, oxidation was carried as complete as possible, and higher results might be given for that reason.

MR. H. S. POOLE—I would have preferred if the samples had been taken in all cases by Mr. Matheson or Mr. Mason. I am under the impression that different men would take out samples in different ways. I think that leaves the returns open to question.

MR. R. H. BROWN—The sample I sent was taken from the top to the bottom of the seam.

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The Trail Creek Gold Mining District of British Columbia.

By Mr. J. D. Sword, Rossland, B.C.

The Trail Creek gold mining district, of which there has been a great deal of notice taken during the past year, particularly in the western mining states of the Union and Canada, and extending to the mining communities of the eastern States and Great Britain, is a section of considerable area and rapidly growing importance, and the large amount of prospecting already done has certainly put the question of permanency beyond a doubt.

The name "Trail Creek" owes its origin to the fact that the celebrated "Dewdney Trail," built some thirty odd years ago, follows the creek for a considerable distance to the Columbia river. The centre of the mining district as at present defined, inasmuch as we are unable at such an early age of the camp to determine properly its limits, is situated at Rossland, which town is seven miles west of the Columbia river and eight miles north of the International boundary. The town of Rossland has a population of about 2,500 people, and has grown from what was, eighteen months ago, a few log cabins, to a well built and busy town, and what would be a typical western mining camp but for the absence of gambling houses, innumerable saloons and such irregularities as an occasional homicide, justifiable or otherwise. Incidentally I may mention that an electric light and water company is at present engaged in installing a plant to meet present requirements and an excess power to furnish light and water in view of the rapid growth of the city.

The means of access to the district are two, viz.: from the northward, taking Revelstoke on the C.P.R. as a point of departure, by boat down the Columbia river to Trail Landing, a distance of over 150 miles, and thence by waggon road to Rossland. From the south and State of Washington, taking the city of Spokane as the departure, by the Spokane Falls and Northern R.R., northward as far as Northport (a small town on the east bank of the Columbia river), and thence by stage after ferrying the river, seventeen miles on a waggon road of good easy grade. From eastern points, such as New York and Montreal, there is no difference in the time occupied in traversing the different routes, providing connections are made immediately on reaching Revelstoke with the steamboat sailing down the Columbia twice a week. In going from the east, via Revelstoke and the C.P.R., one traverses an all Canadian route, and any extra delay in reaching Trail by this route is more than counterbalanced by the delightful trip down the Columbia river in the steamboats of the Columbia and Kootenay Steam Navigation Co., which are well equipped with good berths and have a first-class cuisine.

Another small advantage in coming this way is the shortening of the stage ride about ten miles.

All inward freight, as mining supplies, etc , and outward freight, as ore, is sent by either of the above routes. At present a narrow gauge railway is in course of construction from Trail Landing on the Columbia to Rossland, and branches are being laid to the different mines. This is to be in operation early this spring.

The Canadian Pacific, I understand, are going to build from Robson, or from the Columbia river, and the Spokane Falls and Northern R.R. have their road surveyed from Northport to Rossland ; this road, however, cannot be built until the Colville Indian reservation is thrown open, or the railroad company has permission to build from the U. S. government, which will, no doubt, be given very shortly.

The first location made in this district was the Lily May, which claim was staked some six years ago, on what is known as the South Belt, but nothing was discovered on Red Mountain or North Belt, where at present the principal mines are situated, or, I should say, where the most development work has been done, until July 7th, 1890, when Joseph Bourgeois and Joseph Moris, two French Canadian prospectors, located and staked the War Eagle, Centre Star, Virginia, Idaho and Le Roi mining claims. At that time the law would not allow a prospector to stake more than one claim on the same ledge, and as the Le Roi, Centre Star and Idaho appear to be located on the same lode, they waived their right to the Le Roi and gave the claim to E. S. Topping in consideration of his paying the recording fees.

After carefully sampling the outcrop of the vein and getting assay certificates, ranging from a trace to as high as $500 per ton, Mr. Topping interested some Spokane gentlemen in the Le Roi, and $\frac{16}{30}$ths of the claim was bonded for $16,000, or at the rate of $30,000 for the whole. Mr. Oliver Durant, a mining man of considerable experience in the Western States, was one of the parties interested in the deal, and took charge of the property, and he may justly be considered as the pioneer of the camp, as during all its vicissitudes and notwithstanding the unfavorable reports on it, he still continued to put in his money in development work and in acquiring additional property.

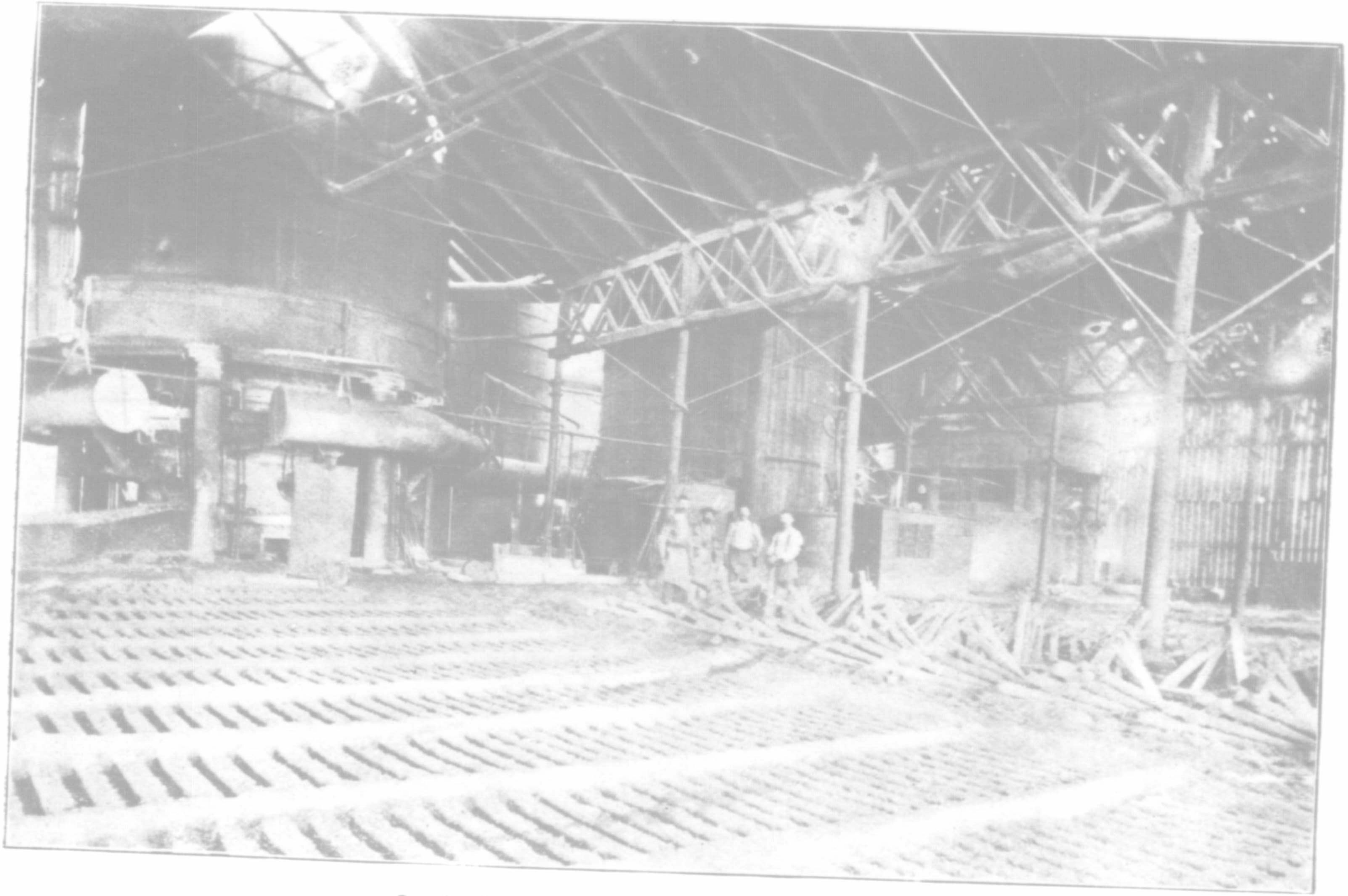
The country at this time was a trackless wilderness of rocky hills, covered with timber and undergrowth, in winter time the snow being from 4 to 6 feet in depth, the only way to reach the district during the winter being by travelling on snowshoes for many miles. During the winter of 1890 a shaft was sunk to a depth of 40 ft. on the Le Roi mine, and a car load of ore was packed on horseback to the river and shipped to Butte, where the smelter gave a return of $86.40 in gold, copper and silver. This gave the company good encouragement to prosecute work, though from that time until 1894 the Le Roi Co. did little else but development work, as the cost of hauling was very high and transportation expensive.

Up to the present, but little or no geological or mineralogical exploration has been done, and the eruptive rocks which form the country rock of the district have not been identified with any particular epoch, and no sedimentary rocks, altered or otherwise, have been noticed within a considerable distance from the camp. The eruptives which form the country of the camp are, however, very similar to those of some parts of Eastern Canada, notably Sudbury. The prevailing rock is a greenstone in all its various refinements of nomenclature, but mostly diorite, syenite and porphyry diorite of all shades and textures, owing to its constituents, viz.: feldspar, pyroxene and hornblende being variously proportioned. At a distance from the veins, the country rock appears to have a lighter color and coarser texture. The whole of the country rocks have a jointage more or less distinct. The lines of jointage or cleavage appear to be more numerous near a vein, and the rocks there have a short, sharp, blocky appearance, which does not obtain so much as at a distance from the ledges. A large portion of the country rock, particularly near the veins, on fracture, shows iron in small flecks in the form of magnetic pyrites, common pyrites, with a few specks of chalcopyrite. Several eruptive dykes, very similar to the adjacent rocks, though lighter in color, owing to excess of feldspar which traverse different sections of the camp. The general contour of the country is by no means abrupt, but the hills appear to have been rounded off by nature and luxuriant timber and undergrowth cover the greater part of it. Winter does not set in until late in the year, and although there is an almost continual downfall of snow, the winter is mild and there is but a very short period of excessive cold, such as we experience in Eastern Canada. The general strike of the veins is east and west, and their dip near the surface between 60 and 70 degs., though on sinking on some of them, notably the Le Roi, the veins become almost perpendicular. Regarding the origin and nature of the veins, I may say, a great deal of diverse opinion and speculation has been expressed, and up to date I do not know of any of the many well known mining engineers who have visited this district who have stated confidently what they deem them to be.

Among the mining engineers of high standing that have visited the camp are: Clarence King, Henry and Louis Janin, Covington Johnston, W. DeL. Benedict, W. Gallagher, Sussman, Clemes and others. Their reports, which, with one exception, were for private enterprise and not for publication, are stated by persons well informed to be highly favorable regarding the permanency and magnitude of the camp. The general opinion regarding the veins is that they are true fissures of the regular order, although much altered by the subsequent and unceasing forces of nature. Another opinion expressed and worthy of consideration, is that the veins are replacements of the country rock by vein minerals along a line of weakness or fracture where naturally the mineralized waters would flow and the country rock at such a place, being in a broken and crushed condition, would be most easily attacked and the minerals deposited. This latter theory is probably correct, as regards some of the smaller irregular veins and feeders.

As it is not my intention to go into the matter of speculating or theorizing on the origin or exact nature of the veins in this camp, I shall not discuss the matter further, but leave the unravelling of any doubtful points to time and the efforts of our Geological Survey men.

In no mine in the camp is there noticeable what is called by the miners "gouge," although the veinstone, as a rule, parts easily from the walls. There is considerable faulting in all the veins, though the dislo-



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The width of the vein filling between walls varies considerably. In the War Eagle and Le Roi the ore bodies in their widest place are from 20 to 30 ft. wide, and narrow down at times to 4 or 5 ft. The ore is essentially a smelting one, consisting of a mixture of pyrrhotite, chalcopyrite, ordinary iron pyrites, and mispickel with quartz and calcspar for a gangue. Some of the ore is all metallic, with little or no gangue, and the amount of copper is extremely variable, as are also the gold assays—they being from a trace to as high as $500 per ton. No gold can be mortared from the ore when not oxidized, although on the outcrop of some of the veins, the rusty soil on being carefully panned gives exceedingly fine gold in a fine streak. Experiments have been made to ascertain which of the minerals mentioned carried the gold, by carefully separating and assaying them, but it has proved nothing, though gold is generally present with copper, and also the arsenical pyrites. The coarse grained solid pyrrhotite does not carry much gold, and the best ore yet mined from the Le Roi and Josie mines was rather more silicious than the usual run. The ore has been in great demand by smelters where they have an excess of silicious, or dry ores as they are called, and as low a rate as $4.50 has been charged for treatment, though the regular price, I believe, is about $5.00.

The greatest expense in connection with the ore is the cost of transportation, as it has to be hauled either to Trail Landing, a distance of seven miles over a heavy road, and loaded on the Columbia river steamers and taken by them to Northport, or else hauled direct to Northport by waggons over a similar road, a distance of sixteen miles, and then shipped on the train to either of the following places: Great Falls, Helena, Everett, Washington, or Tacoma. This will all be saved when the large smelter, now building, and of which I shall speak directly, is finished, or the companies operating put in their own reduction plants.

The ore is splendidly adapted for matteing, and can be run many times into one, by slagging off the iron, the product being a rich auriferous copper matte.

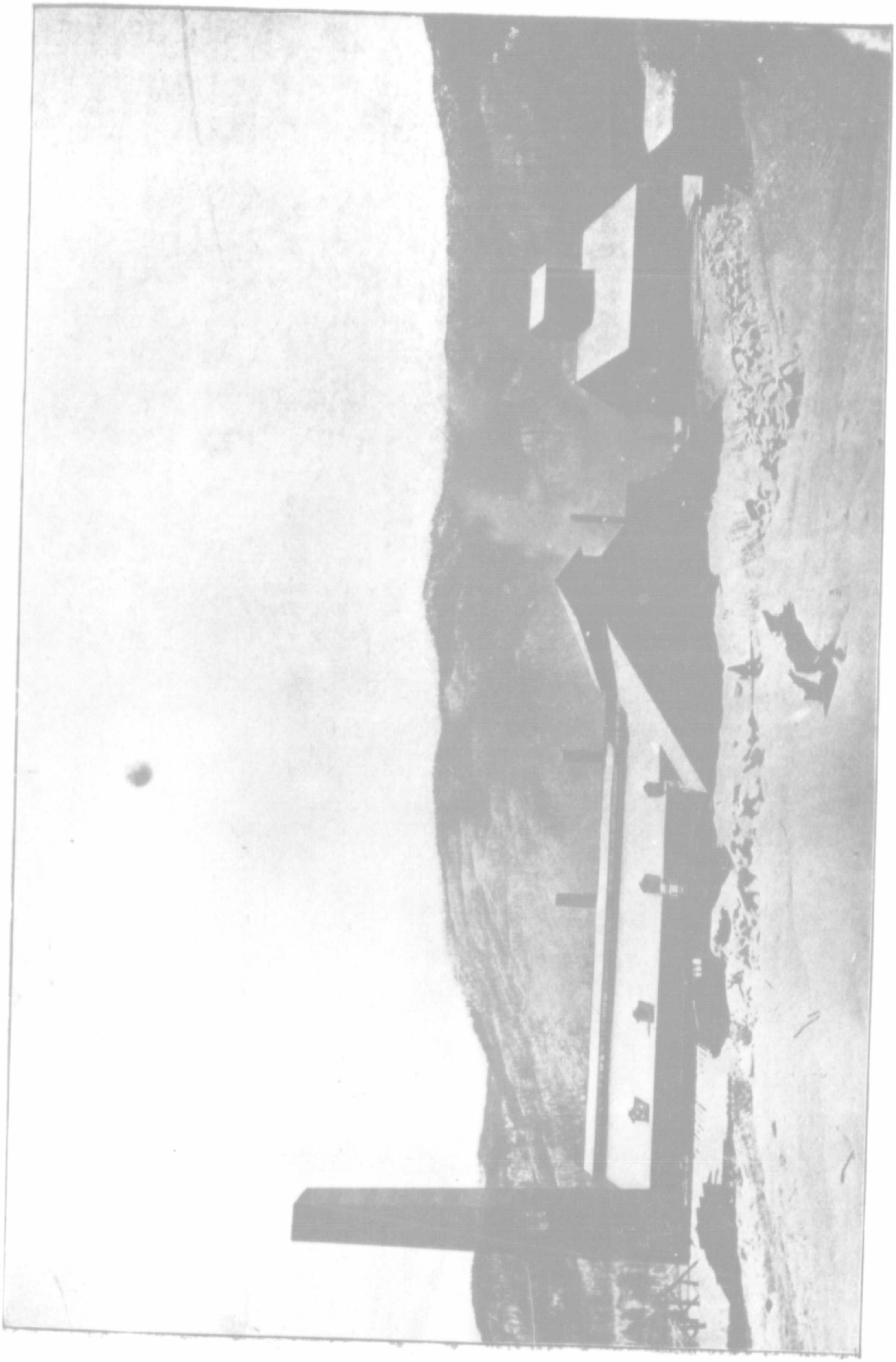
There are in the camp what are known as two mineral belts, although the line of demarkation between them, if any, is very indistinct

The one on the north is called the North Belt, or Red Mountain, and is on the north side of the town, and the South Belt is on the south side of the town and south of Trail Creek. By far a greater portion of the development work has been done on the Red Mountain side of the camp, the mountain being so called, I presume, on account of the appearance of the rock, owing to the amount of iron present. On Red Mountain, and the hills flanking it, there appears to be a system of veins of considerable continuity, one of which can be traced for over 7,000 feet. On this vein are located the Mountain View, St. Elmo, Cliff and Monte Christo mines, two of which are being developed considerably. South of this is another strong vein, on which are located the Iron Mask, Virginia and Iron Horse, and others. Still farther south, a few hundred feet, is the Centre Star vein, on which the Idaho is also located ; this is generally supposed to be the Le Roi vein.

South of this again is the Nickel Plate vein, on the same vein the Golden Chariot is being located. The extensions of this are not at present discovered that I am aware of. It is smaller than either of the foregoing.

Of the leading mines of this great camp, I will give a short account, commencing with the three principal and producing mines.

The Le Roi Mine, which with the Black Bear and Ivanhoe claims is operated by the LeRoi Mining and Smelting Co., a corporation of Spokane gentlemen, is situated on what is called the "LeRoi Hill," a foot-hill of the Red Mountain It is opened on the lead by an inclined shaft 450 ft. deep at the east end of the claim. A smaller shaft has been sunk and a short tunnel driven on the west end of the claim. Levels have been run on both sides of the 450 ft. shaft at convenient depths apart, and the regular system of back stoping is used to take out the ore. On the surface of the claim the vein is traceable nearly the whole length, except on the lower end, where a heavy wash has covered it up. On the surface the ore shows a width varying from 5 to 10 ft. In many places the vein assumed a lenticular form, and on the 300-ft. level bulged out to a width of 30 ft., all shipping ore. During the sinking of the shaft from 350-ft. level to the 450-ft. level, careful average samples were taken daily, and an assay value of less than $100.00 per ton was rarely returned. The assays often run as high as $200.00 and $300.00, and once or twice $500.00. The width of the vein from the 350-ft. to



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the 450-ft. level has not been determined, as the shaft is following one wall and is in ore all the time. I am unable to state the exact amount of gold and copper taken from this mine up to date, but I believe the amount to be at least $500,000, and this must have been done within the last eighteen months, as nothing more than development work was done previous to that time, and that in a somewhat leisurely manner.

The timbering of the mine is in accordance with the usual western practice for such veins. Stulls are used when convenient, and when the ore body gets too wide regular square sets of round timber are substituted. All the ore is broken by machine drills, and after being broken is hoisted and trammed to an ore house, which has a capacity of 2,000 tons. It is then dumped on a sorting floor above the bins, and after having the larger pieces of the waste picked out, is dumped into the bins and is ready for hauling to the river.

The average value of the ore is from $35.00 to $45.00 in gold, silver and copper, the value being principally in gold, there being only from 2 to 5 per cent. of copper and one or two dollars' worth of silver in the ore. The amount of ore hoisted daily from the mine runs between 75 and 125 tons, or an average of about 100 tons. The mine is well equipped with a mining plant, consisting of a compressor, eight or nine drills, two hoisting engines and three boilers, and the company have recently added a large electric diamond drill to their plant The company have also built a fine hotel on the property, including offices.

Judge Turner, the president of the company, estimates there to be at least 100,000 tons of ore in sight. A contract was made last summer to furnish 75,000 tons of ore to the B. C. Smelting Co. at Trail.

The War Eagle Mine—This mine, in conjunction with the Iron Mask and Virginia claim, is owned and operated by the War Eagle Gold Mining Co., another Spokane corporation, and the due recognition of the greatness of the camp, by the outside mining community, is owing more than anything else to the splendid showing of this mine, as well as to the skilful and energetic manner in which Mr. Patrick Clark, the manager, who is at the same time one of the owners with his brother, Mr. Jas. Clark, handled the property. Up to October last this mine, on which work was actively commenced late in 1894, produced upwards of 7,000 tons of ore averaging 2¼ ounces in gold, 3 per cent. in copper, and about 3 ounces in silver. The mine is developed by two tunnels, from which ore is being steadily taken out; another large tunnel is being driven now to tap the already known ore bodies on a lower level—I believe in the neighborhood of 200 ft. lower than the present lowest working. The mode of mining and handling the ore is similar to that pursued in the LeRoi mine.

In making the excavations for the lower tunnel a strong, rich vein was uncovered, but whether this is what is known as the War Eagle vein or still another one is still uncertain; the ore appears, however, to have more copper in it than the War Eagle vein proper. The plant of this company, and which is erected at the mouth of the new tunnel, is a model one in every respect and splendidly installed, and consists of two 100 h. p. boilers, one Duplex Corliss compressor of 20 drill capacity, and a full complement of Ingersoll-Sargeant drills, the air pipe in use being worthy of remark as it is an 8-in. spiral welded steel pipe.

Substantial boarding houses for the miners, offices and other buildings have been erected by the company on the ground.

Josie Mine—The Josie mine, operated and owned by the Josie Gold Mining Co., also of Spokane, adjoins the LeRoi and War Eagle claims, and is in nearly every respect similar to them, the difference of course being that there is a great deal less development work done, and consequently not such a large amount of ore shipped. The development in this mine has not been pushed as much as it might have been, due in a great measure to the lack of machinery, all work being done by hand. It is opened by a tunnel 350 feet long, in the whole length of which there is a strong continuous chute of ore. A shaft has also been sunk to a depth of about 70 feet at the mouth of the tunnel, and the ore shows up well in this also. A complete mining plant is ordered for the property, and is to be in operation in February, when its production will be increased many times. The ore is equal in value to either the LeRoi or War Eagle. Some very rich ore is, however, occasionally shipped from this mine One large shipment averaged $160 per ton. The plant ordered consists of a compressor, boiler, hoisting engines, pump and drills.

Centre Star Mining Co.—This property also adjoins the War Eagle and LeRoi mines, the main and working vein of which is supposed to be the LeRoi vein. It, in conjunction with the Idaho, is owned by the Centre Star Mining Co., and is managed by Mr Oliver Durant, before

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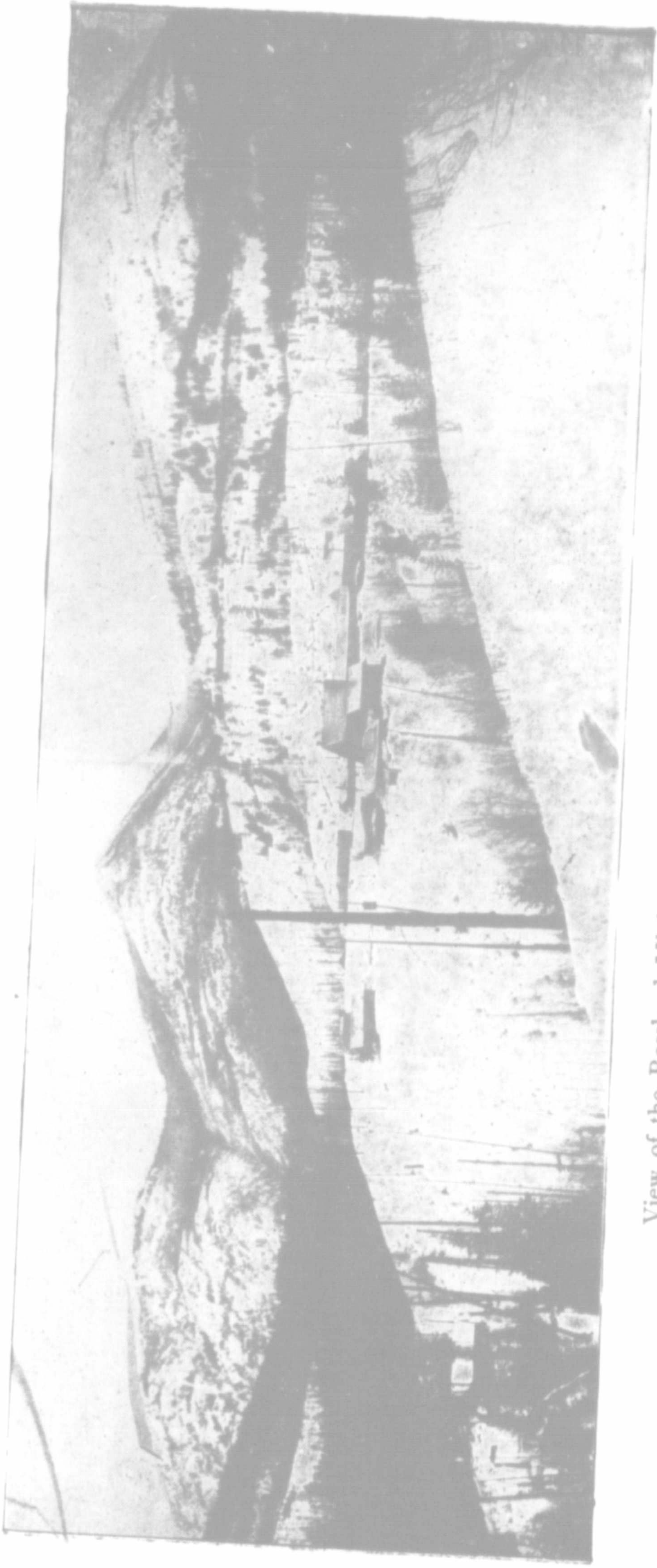

View of the Rossland Mining Camp, B. C., from a Photo taken in 1894.

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mentioned, who is also one of the principal owners. It is opened by a 500 ft. tunnel, driven on the vein, and a 172 ft. shaft sunk from the surface to the tunnel in the vein also. Both the tunnel and shaft are driven into solid ore, the only exception being when the continuity of the ore is broken for a short distance by a hitch or fault. It is the intention of the management to thoroughly develop the mine before taking out any ore other than that extracted on development, and they are continuing the tunnel 800 ft. farther to their west end line, which abuts on the LeRoi ground. There are three other parallel veins on the claim at present unexploited.

The width of the veins in the different parts of the 500 ft. tunnel varies considerably, and in one place a cross cut was made from one side of the vein 25 ft. without striking the opposite wall, and all in solid ore. The ore at present, though not as rich as the three before mentioned mines, would pay for shipment; but it is the intention of the company to hold their ore until a railroad is constructed to Trail, or else they put in a reduction plant of their own—the latter is most probable. The mine is well equipped with a seven drill compressor and complement of Ingersoll drills, and work is being pushed as rapidly as possible, and without doubt this will be one of, if not, the greatest mines in the camp.

A considerable number of well developed prospects are under bond, but as in every case the terms of the bond prohibit the shipping of ore unless as a test, several prospects which could be shipping mines are doing nothing more than development.

The Cliff Mine, which is located on the long continuous lead I mentioned just now, on which are located the Monte Cristo, St. Elmo, Mountain View, also is under negotiation for a sale at present. In this mine there is an immense quantity of ore in sight, but the general average of the ore is below that of the War Eagle, and at present it is doubtful whether ore could be mined, shipped and treated at a profit. The mine owners realize that it would be discounting the value of their property seriously to ship ore until the rate of smelting and transportation are reduced, or a smelting plant is built on the spot.

Before concluding I may give you a brief description of the smelting plant now in course of erection.

Great credit is due to Mr. Heinze for the energy and enterprise he has manifested in putting in this plant, which is easily the finest smelter in British Columbia, and likely to remain so, as it is Mr. Heinze's intention to enlarge the plant as the increased output from the mines demand. Everything in connection with the smelter has been built with the idea of avoiding the handling of the ore as much as possible. The smelter, which is of 250 tons daily capacity, stands upon a high bench overlooking the Columbia, and consists of three main buildings, and smaller ones as offices, blacksmith and machine shop, saw mill, etc.

The ore after being dumped into bins, above and adjoining the sampling mill from the railway cars is fed into the rock crusher and rolls, and is sampled, crushed and dumped into cars. This is done without any handling at all. From the sampling mill it is trammed a few feet and dumped into the roaster building and dumped into the O'Hara and circular furnaces. After being roasted it is trammed into the main building where the matteing furnaces are located. These are, I believe, unusually large and of an up-to-date design. There is also a water jacket furnace which is used in conjunction with the reverberatory furnaces. A short inclined tramway runs down to the Columbia, where a wharf will be built to ship matte and take coke or other supplies. Mr. Heinze is also building the narrow gauge railroad, which, with branches, is about twelve miles in length from the smelter to the mines. This is to be in operation this spring and the activity shown in building this road is in keeping with the energy displayed in the smelter erection.

I hope this paper, which is merely intended as a general description of the district, may be instrumental in inducing some of our eastern Canadians to look up the district, and while not grudging the Americans and English our mines, it is desirable that our people should have a few themselves.

DISCUSSION.

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CAPTAIN ADAMS—We are very much indebted to Mr. Sword for his interesting and valuable account of the Trail Creek district, which is going to do so much for Canada in its reputation abroad, and will show the English, as well as other nations, that money is made at Trail Creek, and it will help the Province of Quebec in a way as giving a reputation to Canada. This district has often been condemned by experts, for though there were large bodies of ore they were considered so refractory that nobody could be induced to look at investment. You will not meet an old timer who has not had the chance of owning these now productive mines. Capt. Stubbs told me he refused to take a half interest in the War Eagle for $500. The War Eagle was bonded formerly to people who spent $60,000. They shipped out the ore and did a great deal of work but the returns were so low they decided to abandon it. Mr. Clarke then bonded it and found the ore body some distance away, showing how purely accidental a good many of these things are. I went through the district with a mining expert from the States and was only there a few hours. He told me he thought there would be a good deal of disappointment to many people who expected the whole country to be a mass of pay ore. No doubt there were pay streaks of immense value there, but the veins were irregular, pockety and bunchy; it was a mistake to suppose the whole country was solid gold.

Mr. Sussman—After Mr. Sword's most entertaining and very exhaustive description of this district, I do not feel that I can add very much.

Some interesting facts might perhaps be mentioned in connection with the distribution of the gold in the ores.

Among the very large number of veins and bodies of pyrrhotite ore in this district, so far only a few have been found carrying gold in paying quantities. Even in these the gold is not found uniformly distributed through the ore, but is found concentrated in the so called pay chutes. These pay chutes are not characterized by any change in the appearance or mineral composition of the ore. Their existence and bounds can only be determined by making numerous assays.

Pay chutes have been found by sinking or drifting in bodies of ore which were quite barren at the point of discovery. While these bodies of pay ore may vary in form, they generally take the shape of chimneys of ore of limited extent when measured along the strike of the vein, but continuing downward to a considerable and so far unknown depth.

These chimneys often make quite an angle with the lines of greatest dip, so that shafts sunk on the dip of the vein often pass through the pay ore into barren sulphide before the miners are aware of the fact. The chute is generally found again by drifting in the vein. The geological conditions which determine the concentration of the gold in these portions of the veins, are not at all understood. The distribution of the gold in the pay or shipping ore, is quite as peculiar and is very similar to its distribution in a free milling quartz.

In a pile of smelting ore there is no marked difference in appearance between pieces of ore that carry only a trace and those that are quite rich in gold. It is, therefore, impossible to increase the grade of an ore by any system of sorting. Notwithstanding the great irregularity in specimen assays, there is a remarkable uniformity in the values per ton of the various shipments from the same pay chute.

This uniformity is more marked in the War Eagle than in the LeRoi mine.

It is reported that the pyritic process for smelting will be revived in this district. I say revived, because I know of no place where true pyritic smelting, that is smelting with a hot blast and without admixture of solid carbonaceous fuel with the ore, is at present carried on. True pyritic smelting has been attempted in different places in the United States with varying success, but has either been entirely abandoned or has been replaced by some modified form of the process.

There is no question about the value of this process as an emergency method where the grade of the ore is low and cost of coke and transportation excessive.

The uncertainty about the amount of the losses of the precious metal due to a greater volatilization has prevented its general adoption where conditions are more favorable. I have no doubt, judging from my own observation, that where higher grade ores and mattes have been smelted by this process, the losses in gold and silver have been excessive.

The question has been asked whether this ore, carrying as it does a much smaller percentage of sulphur than pyrite, is adapted to this process. It has been found in practice that the volatile atom of sulphur yields very little effective heat in the blast furnace; much of the sulphur is distilled before it has a chance to oxidize and clog the charge. I have assisted at the smelting of raw—that is, unroasted—mattes, where a low charge and cold blast were used. It was found possible to reduce the coke on the charge to below 5 per cent. and at the same time make a good concentration.

These pyrrhotites would act much like matte in the furnace. In the smelting referred to, the mattes were fairly rich in silver and gold, and the losses were not inconsiderable.

The modified pyritic process may perhaps be used to advantage in smelting the low grade ores of this district, as it obviates the necessity of a large investment in roasting machinery.

While it is too early to make any predictions concerning the probable future extent of the Trail camp, I have no doubt as to its permanency.

Another interesting fact in connection with this district is its resemblance in many ways to the Sudbury mining district in Ontario.

The two districts have something in common even in their topographical features. Trail, it is true, is laid out on a more massive scale. The hills are higher, but they have the same rounded summits and comparatively gentle slopes. The ore is carried in both districts in a diorite more or less mineralized throughout and with the mineral concentrated both in isolated masses and in so-called veins. These veins in Sudbury consist of a succession of lenticular bodies along a fault contact, while at Trail they are more regular and continuous and bear a great resemblance to true fissure veins though no marked banded structure can be observed. The ores are similar in appearance and with some exceptions are made up of the same associated minerals. I have specimens of pyrrhotite from both districts in which angular fragments of hornblende and crystals of calcite are enclosed by the sulphides, and which cannot be told apart. The observing layman would conclude that the formations in the two districts belonged to the same geological age, and that the ore bodies in each had a similar origin, though the preliminary work of the Geological Survey casts considerable doubt on these assumptions.

The New Smelter at Trail, B. C. Combined Automatic Roasting and Matteing Furnaces.

Rossland, B. C., in 1895.

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The Quebec Mining Act.

By Dr. R. W. Raymond, New York.

In reply to your request for my opinion concerning the Quebec mining law, as contained in the Act of 1892, I beg to say, that I have examined the law with much interest, and that it seems to me to be so drawn as to combine the encouragement of mining with a due regard to the rights of private land-owners. It contains some provisions of an administrative character which might possibly be deemed complicated and burdensome; but these are matters concerning which an outsider is not competent to speak. One might as well undertake to say where another man's shoe will pinch. I have no doubt that this law, adjusted with the liberality and discretion for which it explicitly leaves room, can be comfortably worn by those who are used to it.

The most important feature of it, to my mind, is the certainty of the title it gives. The United States law grants with great liberality an undefined estate; and the uncertainty of the grant nullifies, to a large degree, its liberality. This uncertainty lies in two features of our federal law. The first is the absence of any requirement of notice to the Government of the taking up of mining claims. The locator of such a claim on the public lands records his location, it is true, but not with any official of the United States. The Government owning the lands does not know when the locator's title begins, what it covers, or when it is cancelled by abandonment or failure to fulfil the conditions of possessory title. The maps of the United States do not show what portions of the public lands are thus occupied. Not unless, and not until a possessory owner makes application for survey and patent does the United States become officially aware of his location. Then it requires him to advertise his claim; and, if no one presents an adverse claim, it assumes that his *ex parte* statement is correct, and gives him a title practically dated back, perhaps years, to the time when he made the location.

The second element of uncertainty is not removed even by the issuance of letters-patent. It lies in the grant of the extra-lateral right, which constitutes the essential characteristic of the "law of the apex." This entitles the owner of a mining location to follow in depth, beyond the side lines of his location, and between vertical planes drawn through its end lines, all veins of which it contains the apex. But the definition of this right under the vague provisions of the law is so difficult as to be well-nigh impossible. After nearly a quarter of a century of practice under it, end-line and side-line and apex questions are still litigated in our courts, involving immense sums of money, and unsettling titles that have been accepted for decades. And the principles upon which these questions should be decided are still differently laid down by our district courts, and have not yet been declared authoritatively by the Supreme Court.

I am glad that the Quebec law carries no such fruitful source of mischief and waste.

Another feature deserving of hearty praise is found in section 1422, which admits aliens, as well as British subjects, to the benefits of the law. The illiberal policy of the United States in forbidding the ownership of land by aliens, is an annoyance and detriment to the mining industry, and would be still more so, were it not practically evaded by technical devices, such as the holding of lands by trustees. Considering that the investment of foreign capital in the development of the natural resources of this continent is recognized as desirable, and eagerly invited, the folly of legislative discouragement of such investment should be clear. And in view of the fact that such discouragement never proves effective as a prohibition, but only necessitates extra formalities of evasion, it must be evident that the frank recognition of the rights of aliens, given by the Quebec law, is as wise as it is liberal.

Still another excellent feature of this law is the preferential right conferred by section 1441 upon the proprietor of the soil, to acquire the mining concession thereto. This is in strong contrast with the present outrageous statute of the State of New York, under which, for certain classes of minerals, a simple notice of discovery, filed without sworn or other proof in the office of the Secretary of State at Albany, operates to secure at once to the alleged discoverer the right of entry upon private lands. This and other features of the latest New York statute have not yet been passed upon by our courts; and I have little doubt that they will be declared unconstitutional and void. But the statute, as it stands, is a disgraceful evidence of the disregard of private rights by the legislature of the State.

In my own judgment, the government of any country (at least, of any country under institutions as free as those of Canada and the United States), could safely leave to private interest and enterprise the development of the mineral resources of private lands. Without pretending to discuss the ultimate nature of land tenure, and the extent to which it may be properly modified by legislation in the public interest, I may be permitted to say that, under institutions which otherwise favor individual enterprise, I think history has shown the security of private ownership of land to be the best condition for its proper utilization in the interest of all. I think that, under such circumstances, there is no danger that the agricultural or mineral resources of the land will be neglected to the injury of the community. In the absence of artificial restrictions, such as mortmain, entail, or complicated and oppressive formalities in the transfer and assurance of land titles, there is, in my judgment, no public peril involved in the private ownership, even of large tracts. In the United States, such tracts, if we may judge from experience, will be inevitably divided and sold, under the pressure of economic conditions. At all events, there seems to be no reason for changing the established system which we have inherited under the common law, until real and pressing evils shall present themselves as clearly involved in it.

What is true of the ownership of the soil seems to me to be equally true of the mineral right. Whatever theory be adopted as to the sovereignty of the State over mines, I think that in practice, under free institutions, the development of mineral resources in private lands can be more safely left to the individual interest of the land owners than to any governmental discretion. The possible dangers are two: on the one hand, that valuable mineral resources may be locked up, through the refusal of land owners to exploit them; and, on the other hand, that reckless exploitation may unnecessarily exhaust, or render unavailable, mineral deposits upon which the present and future welfare of the nation largely depends. In view of the latter possibility, I am not disposed to deny that the State might fairly claim to regulate methods of mining, so far as to prevent hopeless injury to its future prosperity; yet experience and observation have led me to believe that such a regulation is likely to be less effective than the simple interest of private owners, and that its exercise would involve more evils than it would cure. But as to the danger that private owners might prevent the development of the mineral resources of their lands, I have no hesitation in saying that no possible governmental control would equal in wisdom and effectiveness the operation of commercial conditions upon individual interests. There is no conceivable way of determining whether a given mineral deposit should be immediately exploited or left for exploitation by posterity, better than the commercial test, whether its present development will be profitable. That secures the answer of the whole world to the question at issue; and the whole world, speaking through prices current, is wiser than any government official could be. And, on the large scale, and in the long run, the opinion of the world would unquestionably prevail with the owner of the soil. In other words, if the development of a mineral deposit would pay, the land owner will either execute or permit that development, in such an overwhelming majority of cases as to take the matter altogether out of the domain of public policy.

So much as to my individual opinion The Quebec law does not go so far; but by reserving to the owner of the soil a "preferential right" to mine therein, it practically relieves him, at least, from the intrusion of adventurers, and protects the appurtenances of his ownership.

I may add, that this preferential right of the land-owner is, I believe, a feature of the German codes which embody, probably, the most extreme view of the governmental sovereignty over mining. It is to be regretted that some crude American legislation on the subject has copied from these codes their oppressive features only.

In this connection, I am led to consider section 1435 of the Quebec law, which reads as follows:—

"The Lieutenant-Governor in Council may, if he thinks proper, and in accordance with the conditions and formalities which he may deem advisable, claim, at any time, the royalty due to the Crown upon any land already sold, conceded or otherwise alienated by the Crown, or which may be hereafter sold, but only five years after the date of such alienation.

"Such royalty, unless otherwise determined by letters-patent or other title from the Crown, is fixed by the Lieutenant-Governor in Council, in accordance with the report of the mining inspector, and taking as a basis the value at the mine, of the mineral extracted, after deducting the costs of the extracting ; and it must not exceed three per cent. of such value."

An inquiry addressed to the Commissioner of Crown Lands, as to the meaning of the first paragraph of this section, elicited the following reply :—

"The words 'but only five years after the date of such alienation,' in section 1435, mean that no royalty can be charged for the first five years after the concession by the Crown. In the Ontario Act (paragraph 4), it is enacted that the royalty shall not be imposed until after seven years from the date of the patent or lease. Our law says five years from the 'alienation,' which means the patent or concession."

I am informed that, under the present administration in the Province of Quebec, no use has yet been made of this discretionary power to exact, after a certain period a royalty from the mining industry. If this be true, the fact is indicative of a wise liberality on the part of the provincial government. But the law remains, nevertheless, a menace to mine-owners, and, in a certain sense, a cloud upon mining-titles. Immunity from special taxation, under the name of "royalty," is not safely secured by the mere "discretion" of a Lieutenant-Governor in Council. Investors of capital in mining enterprises must consider, not what a friendly administration actually does, but what it might legally do, if otherwise disposed.

It is of course not denied that miners, like all other citizens, should contribute equitably to the expenses of the Government. Nor would a tax of three per cent. upon the profits of the business be necessarily oppressive. The taxes on real estate are usually much more than three per cent. of its annual revenue. But the royalty contemplated by this provision would be an additional tax ; and the question is, whether it is wise to suspend over any particular industry the threat of such a special exaction, no matter how moderate.

With regard to this matter, as also to the $5 exacted as license fee from each gold or silver quartz-mill, it may be said that the small revenue to the State is more than covered by the expense of administration, and that the chief object of the special taxation is to secure regular reports of the industry. This brings up questions of administrative policy upon which I will not enter. In this country, the payment of small taxes and fees for separate objects is deemed annoying. Our citizens prefer to pay their taxes, as far as possible, in the lump, and be free from petty details. But custom has much to do with the public feeling in such matters; and the traditional systems of Canada may include without discomfort to its citizens features which would be resented, if novel.

Section 1436 provides that mining concessions shall be of three classes, containing 400, 200, and 100 acres respectively; but the depth of the concession is the same for each class, namely, 80 chains and 80 links, or 1.1 mile; while the width only varies from 52 chains in the first class down to 13 chains in the third. I do not understand the reason for this arrangement, under which, in many cases, the miner would be obliged to pay for a good deal of unnecessary ground For instance, I am told that the old river-beds of the Chaudiere and other streams are now attracting fresh attention as sources of gold. Would a single applicant be allowed to take a mile of such a channel or would he be forced to lay his claim across it, and half a mile into the country on each side? This question is not clearly answered by the law. In surveyed townships the concessions must follow the established subdivisions; in towns projected but not surveyed, the side-lines of the concessions must be parallel to the township side-lines, and the concession end-lines must coincide with the projected range-lines. In unsurveyed territory the concessions, if they border on lakes or rivers, "shall front on such lakes or rivers," and the direction of their exterior lines "shall be determined by the Commissioner."

I think the law might be improved by permitting concessions of smaller size and different shape; but this is a matter of subordinate importance compared with the certainty and definiteness of the title granted.

By section 1452 prospecting upon the unoccupied public lands is free to all, without license. Section 1494 provides that "the discoverer of a new mine on public lands" is entitled to a free mining license, valid for twelve months, such as is described in section 1461. Turning to that section, we find that this license covers a maximum of 200 acres, and costs a fee of $5, and an annual rent of $1 per acre. Hence $250 is the maximum value of the bonus extended by section 1494 to the discoverer of a new mine. The reward is certainly not extravagant. The state of New York gives twenty-one years' free license to mine. The United States gives a perpetual free license. It is therefore all the more surprising to find in the Quebec law a restriction well nigh nullifying the economical *largesse* of section 1494.

Namely, section 1496 declares that "no person is considered to be the discoverer of a new mine, unless the place of the alleged discovery is in a region unknown as a mining region, or at least at a distance of thirty miles from the nearest mine."

The Ontario Act (section 40) declares that "no person shall be considered a discoverer * * * unless the place of the alleged discovery is distant, *if on a known vein or lode*, at least three miles from the nearest known mine or discovery on the same vein or lode." There is some sense in this proposition; I see none in the Quebec burlesque of it. The words I have italicized show the object of the Ontario law to be to prevent the claiming of discoverers' privileges by those who simply locate upon extensions of known lodes. It is analogous to the principle of patent law, under which patents are refused to those who simply carry out the obvious principles of previous patents, without the introduction of any change involving real invention. The locator on the continuation of a vein already worked in the vicinity may fairly be considered to have performed no discovery deserving of special reward. On the contrary, he has been specially benefitted already by the operations of others, which have guided his explorations. But if he finds the vein three miles from the nearest mine upon it, he has made a discovery involving much labor and skill, and of economic importance greater than that of the discovery of a small isolated deposit. The Ontario Act exhibits therefore an intelligent purpose. To take out of it all reference to the vein or lode, and then to substitute thirty miles for three as the minimum distance characterizing novelty of discovery, is to reduce it to nonsense. I make this comparison because, in answer to an inquiry on the subject, the Quebec Commissioner of Crown Lands writes that section 1496 of the Quebec Act does not appear to him to be an extraordinary provision, and cites the Ontario Act as a precedent.

But the Quebec Act still further hampers the prospector upon the unoccupied public lands. The free mining license for one year, promised to a "discoverer," is conditioned upon the immediate report of his discovery; and section 1495 provides that "anyone who does not immediately report such discovery shall be deprived for the space of one year of the right to mine on public lands." How this provision is to be enforced it is not easy to see. A prospector discovers an outcrop which, upon preliminary examination, seems to him unpromising. So, not wishing to waste time in a journey through the back-woods to find the nearest mining inspector, he decides not to report and claim it, but to pursue his explorations further. Or, he thinks a better mine may exist in the neighborhood and prefers to hunt a while for it. Or, he fancies that his first discovery is less than thirty miles from a known mine, though it is, in fact, more than thirty. In any case, how is his omission to report the first discovery to be proved upon him? and when does the penalty of section 1495 begin to run? Suppose he has not found out until he has actually gone on prospecting for another year; will the penalty date from the time he is found out?

All these provisions concerning the discovery of new mines seem likely to have little effect either way. They can do no great harm, but they can do little good, and that will diminish to nothing at all at no distant day; for it cannot be long before the "mining regions" of Quebec will be all "known"—if, indeed, this is not the case already. And if mining thrives, it will soon be impracticable to locate a new mine which will not have a neighbor within thirty miles in some direction. Then sections 1494, 1495 and 1496 will be a "dead-letter."

I repeat, however, that these frank criticisms of minor features in the Quebec law do not outweigh my hearty appreciation of its general excellence.

DISCUSSION.

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CAPT. ADAMS—It is a great privilege to have our laws commented on by so great an authority as Dr. Raymond. We would like to have some remarks on the subject.

MR. J. E. HARDMAN—I heartily agree with Dr. Raymond in commendation of the general features of the Act and in almost all he has said, with this exception, that I fail to see the benefit of the preferential right. I think it is rather a hardship to the miner than otherwise Not one of the men who have the ground surface, that is the farmers, want to take up the land at the Government price of $10 per acre, but knowing its value they keep holding up their preferential rights as a kind of bait before the miner or investor, and, naturally, when they have got three or four men pitted against one another in competition, they usually get more than it is worth. The farmer has no intention of working it himself, but he looks to get three or four speculators after it, and I think it is rather a hardship than otherwise upon the man who first discovered the property to be of value. In practice the working of the Act is like this:—If I desire to make application for a concession I am obliged to go to the farmer who owns the surface right in order to buy the preferential right to the mineral. I wish to know how much he wants for it. He says, "What have you found?" Supposing the farmer and myself strike a bargain; I have then to bring evidence to the Commissioner of Crown Lands that I have *bona fide* paid for the preferential rights. Even then I do not get them. I have got to bring the grantee (or the grant, if I cannot bring the grantee), with a certificate duly sworn that I have paid for every preferential right. Then the Government does not give me the mining right, but upon the back of this first grant they endorse a certificate to the effect that the within named grantee has this day bought the mining rights, &c., &c. Then I have to go to a notary and have the mining right transferred to me, as if it were a piece of real estate. This is one of the conditions that is justly open to criticism. There are a good many of these points that come up in practice, and it was some of my difficulties, of which I spoke to the secretary of this Association, which evoked Dr. Raymond's paper.

With regard to the royalties I heartily endorse every word Dr. Raymond has said. The safety of the mining industries in the Province of Quebec depends upon the feeling of the Commissioner towards these industries. It is fortunate that we have at present such a man as the Hon E. J. Flynn as Commissioner, a man who has the mining interests of Quebec at heart, and who appears to want to do everything in his power to further those interests; but Mr. Flynn is a creature of circumstances, political circumstances, and the man who succeeds him may not have any of his statesmanlike qualities and may not appreciate the importance of these mining industries. He may look for means to replenish the provincial treasury and decide to enforce this royalty clause. What then are you going to do? Repeat the experiences of 1892 and 1893? If this law is not going to be enforced and is not meant to be enforced, let it be repealed. If this is the sense of the legislators of Quebec, why should it remain on the statute book? Political gentlemen are only creatures of circumstances; Ottawa shows that today. In regard to the dimensions of the concession there are three classes, 52, 26 and 13 chains, containing 400, 200 and 100 acres respectively, and the price to be paid (within 12 miles of a railway station) is $10.00 per acre. Now take the case of an old river-bed—so far as the paying portion of these old river beds is concerned, they certainly do not exceed in width 300 ft. Supposing, therefore, I want a strip through a farmer's location of 300 ft.; we will say he has got the widest width, 52 chains, 3 200 ft., under the law; I am obliged to pay $4,000 for 400 acres, when only 24 acres are of any value to me. If all the veins which occur in Quebec should run parallel with the side lines, the clause would not matter, but in reality, according to the map I have, the side lines run in all directions. In any extended beds of precious metal of any sort, alluvial strata, old river-beds, or quartz veins, how are you going to get what you want and absolutely require, unless you buy probably ten times as much of what you do not want? If any suggestion is in order, I think that the law should be so amended that if a man desires to take up only a portion of a concession he should be permitted to pay for that portion only and not be compelled to pay for mining rights on the whole lot or concession.

MR. PAINT—Is Mr. Hardman acquainted with the Nova Scotia laws?

MR. HARDMAN—The Nova Scotia laws are very different in regard to location. In the first place there is no preferential right; the owner of the surface has no right whatever to what lies below that surface. The locations are 150 and 250 ft. and are called areas, but if my location is beneath private lands I am obliged to enter into a bond with the Provincial Government not to trespass upon that private land until I have come to terms for damages with the owner.

In reply to a question as to the cost:—

MR. HARDMAN—$2.00 for each area, with an annual rental of 50 cents; not more than 100 areas in any one name. The royalty is 2 per cent. on gold. It is perfectly absurd to levy a royalty on *net values;* how are you going to assess and collect it? For instance, I have a mine on one side of a river and my friend has a mine on the other side; he may be honest and say his cost is only four dollars per ton; I am dishonest and say my cost is twelve dollars per ton; how are you going to prove I am wrong? It is a matter of bookkeeping only. The royalty on net values is simply a question whether a man is a liar or an honest man.

A small committee might be empowered to think over this matter and bring it to the notice of the Government, and I think this Association might fairly co-operate with the Government. The Government would be all the better informed, and such a committee could make some recommendations in regard to these infrequent but none the less important matters.

MR. DRUMMOND—Why not empower the same committee appointed to interview the Government with respect to the proposed Provincial Mining Bureau in Montreal to see to this, adding Mr. Hardman's name?

MR. BELL moved that the committee be empowered to act on the lines of this discussion.—Carried.

HON. MR. FITZPATRICK—I may say, referring to the question of the mining law, that I know very little about it so far as contained in the statute of 1892. I suppose, at that time, I was a member of the legislature, but there are some things even legislators do not know all about. I think I may say that a modification or amendment seems to me extremely reasonable. I may not have the ear of the Commissioner of Crown Lands, as I do not sit on the same side of the House, but I am sure he is a person who is glad to hear suggestions so far as his department is concerned. If you would suggest any amendment I am quite certain it would be cheerfully received by him and promptly acted upon. I think you will find the legislature always open to receive advice from practical men, and we have in the house the member for Megantic, who can give us practical information on matters of this nature. I must confess to you that this discussion has been a complete revelation to me, and shows me how important it is to have men talk about things who understand them. Dr. Raymond's paper upon our Mining Law was admirable and showed how matters of this nature, in the hands of competent men, may become interesting, and I am sure that if that paper were submitted to the Commissioner he would make practical amendments, and would be able to amend the law so as to meet the difficulties you have pointed out. The real point is the permanency of title. If there is one thing we pride ourselves upon in this Province it is that if any man gets anything from our Government he gets a permanency. Having said this much I can assure you that as far as I may speak for the Opposition, we will co-operate with the Government in the direction of bringing in amendments.

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The Gold Deposits of the Eastern Townships.

By Dr. R. W. Ells, Ottawa.

So much has already been written concerning the gold of Eastern Quebec, that at the first glance it would almost seem unnecessary to add anything further to the literature on the subject. In view, however, of the renewed interest which has arisen in connection with this field, more especially as regards the Beauce district, it is thought that a few additional notes relating to the original source of the alluvial gold deposits, together with some well ascertained facts bearing upon the distribution of the auriferous sands and gravels, may be of sufficient interest to merit a few moments' discussion.

In the early reports of the Geological Survey's operations in the Beauce gold district, the statement is made that "the source of the gold appears to be in the crystalline schists of the Notre Dame range, and the materials derived from their disintegration not only constitute the superficial material among the hills of this range, but are spread over a considerable area to the south of them." * In support of this statement reference is made to the presence of gold in veins among these schists near Sherbrooke, as well as in Leeds, where "masses of native gold of several pennyweights are found with copper glance and specular iron in a vein of bitter spar." Recent discoveries of native gold have also been made in a small vein of quartz, which cuts the schists in Westbury, south of Dudswell. All these widely separated finds show that the hypothesis put forward so many years ago as to the source of the gold is true, to a certain extent at least, and the metal is clearly visible in certain veins found in connection with the pre-Cambrian rocks of the central anticlinal.

Reports of gold also from the mountain ridge of schists on the west side of Massawippi lake, in a brook which flows over similar rocks to those found in the ridges farther north, furnish further confirmatory evidence in this direction; while the recurrence of alluvial deposits on

*Geol. Can. 1863, p. 519.

the west side of the Belvidere road, which keeps along the west flank of the Sherbrooke and Lake Memphremagog ridge of similar schists would show that probably the gold there found was derived from quartz veins which cut these rocks. So also in the township of Halifax, where crystalline rocks occur, gold has been found in the gravel.

The age of the crystalline schists has now been definitely recognized as Huronian. To the rocks of this system, presumably also belong the gold bearing rocks of the Lake of the Woods and Sudbury districts, the resemblance in character between the rocks of all these localities being marked. It is also highly possible that the gold-bearing schists of the Marmora and Madoc districts are not very different in age from these, though this point has not yet been definitely settled. The evidence therefore that the Huronian crystalline schists and associated rocks carry auriferous quartz veins is very conclusive.

On the other hand it is very well established that the auriferous quartz veins in Nova Scotia occur in slates and other strata which are called Cambrian, and which, geologically speaking, succeed the crystalline schists and other associated rocks of the Huronian just described. This gold-bearing belt in Nova Scotia has been carefully studied by the Geological Survey staff, as well as by others, over many miles, and the peculiarities of its structures, and the conditions under which profitable gold-bearing veins occur, have been carefully noted. This work in Nova Scotia is of interest as bearing upon the question of the Quebec gold deposit ; since we have now ascertained, quite conclusively, that much of the slates and quartzites which underlie the most productive alluvions in Quebec are precisely similar in character to the gold bearing slates of Nova Scotia and are their probable equivalents in age. The fact that the richest pay streaks in Quebec, or those yielding the largest nuggets and the coarest gold, have been uniformly found overlying or near quartz veins, which traverse these Cambrian rocks, is an important one, and should be kept in mind in future investigations.

In view of this important determination, we may consider, first of all, if there are any peculiar conditions existing in the Cambrian slates to warrant the hypothesis that the gold may be derived from quartz veins in this series ; secondly, whether any similar conditions occur in the pre-Cambrian slates, and thirdly, what conditions existed which could afford the present alluvial distribution of the gold itself as we now see it.

On the two eastern map sheets of the township series published by the Geological Survey of Canada, the distribution of the rocks assigned to the pre-Cambrian, Cambrian and Cambro-Silurian systems, has been delineated as well as could be done in a series of highly disturbed strata, for the most part destitute of organic remains by which exact horizons might be defined. The mapping of the crystalline schists of pre-Cambrian age was rendered comparatively easy from their lithological character, as contrasted with the slaty and sandy strata of the overlying formations, while the older aspect of certain slates and quartzites which flank the crystalline rocks at many points, and which are intermediate between these and the overlying series of slates and limestones which contain fossils of Chazy-Trenton age, enables us to define, with a fair degree of accuracy, the outlines of the Cambrian series, the rocks of which are, as already stated, probably the equivalent of the Nova Scotia gold series. Quartz veins are found in the rocks of all the systems, and it is scarcely necessary to say these have been produced in the containing strata at some date subsequent to their deposition, and are presumably due to some disturbing cause, either of folding, cracking or metamorphism which has affected large areas of all these rocks.

If, now, we examine the structure of the schists, we find them not only highly inclined, contorted, and in places overturned, but intersected also by numerous intrusive masses or dykes of granite, diabase or some other form of igneous rock ; and it is near these intrusive masses that the metalliferous lodes, such as the copper and iron are found ; similar conditions prevailed in the still older Laurentian rocks in connection with the deposits of mica, apatite, etc., and also in the mining area of Sudbury with the deposits of nickeliferous pyrites. It may therefore be inferred that the presence of intrusive dykes, both in the schists and the overlying slates, has exercised a marked influence for good in the production of the gold there found. These intrusive masses, it may be said, occur at all the places where gold has been noted in the quartz veins, at Leeds, Dudswell, Westbury, the Sherbrooke anticlinal, etc., in all which places, and in many others, dykes of diorite are clearly defined ; but in none of these has the quantity of gold yet discovered been sufficient to warrant the expenditure of much capital in its extraction.

In the Chaudiere section, the Cambrian slates and sandstones are well developed along that stream for some miles. They are well exposed along the line of the Quebec Central Railway from Thetford north, and the contact with the underlying schists is apparently about midway between Beauce Junction and the village of St. Joseph. Thence they extend upward along the stream to the Famine river, near the village of St. George, Beauce, and in this part of the section we have the rich alluvions of the Des Plantes, the Gilbert and the Famine on the north, and of the Millstream and the Bras on the south, as well as of the bed of the Chaudiere itself. Many quartz veins occur in this area, some of which are of large size, but in which visible gold has been rarely found. In the Geology of Canada, 1863, however, we find free gold reported from a quartz vein which crosses the Chaudiere at the Devil's Rapid, between St. Francis and the Gilbert, and on Bras, as well, in a garnet rock in which small grains have been found.

The presence of gold in pieces of quartz near the Devil's Rpaid vein, recorded in the Geology of Canada, leads to the remark then made, that "it was derived, in part at least, from beds or veins of this mineral which are common among the talcose slates of the region."*

An examination of the rock along this portion of the Chaudiere shows the presence of intrusive masses at many points. In the vicinity of St. Francis, and between that village and the Gilbert, these intrusions are specially conspicuous in the form of masses and dykes of dioritic diabase, which cut the Cambrian slates and alter them along the contact. West of St. Francis village, towards the Bras stream, intrusions are also seen in the hillsides and along the roads, as well as on the Bras itself; while on the north side of the Chaudiere about the Rochers station, and in the Des Plantes river, the intrusive rocks are frequent and include both granites and diorites, the latter being altered in places to serpentine and carrying small veins of chrysotile. While there is no evidence to show the precise date of these intrusions, they are certainly newer than the slate which they penetrate; but as very considerable disturbances of the strata occurred in this area subsequent to the Silurian time, as seen by the altered condition of the Devonian rocks near St. George, it is probable that some of the intrusions at least belong to a comparatively recent period, and are presumably about the time of those found to the south and south-east as at Montreal and the other dioritic mountains of the Eastern Townships.

*Geol. Can., 1863, p. 254.

That the greater increase in the yield of gold from these portions of the slate formations affected by these dyke masses is due to this agency is supported by the evidence from other localities. Thus at Marmora and Madoc in Ontario, the gold-bearing belt is in close proximity to a mass of granitic rock which has penetrated the strata at that locality, while at the Risborough and Marlow silver mines the dioritic dykes are closely associated with the metalliferous lodes.

The same beneficial action upon, or at least intimate association of intrusive rocks with the strata containing our economic minerals, has been pointed out at many other places.

Bearing this in mind we would naturally suppose that the most favorable place for profitable gold mining in the Beauce district would be found where these intrusions are the most marked; and the past history of the industry clearly supports this aspect of the case.

The consideration of the alluvions presents somewhat different features, though as a whole it is closely allied to the question just discussed. The work of the last fifty years along the Chaudiere shows that by far the richest deposits have been found in the streams between St. George and St Joseph, notably on the Des Plantes, the Mill-stream and the Gilbert; much of the gold obtained in these streams being coarse; while large nuggets are not infrequent in these localities, as well as the channel of the Chaudiere itself. Further to the south and to the south-east but little attempt has yet been made to find the ancient channels of the many streams which are tributary to the Chaudiere. The gold is found at many places, in fact there is scarcely a stream anywhere throughout this great synclinal valley, between the boundary of Maine and New Hampshire on the east, and the Sherbrooke and St. Francis ridge on the west, in which gold cannot be obtained. Much of this, however, is very fine, and appears to have been carried a long distance; while the coarse gold is invariably found in close proximity to quartz veins in the Cambrian slates, both in the Chaudiere and the Ditton areas.

This coarse gold drift is evidently largely local, and occurs for the most part in old river channels, some of which have been recognized for years, but none have been thoroughly explored. Where work has been carried on in the old channels, as in that of the Gilbert, the returns in gold have been very great even with the most ordinary appliances, since no attempt has ever been made apparently to carry out the work in any scientific manner or by the employment of proper engineering skill. The natural inference therefore should be that the coarse gold is derived from the reefs which traverse this area.

The gold found in these old channels should not, however, be confounded with that obtained from the widespread areas of sand and gravel which now in many places border the present channel of the Chaudiere and are found along some of its branches. There is a wide difference in the age of the two deposits. Thus the old channel gravels are clearly proved to be older than the glacial period, since they are covered frequently by a great thickness of other sands and gravels and surmounted by heavy beds of boulder clay. These glacial deposits have effectually closed up the pre-existing channel and forced the streams into new courses. As for the widespread areas of sand and gravel, such as are seen about the junction of the Du Loup and Chaudiere, a part are presumably of about the same age, since they are also overlaid by boulder clay, while other portions may be more recent. These have evidently been carried down in the waters of the two streams and deposited here after the manner of other widespread superficial deposits of much more recent date. As a source of gold, however, many of these deposits are destined to be of great importance, and many hundreds of thousands of dollars' worth of the precious metal are there hidden, waiting for the enterprise and engineering skill which, with a proper amount of capital, will certainly make some one wealthy.

The tests made of these gravel deposits by the Geological Survey in 1852 show that the average amount of gold per cubic yard in the area tested was $1.40. Anyone familiar with hydraulic methods can easily reckon the profit to be derived from the exploitation of a few hundred acres of such a deposit, since with proper appliances the cost of washing and extraction should not exceed 4 to 5 cents per yard. In view of the difficulty of locating the old channels of these streams it would almost appear at the present time preferable to turn our attention to these easily reached deposits, especially in view of the fact that a ditch capable of affording a head of water of over 200 feet is already available or can be made so at small expense. It may be mentioned also in connection with these gravels that nuggets of good size were obtained at the trial, one of which was valued at $124. It may, however, be assumed that, with the comparatively crude appliances then used, all of the gold was not collected, so that presumably the real value per cubic yard of gravel is still greater than the figure stated.

It is to be expected that an old channel of the Chaudiere exists near the juncture with the Du Loup, but this will probably be found difficult to work by ordinary methods owing to heavy water. Could it, however, be successfully located and operated, there should be very profitable returns, as the specimens already obtained from the experiments made, show that much coarse gold is there buried.

These extensive deposits of surface gravels and sands of the Du Loup and Chaudiere area have evidently resulted from the destruction of the slates and contained quartz veins which are found along the upper part of these streams and which have been brought down in periods of high water, the gold being as a whole somewhat finer than that found in the old channel of the Gilbert or in the main stream as along the Devil's Rapid vein. The fine gold which occurs over so wide an area of the Eastern Townships, on the other hand, has probably been distributed first of all, through the influence of local glaciers, and secondly by the overlying currents of water that evidently swept over this entire area, subsequent to the retreat of the ice sheet.

It is encouraging to notice the renewed activity which has arisen in connection with the gold deposits of Canada, not only of the east, but of the extreme west. And especially so in connection with the Beauce district, where the subject is now being investigated by proper scientific methods by one of our most able and active members, under whose management we feel sure the enterprise will be thoroughly tested; and we trust his efforts will meet with the financial reward they deserve. In the meantime I do not think that the pursuit of old channels should be allowed to draw off the attention of capitalists from the exploitation of the rich gravels of the Du Loup, which have already been shown by the efforts of the Geological Survey to be so productive of gold when properly worked. I can only reiterate my belief that if the mistakes of the earlier operators are avoided, the scientific testing of these gravels will be productive of very rich returns; and I believe the day is not far distant when the gold fields of Quebec, although they are near home, will be quite an important factor in the output of the precious metal, as many of those areas in the more remote portions of Canada, from which such glowing accounts have lately reached us, but in some of which at least the promised returns are largely swallowed up by the difficulty of access and the greater cost of working.

DISCUSSION.

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Mr. J. E. Hardman—Dr. Ells' paper suggests many points for discussion, so very many in fact that I can only touch upon one or two points with which I am compelled to differ.

Dr. Ells makes some statements which I do not think would be made by a man who had specially studied the economic minerals of the county of Beauce.

In the first place Dr. Ells make a comparison (which has been made elsewhere and somewhat frequently) between the gold-bearing rocks of Nova Scotia and those of Quebec, and states that the slates and quartzites underlying the alluvions in Quebec have been ascertained, "quite conclusively," to be "precisely similar" to the gold-bearing series in Nova Scotia.

Now, during a protracted residence in Beauce last summer, I was quite unable to see for myself, or to get authentic information from others, regarding these rocks underlying the *original* gold alluvions of Beauce county, and for the very good reason that no one was working original alluvions, but only the re arranged *post-glacial* gravels derived from the old or *pre-glacial* river beds. However, as Dr. Ells is professionally a geologist and I am not, it is wisdom to give his assertions the benefit of the doubt, remarking only that speculation as to the origin of these gravels and their native *habitat* must remain speculation until the miner has wrought for several years in the original alluvions and has gathered a mass of *facts*, upon which some hypothesis may consistently be formed.

It is not sufficient to say that the Cambrian slates of Beauce carry quartz veins and the Cambrian of Nova Scotia carries *auriferous* quartz veins, and that therefore the quartz of Beauce must be auriferous. Whatever their age, similar or dissimilar, the Cambrian quartzites and slates of Nova Scotia have been subjected to such a metamorphism, such stress of heat and pressure as to make the widest divergence in genetic conditions very possible, if not probable. My experience in Beauce is limited to a comparatively small area, but in that experience I am compelled to say that I have seen no quartz veins which would be considered in Nova Scotia as probable producers of gold in economic quantity.

Of quartz veins, and frequently large ones, there is no lack in the 12 miles from St. Francis to above the forks of the Du Loup, and even to above the High Falls of the Chaudiere, but they are barren of gold so far as economic quantities are concerned, and lack that vital constituent of all permanent productive gold veins, viz: metallic sulphurets.

I have seen in Quebec no gold quartz that would tempt a gold quartz miner to consider the vein worth opening, and I think the experiments and tests which have been made there during the last year or two by our worthy past president will bear me out. Very little gold that can be seen without a glass is found. I remember a French gentleman, to whom I had expressed similar views, coming in to see me one day and saying, "Mr. Hardman, I have at last found free gold in Quebec quartz." He gave me the specimen, but I failed to see the gold, when he said, giving me his magnifying glass, "You can see it easily with this glass." I replied, "If you've got to use a glass to see the gold I don't care for it." This specimen came from the recent find at Westbury, near Dudswell, to which Dr. Ells refers.

It is an absolute fact that as yet no one has discovered gold in quartz in anything like economic quantities in Quebec. I think the reason for this is largely owing to what Dr. Ells states, that the whole of the country is covered with 100 to 250 ft. of glacial drift. The only exposures are on the south or southeasterly side of the streams where the present river bed has been forced to that side and has washed the rocks clear. It was this enormous ice-sheet that came down from the North-west and filled up the hollows with 200 ft. or more of glacial drift by which the river was forced over to the south side. Take the Chaudiere river for example. There are several bridges which cross it, and you will find uniformly that the abutments on the southeast side are on bed rock, but for the second pier you have to sink 15 ft. or more to get bed-rock, and the third pier is never on bed-rock but on clay, and the abutment on the north side is never on bed-rock but always on clay. At St. George, on the north side, a well was sunk 77½ ft., or 59 ft. below the present river, and still was in glacial clay. From this it is evident that the country cannot be prospected easily or rapidly.

Dr. Ells makes mention of a vein at the Devil's rapids, known locally as the O'Farrell vein. I had heard of this vein years before I went to Beauce, and it was one of the first things I went to see. We would not look at it in Nova Scotia. We would hardly think it was worth taking samples from. That there are productive gold veins in Quebec is very likely, else where did the gold come from? But if such veins are found at all they will be found in the deep excavations which may be made in mining for old river gravels, and if found may be rich enough to pay to work as quartz mines.

There is another fallacy, at least in my opinion. It is a fallacy that has found its way into all the books on Quebec gold mining, viz: that the gold has been derived from the quartz veins which cross the present streams, and that in these are found the largest nuggets.

Where a workable alluvial deposit has been found it has always been where the old river bed has been cut diagonally across by the present stream. The quartz veins cropping in the present streams have nothing whatever to do with the origin of the gold found in the gravels, and if more gold or richer gravels are found just below these veins, it is because the quartz, being harder, has withstood erosion better, and has therefore acted as a riffle to concentrate the gold as it was washed down the stream. These modern alluvions are merely rearrangements of the old pre-glacial beds at points where the present streams have touched the old deposits or cut through them.

That the ultimate source of the gold was in quartz veins and slate belts, I don't wish for a moment to controvert, only to dispel the idea that the source is immediately at hand in the veins shown above the river washings.

I have yet to find the miner or habitant who has authentic data regarding the finding of gold in the quartz veins *in situ*, uncovered by the washings which have so far been undertaken from the Des Plantes in the north to the Du Loup in the south.

Another thing that Dr. Ells says,—the bulk of the gold has been taken from down the river, between St. George and St. Joseph. The records show that about as much gold has been taken from the Gilbert river alone as from all the rest of the Chaudiere country; and eliminating the Gilbert the richest and best deposits have been found above St. George on the Du Loup. Records show that a superficial acre contained $17,000 in the Du Loup. The washings which have been made have shown that the upper gravels (*i e.*, above the Gilbert) are as good, if not better, than those farther down. As to the ultimate source of the gold as yet no one knows anything whatever, and Dr. Ells may say that it is derived from the veins in the Cambrian schist without contradiction, but also without satisfaction to those mining there. The Geological Survey, under the able direction of Dr. Dawson, who is taking up the economic side of geological investigations, sent up last summer Mr. Chalmers to make an economic survey and to determine, if possible, the origin and source of these gravels It was impossible, however, for any man to form a generalization, in view of the extremely limited number of facts available. Mr. Chalmers was entirely of the same opinion that before any theories can be advanced as to their origin, these old river gravels must be carefully and scientifically worked, and a body of data accumulated.

The ordinary miner in past years, with wing dams and crevicing, has been only fossicking and digging gopher holes and has added nothing to our store of facts and has done no good to the country. It is hard to say this of such a promising country, but every one of you who visits the district must say the same,—that there has been nothing but "fossicking."

The Chairman—This is a most interesting question. We hear so much of the great wealth of some of these mines. I would like to call the attention of the students that this rich gold is to be found at the junction of the Du Loup and Chaudiere rivers.

Mr. Hardman—In looking up this matter it will be found that, from the best records available, the production of the whole of Quebec has been about two millions of dollars, washed out of the Beauce country since the finding of the first nugget in 1844. About one half of that, nearly one million dollars, was taken from the old river bed of the Gilbert.

Hon. Mr. Fitzpatrick—Beauce is a tender subject with me. I have got a client who has put in $150,000 to $160,000 in that country. I am sorry I did not know you were in Beauce [to Mr Hardman], I certainly should not have been very far away from you. I would like a little explanation of some things. On a portion of the Gilbert river, lot 13, within an area of not more than a quarter of an acre, it is proved beyond all doubt that St. Onge Bros. took out, at an average depth of 80 ft., something like $40,000. I would like to know where that gold came from? At the Devil's rapids also considerable gold was taken. The Chaudiere river was very low at that time. I was looking after some property and I myself saw a miner pick up a piece of gold which I brought home and got $43 for. I have seen in the records of the court of Quebec, in a trial going on, the evidence of a man named Poulin, who swore he took $18,000 out of the Devil's rapids quartz vein. If there is nothing in the country, where did all that gold come from? Perhaps it is unfair, however, to get a professional opinion from Mr. Hardman without the usual fee. I will conlude my remarks. I am very much obliged to you, and if I can do anything on my part in any degree, as the owner of a seat in the house, I shall be delighted to do so on behalf of your Association.

MR. HARDMAN—I think I can answer one portion of Mr. Fitzpatrick's remarks, non-professionally of course. I deprecate the idea that anyone should think I have said, for I did not mean to say, that there was "no gold in Beauce," for I hope to take a good deal out of Beauce myself. With regard to the Devil's rapids, you say that $18,000 had been taken out of that vein. I have nothing to say about the affidavit, but I never heard of a sufficient quantity of quartz being taken out of that vein to yield any such sum. I have seen the excavation made, and if $18,000 was taken out of that vein it must have been the richest I have ever seen, and I have seen 80 oz. quartz. Is it not possible that that $18,000 came out of crevices just below the quartz vein and was really alluvial gold? Devil's rapids is in Rigaud, Vaudreuil, which is the only place where the mining rights belong to the seigneur and the Crown has nothing to do with them. As to the matter of picking up a $54 gold nugget, I saw a nugget which I was credibly informed was worth $200, which is still larger. These are the nuggets which I believe are to be found in the old river-beds, because these old pre-glacial crevices having been cut, have acted like riffles in sluices and have caught the gold which has been released from its primal deposit, viz., the quartz.

MR. LOCKWOOD—Take, for instance, the Gilbert districts, the gold is distinctly different in kind. In many cases it has been found below the veins, crossing the old river-beds. It has been found in natural quartz in various sizes and of identically the same character as the vein itself. Some of these specimens are in the Geological Museum in Ottawa. I have myself been in Beauce for many years and worked on the Gilbert. I believe that a large portion of the gold comes from the veins crossing the district. On the north branch the gold is different in character from that on the south branch. It is also different from the Gilbert river old bed.

MR. HARDMAN—I visited the old McArthur claim at the Gilbert, and was willing to pay a very high price for a piece of quartz from one of these veins crossing the Gilbert river, which should carry gold. I was told by a Mr. Brown, who had been there ten or twelve years, that he had never seen any. As to the different values of gold, it is a very important question and should be investigated. In the early days of the Black Hills it was supposed that the gold found in the river-beds was simply owing to the disintegration of the veins in the slates.

Mr. Devereux, in a paper communicated to the American Institute of Mining Engineers,* ascertained that the gold in the cement and in the vein was of different degrees of fineness. The theory of Mr. Devereux was that the gold in the veins had been dissolved and re-precipitated in the cement and was therefore not the same gold. As to the gold in the old river-bed being of different value to that in the vein, I will admit that it is a very important factor to be determined in assuming that there is gold in the present quartz veins, but until this is established I should like to be permitted to hold to my own opinion.

(From the Canadian Mining Review.)

SIR,—In your REVIEW of February, '96, I read a discussion on a paper by Dr. Ells on the Slates and Quartzites of Quebec, read before the G. M. A. of Quebec. J. E. Hardman, M.E., who was present, made some remarks about the slates and quartzites of the county of Beauce, which I think are not according to facts, and if you will allow me a small space in your valuable journal, I would like to say a few words in regard to what he said, and if you think any remarks I may make will benefit the mining community, please publish the same. But before I say any more, I may state that I spent about 20 months on the Gilbert river in 1878-79. I sunk a shaft close to the St. Onge shaft, where Mr. Fitzpatrick says they got so much gold. Our shaft was known as the Forgie shaft. I am only saying this to give you an idea that I know a little about the Gilbert river. I have been in Nova Scotia for a short time, mining for gold, but it was in a conglomerate, and I have seen some of the slates and quarzites there, and I must say that Dr. Ells is perfectly correct in saying that the slates and quartzites of Quebec are similar to those of Nova Scotia. Perhaps Mr. Hardman has never sunk a shaft on the old river bed (I am speaking with regard to the Gilbert river), if he had he would find the bed-rock there similar to the slates in Nova Scotia,

* Trans. Am. Inst. Min. Eng., Vol. X., p. 241.

at least in that part where I was, and that was in Gay's river, where there is a large body of conglomerate overlying them, the lower part of which is gold-bearing. Between the conglomerate on the bed-rock and the conglomerate above it, there is a bed of sand (now sandstone) which is quite distinct from the conglomerate below; that bed of sandstone forms a bottom for the upper conglomerate. And if Mr. Hardman is sinking for any of the old river beds in the Chaudiere district, he will find something similar; it may be not cemented, but he will find a change in his sinking before reaching pay dirt; if he does not, he will get very little gold. In the shaft I sunk on the Gilbert river, I went through a fine body of silt, about 40 ft. in depth; some of the miners called it clay, but it was a beautiful fine silt, evenly deposited, and lying on top of the *pay dirt*. That silt formed a bottom for a drift which rested on top of it, and it was from that drift where the most of our water came from. A short distance to the side of the main channel, the sinking was through tough clay, some of it like leather, and no gold underneath, which the same St. Onge Co. knew to their cost. I think Mr. Lockwood will bear me out in what I say, for he was there at the time. As a general rule, the softest and easiest sinking is over the deep ground in alluvial sinking, and hardest if lava rock takes the place of alluvial; at least that is my experience on the Ballarat gold fields of Australia. And I must say, the old river bed of the Gilbert river resembles the old river beds of the Ballarat in every particular. And I may here remark that in sinking a shaft in alluvial for gold, and when getting close to the pay dirt, if you don't find the different strata evenly deposited, very little gold will be found. The pay dirt should have a clean appearance, the boulders cleanly washed, the same as if a good current of water had been playing around them; but it takes a little experience to be able to tell the difference between clean and dirty pay dirt. The depth of the present river beds is no indication of the depths of the old ones, for they are generally deeper than the present beds. The main old river bed at Ballarat is hundreds of feet below the bed of the present one. And if any party sink for the old channel of the Chaudiere, they will find it a great deal deeper than the bed of the present one. Mr. Hardman instances a well being sunk at St. George on the north side of the Chaudiere, 59 ft. below the present channel and still in clay. I think that proves the old channel to be much deeper than the present one. And if any party sink on the north bank of the Chaudiere, say between the Gilbert river and St. Francois (that is ground I know), they will find the old river bed much deeper than the present one, and I am sure they will get gold, but whether payable or not I can't tell; and perhaps by doing so they will find payable quartz reefs. That is how some of the best paying quartz reefs were found out in Ballarat and district. Some of the companies in that district sunk through nearly 400 ft. of lava rock, which lay on top of the alluvial deposit, lying on the bed-rock; that was their pay dirt, and some of it was very rich. In working out the deposit on the old river-bed, they came across quartz reefs, and it is some of these they are working now, after taking out and washing all the alluvial that was payable, and at last accounts are now working these reefs at a depth of nearly 2,000 ft. Mr. Hardman, in speaking of quartz, says that if he requires a glass to see gold in it, he does not care for it. Now, I take exception to that remark, and I'll give an instance of very rich quartz where gold was not easily seen in it. The Caledonia mine in New Zealand, about 26 years ago, struck very rich quartz—so rich, that within two months from the time of striking it, a debt of $100,000 was paid; and still very little gold could be seen in the quartz, for the gold was coated with something of a blueish color and could not be seen. In your February number of the REVIEW you will read of quartz taken from the Lake Harold mine, Rainy river, which did not show gold but yet assayed well. Ricketts & Banks, of New York, made an assay of it, and as the test was a high one, and no gold to be seen in the ore, they repeated it, the result showing $314.00 per ton. So after all, although gold can't be seen in quartz, still it may be payable. Mr. Hardman also says that the ordinary miner in past years has done nothing but fossick and dig gopher holes. I think he can't say that of the miners of the Gilbert river, for they had to sink and drift in the old river bed before they could get much gold. Hoping I have not trespassed on your space too much.

Yours, &c., WILLIAM TODD.

Louisburg, Cape Breton, April 21st, 1896.

Reading Professor Hardman's remarks in your February number on Dr. Ells' paper on Gold in Quebec, I have been astonished that he should not have referred in any way to the history and bibliography of gold mining in the Province of Quebec as recorded in detail in the publications of the Geological Survey of Canada.

Your readers might be referred to the Geology of Canada, 1863, pp. 518-520 and pp. 739-745; also to subsequent reports by Mr. Michel and Dr. T. Sterry Hunt, Vol. 1863-1866, also to my own report, Vol. 1871, on the gold fields of Quebec and Nova Scotia.

Mr. Hardman might perhaps learn some facts from a careful perusal of the reports referred to, which his remarks on Dr. Ells' paper justify me in supposing he has never read. Neither in Dr. Ells' paper nor in Mr. Hardman's criticism of it are there any new facts advanced affecting the practical development of the Quebec gold mines.

Dr. Ells makes no statements respecting them that would not be made, and indeed have not already been made by others who have "*specially studied* the economic minerals of the County of Beauce," Logan, Hunt and myself included, all of whom have done so, and may be presumed to have some knowledge of gold mining.

Mr. Hardman's contempt for quartz in which the gold could not be seen without a lens can only be regarded as an indication of his very limited experience in the matter of gold quartz mining.

ALFRED R. C. SELWYN, F.R.S.

Ottawa, 28th April, 1896.

Your favor of April 9th, enclosing copies of letters from Dr. Selwyn and Mr. Todd, and requesting a reply for the next issue of the REVIEW, has been received.

I am not at all sure that I can comply without discourtesy to the General Mining Association of the Province of Quebec. Dr. Ells' paper and my discussion were a part of the proceedings of the Association at its regular meeting in January, and were published in the REVIEW solely because that paper is the Association's official organ, and not in any guise as "copy" or newspaper material. Therefore it seems to me that any further discussion should properly be first submitted at some meeting of the Association before publication; and if an apology is needed for the following it must come, Mr. Editor, from yourself as the Secretary of the Association.

Dr. Selwyn's letter embodies five statements, viz: First, his "astonishment" that I did not refer to the "history and bibliography" of the subject under discussion; second, that I have never read the references he gives, or I would have learned some "facts;" third, that neither in the paper itself nor the discussion were any new facts advanced "affecting the practical development" of Quebec's gold resources; fourth, that Logan, Hunt and Selwyn "may be presumed to have some knowledge of gold mining;" fifth, that because I expressed a desire to see visible gold in the veins of Beauce, I must have a "very limited experience in the matter of gold quartz mining."

I will take these statements up seriatim: (1) I fancy the Dr's "astonishment" will be exceeded by that of such of your readers as are members of the technical societies, when they learn that a member who *discussed* a paper is supposed to give the "history and bibliography" of the subject. I had always fancied myself (and it has been my experience) that if any "history and bibliography" were wanted its proper place would be the *paper itself*, and not *discussion*. If the venerable ex-Director will go so far out of his usual path to read the papers and discussions of other technical societies his "astonishment" will increase and have plenty to feed upon, but he will find I am in good company. (2) I beg to inform Dr. Selwyn that the Geol. Survey Reports for 1863, 1866 and 1871 are on my shelves, together with Mr. Michel's report and many others which the Dr. does not mention; that I read his references carefully several times before, during and after my visit to Beauce; that I did learn some facts from such perusal, and that I learned also a lot of facts which are not contained in those volumes, and some facts which are not in accordance with the *speculations* to be found therein.

(3) Dr. Selwyn is unconsciously correct in his third statement, for there *is* no "practical development" to be affected by "facts," "new" or otherwise. *Practical development* is what is wanted to *furnish* facts, practical development is what Beauce County never has had, and the whole mass of writing, theories and surmises constituting the "history and bibliography" of this region must be taken on trust until development proves or disproves it. Beauce has had geologists galore, and what there is to know from present facts is fully and admirably set forth by Dr. Selwyn in "Report of Progress, Geol. Survey of Canada, 1870-71." What is now needed is a period of development by practical men, educated engineers, who shall accumulate a store of *new* facts for the geologist of the immediate future.

(4) The fourth statement, that Logan, Hunt and Selwyn may be presumed to have had some knowledge of *gold mining* is debateable; that all of them are past masters in geology goes without saying; that any of them ever had any *practical knowledge* of mining invites proof.

(5) Had Dr. Selwyn attended the evening session on January 8th, as well as the afternoon session, he would have known that my remarks concerning visible gold in quartz referred entirely to Nova Scotia quartz, and the Quebec quartz characterized by Dr. Ells as "precisely similar." In the condensed stenographic report of my discussion this is not so clear as perhaps it should be. However "limited" my experience for the last nineteen years in various parts of the North American continent may appear to Dr. Selwyn, it has been long enough to teach me that the vast majority of paying gold quartz mines in North America have been discovered through the finding of outcrops carrying visible gold; I am not talking of auriferous pyrrhotite nor smelting ores, but of free-gold quartz.

It is perfectly true that we may look over tons of rock from the Alaska-Treadwell, from the "Belt" in the Black Hills, from the "sugar quartz" of Georgia, Alabama and the Carolinas, from many of the Bodie mines and others in California, without seeing a "color," and yet have the same rock contain a paying amount of gold, but it is equally true that if you cannot see the "color" in Nova Scotia quartz you are pretty sure of a loss and not a profit.

For nearly 50 years the "history and bibliography" of the Beauce district has been recording "assays" of quartz veins, running from a trace upwards; for nearly 40 years intelligent *habitants* have been searching for a paying gold quartz vein; for nearly two years past a three stamp mill has been testing the veins of one locality, and what is the sum total of results? No paying gold quartz vein has yet been found in Quebec. If superannuation has not prejudiced Dr. Selwyn let him read page 92 of the Summary Report of the Survey for the year 1895. The utter unreliability of an *assay* of free-gold quartz never had better exemplification than the past record in Beauce.

As to Mr. Todd's letter, a few words will suffice.

He acknowledges that his experience in Nova Scotia is confined to a short period on the Gays river conglomerate, hence I must question his knowledge and ability to compare the gold series of Nova Scotia with the Cambrian of Quebec.

Mr. Todd's reference to visible gold is answered above.

I have never *sunk* a shaft on the Gilbert, but I have seen the slates of the "old river-bed" *in situ* there, and have seen the "bed-rock" of other old channels in other parts of Beauce, and I agree to differ with Mr. Todd upon this matter. Furthermore, it was precisely these old workings in the Gilbert district rather than anywhere else which led me to use the words "fossick" and "gopher" to which Mr. Todd objects.

What the occurrence of "lava" and "alluvial" in Ballarat, and how the pay dirt should appear, and kindred topics, have to do with my discussion of Dr. Ells' paper is not apparent to me, and calls for no reply.

(Signed) JOHN E. HARDMAN.

Montreal, April 30th, 1896.

SIR,—The discussion in the April number of the REVIEW over my paper on "The Gold Deposits of the Eastern Townships" seems to be largely wide of the mark. The paper was intended simply to call attention to two points, viz., the great value of the gravels along the Upper Chaudiere and the Du Loup, and the desirability of exploiting these properly by the hydraulic method ; and, second, the presence of the many intrusive masses of granite, greenstone, etc., seen in the vicinity of the Bras, on the south side of the Chaudiere and in the area between the Des Plantes and the Gilbert on the north side of that stream. No comparison was made between the quartz veins of the Chaudiere and those of the Nova Scotia gold field, nor was any comparison of all the rocks of the two localities attempted, since that would have been absurd. Mr. Hardman has doubtless examined the geological map of the Chaudiere district, and has seen that no less than three geological formations are there represented, viz., the Cambrian, Cambro-Silurian, and the Silurian or Siluro-Devonian ; the latter occupying a small basin-shaped area to the north of the river between the Famine and the village of St. George. The only rocks I compared with the gold series of Nova Scotia were the slates and associated beds of the Cambrian area which extends on the Chaudiere from the Famine river to below the village of St. Joseph. These are well seen on the Gilbert, the Millstream and elsewhere, as also to the south-west in Ditton, and to the south-east on the upper part of the Du Loup. The point I wished to make in regard to these rocks which underlie the richest gold alluvion of the district, in so far as yet known was in relation to the intrusive masses, since we find at most mining areas that diorites have had an apparently marked influence upon the presence of minerel lodes, and it is presumable that the same favorable conditions may prevail in that portion of the Chaudiere where these intrusives are especially numerous.

(Signed) R. W. Ells.

Ottawa, May 4th, 1896.

Water Tube Boilers.

By Mr. W. T. Bonner, Montreal.

When our worthy Secretary called upon me for a paper on water tube boilers, I little realized the difficulty attending the work, for the subject has already been so fully and so ably discussed in the technical journals, and even in the ordinary trade catalogues, that I fear my humble contribution to the proceedings of this Association will contain little that is new or interesting. However, hoping that I may at least be fortunate enough to glean from fields, which possibly some of you have passed over, I beg your indulgence and attention to certain facts which we of the water tube persuasion believe to be proof positive of the correctness of our system.

Old and New.

Not at all unfrequently are the promoters of water tube boilers called upon to furnish evidence of the extent to which such boilers are, and have been used. The prevailing idea in the minds of many steam users appears to be that of mistrust in the principle and effect of water tube boilers. It is not what their fathers used, neither does their local boiler maker approve of them, a negative premise naturally calling for a negative conclusion.

Why are not water tube boilers in more general use? Because, as was explained in a discussion* of the subject by the American Society of Mechanical Engineers, they require a high class of engineering to make them successful. The plain cylinder is an easy thing to make. It requires little skill to rivet sheets into a cylinder, build a fire under it and call it a boiler; and because it *is* easy and any one can make such a boiler, because it requires no special engineering, they have been made and are still made to a very large extent. The water tube boiler, on the other hand, requires much more skill in order to make it successful, a fact proven by the great number of failures in that line.

*Trans. Am. Soc. Mech. Eng., vol. vi., page 566.

Water tube boilers are not new. From the earliest days there have been those who recognized their advantages, and in modern practice to refuse them equal consideration with the best known mechanical appliances of other types, is only pardonable on the ground of ignorance or injustice.

I was greatly amused recently to find in a so-called Engineering Journal, the following item of news :—

"At Davenport, Ia., the old battery of four boilers at the Arsenal is being replaced by two new boilers of novel construction in that region. The new boilers are of 200 h.p. each, and instead of the heat passing through tubes surrounded by water, as in the ordinary boiler, the process is reversed and the water in pipes passes through a current of hot air, thus giving a greater heating surface and insuring the greatest safety.'

Plainly those are nothing more nor less than our ordinary water tube' boilers, and it is quite evident that the author of that item gauges the progress of this world by the developments on the little rock island in the Mississippi occupied by the U. S. arsenal.

Contrast with this another item of news in the *Youths' Companion*, to which my nine-year-old boy called my attention a few days ago. It read as follows :—

"An interesting discovery has recently been made in the Museum at Naples where the works of art and utensils found in the buried city of Pompeii are preserved. Careful inspection of one of the ancient copper vase-shaped vessels there has shown that it is in reality a tubular boiler. That this form of boiler should have been known to the Romans two thousand years ago is somewhat remarkable. For just what purpose it was used is not known, but the boiler is well constructed and contains five tubes running across a central fire-box, and so arranged as to permit the water surrounding the fire-box to circulate through them in a continuous current. The soldering of the tubes was so skilfully done that it remains intact today, and the cover of the boiler closes hermetically. The entire height of the machine, which, as remarked above, is shaped like a vase with two side handles and three feet, is only about 17 inches. It has been suggested that it may have been employed for distilling purposes. However that may be, its preservation under the ashes of Vesuvius proves that tubular boilers are not altogether a product of modern invention."

No doubt you have all read Lord Lytton's account of the Last Days of Pompeii and recall his description of the wonderful therme or baths which formed so prominent a feature of every Roman city during the first century. Possibly this ancient boiler was designed by one of those bright Roman or Grecian mechanics for heating the water for the sudatoreum or warm baths. We find it duplicated almost exactly in the Galloway water tubes of the present day, and I have no doubt if we could follow up this investigation of ancient boilers, we would find the knowledge possessed by the ancient Greeks and Romans was not confined alone to poetry, sculpture and art, but that even water tube boilers or heaters were known to them.

The principle of the Galloway tube originated at the time when probably the first steam boiler ever made in this world was constructed. It is not known when the first steam boiler was constructed, but the first steam boiler recorded was made at least 200 years before the year 1 of our era.

In a discussion * of various forms of shell and water tube boilers at the New York meeting of the American Society of Mechanical Engineers in 1885, Mr. W. F. Durfee gives an illustration of this very unique boiler, copied from the first Latin translation † of the Pneumatics of Hero of Alexandria, who lived and wrote about 200 B.C.

Its construction is shown in Figs. 216 and 217. The first figure is copied from the Latin translation referred to and represents a perspective elevation of the boiler and its appendages, showing its internal construction by dotted lines. The second figure (217) was drawn by Mr. Durfee to facilitate explanation; it shows a horizontal section of figure 216 taken just below its top.

The apparatus consists of a vertical cylindrical shell, whose ends are closed by heads, through the centre of which passes a vertical cylindrical flue, D, whose upper end is provided with grates for the support of the fire, Z, the hot gases from which pass downward through the flue. The space between the flue and shell is divided by diapragms into three unequal compartments, A, B, C, in the first of which steam is

* Transactions Am. Soc. Mech. Eng., Vol. VI., p. 566.

† Heronis Alexandrini Spiritalium Liber. A Federico Commondino Urbinate, ex Graeco, nuper in Latinum Conversus: cum privilego Gregorii XIII. Pont. Max. Urbini, 1575.

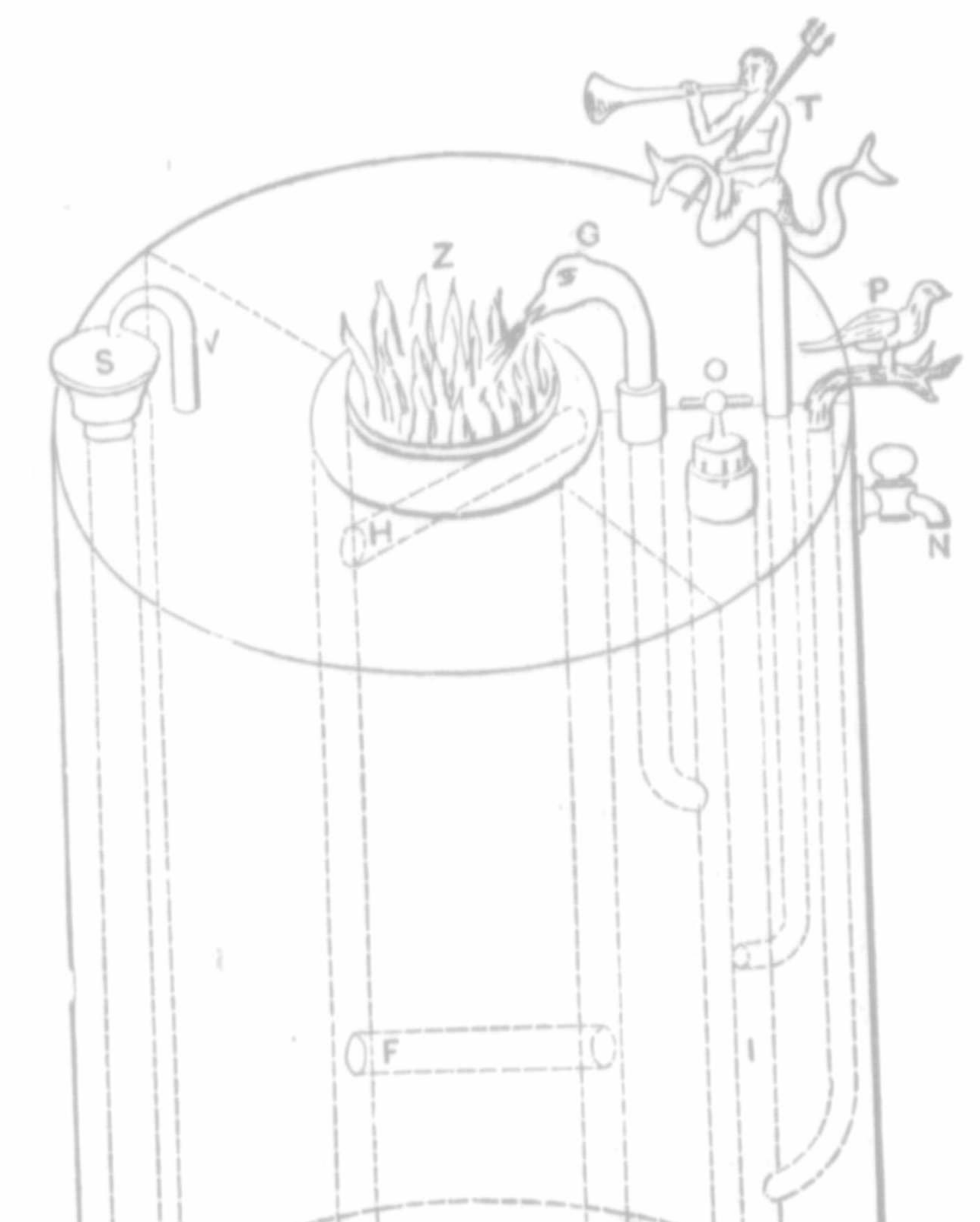

FIG. 216

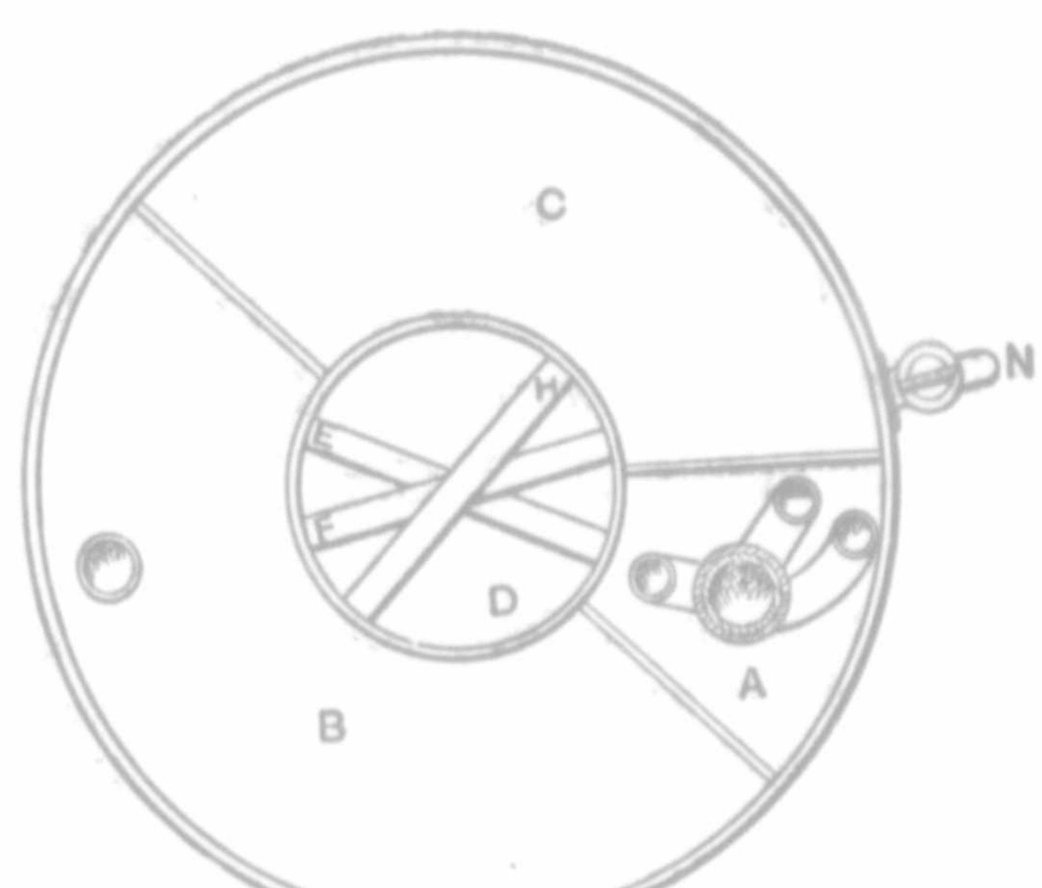

FIG. 217

generated, the others being simply reservoirs of hot water. The central flue, D, is crossed by three cylindrical tubes, H, F, E, the tubes H, F, connecting the hot water spaces B, C, act in the same way as the Galloway tubes, now in common use, but the bottom tube is closed at the end, E, its opposite end opening into the smallest or steam comparment A. The compartment, B, is provided with a funnel, S, whose tube extends nearly to the bottom of the boiler; and also with a safety tube, V, whose curved upper end is immediately above the fudnel, S. The compartment, C, has a cock, N, from which the hot water is drawn. The compartment, A, has within it a three-way cock, I, the three discharge pipes of which are connected with the goose-neck blow-pipe, G, the Triton, T, and the singing-bird, P, respectively. The three-way cock, I, is operated by a cross handle, O, and the upper end of its plug has graduations which, when brought opposite an index mark on the shell of the cock, determine which of the three discharge pipes shall receive the steam generated in compartment A.

The principal function of this apparatus was to furnish hot water, and it is so contrived that it is impossible to draw any considerable amount of hot water from the cock, N, without putting in an equal quantity of cold at the funnel, S. In order to put this apparatus at work, the compartments B and C were filled with water to a level above the upper water tube, H, by means of the funnel, S; the goose-neck, G was then removed and water poured into the compartment, A, sufficient to fill it nearly to the lower end of the three-way cock, I; the fire was then lighted, and as soon as steam manifested itself, the goose neck, G, was returned to its socket and placed in such a position that the fire, Z, was blown by the issuing steam. The three-way cock, I, could be turned by its handle, O, so that the steam would cause the Triton, T, to sound his trumpet, or the bird, P, to warble, and thus announce to interested parties that the water was "boiling hot."

In case any steam generated in the compartments B and C, it found an exit through the safety pipe, V, and any entrained water re-entered the boiler through the funnel, S. In case it was desired to draw hot water in any great quantity from the cock, N, it was necessary to supply an equal amount of cold water through the funnel, S, this requirement insuring a constant volume of water in the boiler.

But I need not weary you with ancient history,—it may satisfy our curiosity and lend some additional color to Solomon's proverb that "There is nothing new under the sun;" yet we cannot expect ancient Greece or Rome to furnish models for our boiler-makers of to-day. Only by comparison do we really begin to appreciate the vast changes by which the engineering talent of today is taxed to its utmost to produce machinery and appliance which will accomplish the greatest amount of work for the longest period, with the least expenditure of effort.

Steam boilers perhaps have not attained that degree of perfection usually accorded to the steam engine, yet when we note the progress which has really been made and realize how close we have approached to the theoretically perfect boiler, we have great cause to feel encouraged.

Of the two hundred and sixty odd boilers recorded in Mr. Bell's most valuable Directory of Canadian Mining Industries, 30 per cent., or 5,400 h. p., are of the water tube type, and 50 per cent., or 9,000 h. p., are shell boilers, leaving 20 per cent., or 3,600 h p., unclassified.

Since pracically all of the above water tube boilers have been installed within the past ten years, we can safely infer that in the mining trade at least, more horse power of water tube boilers are now sold each year than all the other types combined.

There is no better evidence of the survival of the fittest in modern boiler practice, than a comparison of the various types exhibited at the Centennial Exhibition of 1876 with those shown at the World's Fair, 17 years later. At the Centennial there were exhibited fifteen different types of boilers, of which two were cast-iron sectional, four were shell or tubular boilers, two were shell boilers with water tubes crossing internal fire tubes, while seven were exclusively water tube boilers. Of the whole number exhibited at the Centennial, but one, the Babcock & Wilcox, reappeared in its original form at the World's Fair in 1893. Of the fifty-two boilers exhibited in the main boiler room at the World's Fair, all were of the water tube type, while thirty-one of them were distinct copies of the original boiler patented by Stephen Wilcox in 1856, just forty years ago.

The Perfect Boiler.

What really constitutes a perfect boiler? Mr. George H. Babcock, in his lifetime, undertook to formulate the twelve fundamental principles upon which it should be built. It was about twenty years ago that his formulas were first published, yet those same principles still live and are looked upon to-day as the acme of scientific boiler construction. I need not repeat them here, they have long occupied a prominent page in the Babcock & Wilcox Co's book "Steam,"* but rarely do we find so much truth in so few words.

Few boilers there are entirely devoid of all good talking points, but do not be satisfied with a boiler simply because it is made of good materials and workmanship, or because it has a mud drum, or because it has large water and steam capacity, or because it has a large disengaging surface, or because it has a good circulation, or because it is built in sections, and is therefore safe in the event of explosion, or because it is able to withstand high pressure and unequal expansion, and has its joints protected from the fire, or because the furnace is provided with chambers for the proper combustion of the gases, or because the heating surface is composed of thin metal so arranged that the heating gases will cross it at right angles and only leave it when the greatest possible heat is extracted from them, or because it will work up to or over its full rated capacity with the highest economy, or because it is fitted with the best quality gauges and fittings. Each of these qualities add greatly to the value of a steam boiler, but that one is best which combines the greatest number of such qualities, and therefore proves the best investment independent of first cost.

Messrs. Galloway, Ltd., of Manchester, Eng., illustrate on page 94 of their late catalogue, what they are pleased to designate as their "Manchester boiler," but which is in reality a reproduction of the ordinary inclined water tube boiler, built by so many manufacturers of to-day. In explanation of this marked deviation from the Galloway, Lancashire and Cornish boilers, which they have been building for so many years, Messrs. Galloway, Ltd., say :—

"For ordinary pressures the Galloway boiler possesses great advantages, but beyond that, cylindrical boilers are frequently of large diameter, necessitating extremely heavy plates, and although for marine practice this is carried out, yet for situations where the conditions are less rigid, it is advisable to have a boiler more suited to the requirements of the case.

*Steam, 28th edition, p. 7. Babcock & Wilcox, New York and London.

"In addition to this, where transport of large pieces is difficult, the Manchester boiler offers considerable advantages, as the largest piece is the upper vessel, which rarely exceeds 5 feet in diameter, 20 feet in length and four tons in weight, the tube rods and boxes being separate. It will be seen that all the tubes are inserted into one water-box or chamber at each end, the front one connected to the upper vessel by a wide neck, and the back chamber by a large circular connection, by which means an even circulation is kept up. The boiler is further provided with an internal arrangement in the upper vessel for separating the steam from the water, thus preventing priming and its attendant evils. This arrangement of boiler has been largely adopted on the continent, and we anticipate that, when its merits become known, it will be received with great favor by steam users requiring boilers for high pressure."

That is good; coming from such an eminent authority, we can only interpret their adoption of the water tube principle as a strong endorsement of the work accomplished by their predecessors in that field of engineering. I fully expect, however, in the next issue of their catalogue Messrs. Galloway will have overcome their prejudices sufficiently to limit the diameter of their drum to 36 or 42 inches, and that they will further arrange to enclose the drum so as to utilize its surface for heating rather than condensing. Then they may add to the merits of their boiler, safety and economy.

I might add that although Messrs. Galloway are pleased to limit the use of their water tube boilers to stationary work, the boilers of that type are just now making tremendous strides in the race for supremacy in marine practice.

In proof of this statement I might refer to the steamers Turret Cape and Turret Crown, which have just closed a very successful season in the coal carrying trade between Sydney and Montreal. From their lessees, the Dominion Coal Co., I learn that the two steamers have a combined record of 27 trips, extending over a period of 44 weeks, during which time they brought 66,981 tons of coal into this port. To this total should be added 11,700 tons for short cargoes, made necessary by the very low water in the river and canal, which difficulty prevailed through all of last season. Had there been a sufficient depth of water both steamers could just as easily have brought in a full cargo each trip.

The actual carrying capacity of each of the turret boats is 3,000 tons. They are fitted with water tube marine boilers, 2,200 square feet of heating surface being the total for each boat. They have been kept in continual service right through the season, and the captain's log shows a clean record for the boilers.

Many other and larger steamers fitted with water tube boilers have gone into commission during the past few months, and in every case the boilers have given the greatest satisfaction.

Capacity.

The term "horse power" is one which admits of a wide interpretation, being little understood by some and often misapplied by others. Originally used as a unit of capacity by James Watt, and supposed to be the average amount of work performed by a good strong English cart horse, its value is 33,000 lbs. raised 1 foot high per minute. It may be expressed in any equivalent of this unit, as 1 lb. raised 33,000 ft. high per minute. At best this is but an arbitrary unit since the actual value of a horse power depends, as a Yankee boiler maker has very aptly expressed it, upon the size of the horse. The evolution of the term "horse power" as applied to steam boilers has been gradual, but not the less marked.

Prior to the advent of compound and triple expansion engines, it was always customary to calculate the steam consumption of the ordinary slide valve engines then in most common use, at the rate of 1 cubic foot of water per hour, or say 62½ lbs. For instance, a 10 h.p. engine would require a boiler capable of evaporating 625 lbs. of water per hour. In general practice it was found boilers of different types of construction varied in evaporative capacity according to the efficiency of their total heating surface, the amount required per h.p. averaging about as follows: For plain cylinder boilers, 10 sq. ft. For large flue boilers, 12 sq. ft. For horizontal and multitubular boilers, 15 sq. ft.

Of late years tremendous strides have been made in the development of the steam engine, so that instead of one cubic foot of water, or 62½ lbs. steam consumption per h.p. per hour, the modern engine builder knows that he must develop a h p. with less than 30 lbs. of steam for simple non-condensing engines, and from that down to 13 lbs. or less for triple expansion condensing engines, depending upon the size of plant and number of cylinder expansions.

Here then arises a serious complication in the determination of h.p. Shall it be a large or a small horse? The prospective purchaser should consider this matter carefully and demand that all tenders must state specifically the actual evaporative capacity of boilers to be purchased, to be determined if necessary by a practical test. The American Society of Mechanical Engineers has very properly solved this problem by the favorable consideration of its special committee's report at the New York meeting in 1884, whereby the equivalent evaporation of 30 lbs. of water from a temperature of 100° F. into steam at 70 lbs. pressure is fixed as a boiler h.p.

American manufacturers generally have adopted this standard, and while they may differ in the number of square feet of heating surface they allow for developing a h.p., there is no longer any doubt as to the size of the horse

I cannot leave the subject of h. p. capacity without first making a strong appeal for a more uniform rating of boilers, a rating which has some tangible basis. Not until you are able to compare boilers by the actual number of square feet of effective heating surface they contain, or the actual number of lbs. of water they will evaporate under ordinary working conditions, can you judge whether one boiler is cheaper than another.

I confess I was greatly shocked, only a few days ago, to hear the admission of a fire tube boiler man, that he only figured the upper half of his tubes as effective heating surface. I shall always remember him as an honest man of good sense. There is no question but that fire tubes and shell plates exposed to the direct action of hot gases, form very efficient heating surface when they are clean, but who is there who will claim the possibility of keeping such surface constantly clean while the boiler is in active service?

Effective heating surface is that which receives the direct contact of the hot flames or gases and continues to do so without interruption from soot, or interference by close furnace walls or baffle plates. This is the proper basis upon which to purchase your boiler, other conditions of course being equal.

SAFETY.

I have been asked why a water tube boiler is necessarily a safety boiler. It is not necessarily a safety boiler; in fact, I could name a number of water tube boilers which are safe in name only. Certainly a boiler with very wide, flat stayed surfaces, enclosing chambers receiving the combined circulation of all the tubes, should not be considered a safety boiler. Stay bolts and braces at best are a constant menace to safety, since they are usually located in inaccessible places, difficult to inspect and repair. But the principal objection appears to be the impossibility of providing braces which brace at the proper moment. How can it be possible to assemble a number of pieces of metal, all of different sizes and shapes, and subject to greatly varying temperatures, and expect them to expand, contract, and remain uniformly tight at all times? But it is to be regretted that in defending the principle of water tube boilers, there are other weaknesses to apologize for than braces and stays. There are those with tubes closed at one or both ends, the aggregation of pipe and fittings, and the bent tube monstrosities, so aptly described in a recent publication called *Facts*, all more or less dangerous because they cannot be cleaned.

DISCUSSION.

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Capt. Adams—We have all listened with much pleasure to Mr. Bonner's paper, as anything that has to do with the raising of steam, has, of course, to do with mining men and machinery men. The paper has suggested a good many points for discussion, and I trust that we may hear from quite a number of the gentlemen present.

Mr. Fergie—Mr. Bonner's paper has interested me very much. I had a conversation with him last night on the subject of the comparative merits of the Babcock & Wilcox and the Stirling boilers. We are using a battery of Stirling boilers at our mines, while our neighbors have Babcock boilers, so we have a great opportunity of comparing them. The only objection I have to the water tube boiler is the small steam capacity, and I claim the Lancashire boiler has an advantage in that respect. Two weeks ago something went wrong with the feed valves on the Stirling boilers. If they had been Lancashire boilers we could have run for three hours afterwards. As it was, we immediately shut off the water supply, compelling us also to close down the mines and withdraw the men. Another objection I find is that water tube boilers are more liable to prime. Mr. Bonner informs me that they should not. We cannot get as dry steam with the water tube boilers as with the Lancashire boiler. Otherwise, I am satisfied that it is a cheaper boiler in every respect, and with regard to the consumption of fuel, more economical.

Mr. Leckie—The raising of steam is a most important matter; still a good many of us find "raising the wind" to start with, of equal importance. I may say in a general way that a boiler that would suit for one purpose, under certain conditions, might not in another. For instance water tube boilers are being placed on the new fast torpedo boats as being best adapted for that purpose. They are of the Yarrow and Belleville types, very similar to your (Babcock & Wilcox) marine boilers, I suppose, with some modifications. Marine boilers are under the care of experienced engineers and firemen, whereas miners have to look for possibilities that render necessary a plant of less refinement, one that will work under different conditions, such as Mr. Fergie mentions, where we have very dirty water, and where we want boilers that are not liable to get out of repair. Sometimes it may be we are 50 miles from a repair shop, and a boiler less liable to get out of repair, even though it wastes a little more fuel, would be preferable. It is the same with steam engines. I have found Buckeye engines, in places where there is a great deal of dust, and especially in smelting works, or where they use bituminous coal, soon get out of repair, and their efficiency ceases. After all, the most efficient boiler for a miner, is one that will work with dirty water when necessary, and require very little repair. I have had at Londonderry three Lancashire boilers made by Galloway, in Manchester, which have been running over 18 years, and yet have not cost a dollar for repairs. We can work up to 80 lbs. pressure with them, but for very high pressure they would be unsuitable. Where you would run up to 250 or 280 lbs., as they do in the new torpedo catchers, they would be altogether unsuitable.

Mr. Hardman—I can only say from the standpoint of the working miner that what he wants is a machine that is strong and capable of being used by the ordinary stoker and fireman.

In many localities fuel is a very important consideration. I have found not only with the Babcock & Wilcox, but with the Stirling and other styles of water tube boilers, that the heating surfaces were difficult to keep clean if you did not use hard coal. I say this not from personal experience, but from observation of the experience of other people.

I have frequently found that fully one-half the efficiency of the heating surface was destroyed by having a coating of soot averaging from 1-16 to 1-8 inch thick, and this soot is a non-conductor of heat rather than a conductor

Mr. Gardner—I favor and always have favored the water tube boiler on the point of efficiency. Where boilers are required in isolated places, or where it is hard to get a man to make repairs, it may make a difference. There is a great deal in that.

Mr. Bonner—I can readily concede the force of Mr. Leckie's argument that water tube boilers may not be the best for all purposes, but the exception must be some place where neither efficiency, safety, durability or economy have any consideration. Do not understand me, however, to claim that we have the only good boiler. There are many other good boilers besides the Babcock & Wilcox, but when you want the best, examine our record,—you will find the evidence all on our side.

I cannot concede that a shell boiler, whether it be an old-fashioned "Egg Ender," a horizontal tubular, or a Lancashire boiler, is any better in the hands of the working miner than a water tube boiler, either in point of safety or maintenance of efficiency.

"Raising the wind," as Mr. Leckie expresses it, is indeed an important consideration in the purchase of a boiler, and I am satisfied that is why the cheap shell boilers continue in favor. The first cost of a good water tube boiler is considerably more than a shell boiler of equal rated capacity, and for that reason the prospecting miner, or the beginner of any small or uncertain manufacturing plant with a limited capital, very wisely crawls before he leaps. For permanent works, however, employing steam in any considerable quantity, whether they be operated by skilled or unskilled labor, there is no longer a single argument to be advanced in favor of shell boilers, which cannot be met by half a dozen in favor of water tube boilers. The three Lancashire boilers mentioned by Mr. Leckie have certainly given very satisfactory service, but he also admits they are unsuitable for pressures above 80 lbs. The history of the Babcock & Wilcox boilers, crude as they were in their infancy, will compare very favorably with the Lancashire boilers in point of durability, and when we consider the many instances of criminal carelessness on the part of attendants who do not hesitate to pump cold water into red hot boilers, the wonder is that the repair account can still be expressed in fractions.

In my conversation with Mr. Fergie last evening I took the ground that with a water tube boiler properly proportioned for the work it is intended to perform and with a proper arrangement of the steam piping, there need not be any trouble on account of priming. I speak now of the Babcock & Wilcox boiler only, for in it the circulation is absolutely free and unrestricted, and the disengaging surface and steam space are both amply large, so that there is nothing to hinder a complete separation of the steam from the water.

It may be an advantage sometimes to have boilers with sufficient storage capacity to run for a long time after the water supply has been shut off, but while such accidents seldom occur, the loss of efficiency due to carrying such a large volume of water, is a constant factor. Large bodies move slowly and large volumes of water steam slowly. The Babcock & Wilcox boilers will run for an hour and a half at their full rated capacity without exhausting the water in the upper drums—time enough, certainly, to make any ordinary repairs in a well regulated plant.

Mr. Hardman has very innocently ventured on the battle ground of vertical vs. horizontal water tubes. Since he has pronounced us both guilty, I would say—and here again I speak for the Babcock & Wilcox boilers only—they are more accessible for cleaning than any form of shell boiler. With side-cleaning doors opening into every part of the boiler, it is possible to remove every particle of soot from the exterior heating surfaces while the boiler is in full operation. It is also possible to examine every joint and surface about the boiler as minutely as would be possible were the boiler taken entirely apart in the shop, and all without disturbing a single permanent joint.

If the soot from bituminous coal so seriously affects the water tube boilers, why should it not be more detrimental to the fire tube and shell boilers?

In the water tube boiler, the principal heating sufaces are of very thin metal, so that instead of 5-16-in. to 9 16-in. plate to start with, you have only 1-8-in., therefore the total thickness of metal and soot must also be less. It requires a pretty large book to tell all the good features of the water tube boiler, but I am pleased to say such a book has been published, and will be sent to any one free upon application.

Mr Sword—What I consider the main point has been somewhat overlooked in this discussion It is not a question which boiler is the best, as if one boiler could be better than another under *all* circumstances. It is really a question of what kind of boiler is most suitable for particular requirements. I think all the boilers mentioned have their proper place. In Mr. Bonner's clever and instructive paper he does not touch on this, neither does Mr. Fergie state the advantages of a Lancashire over a water tube boiler. I think that where the water is bad, requiring frequent cleaning of the interior surfaces, also where fuel is cheap, and the cost of boiler a considerable factor, that a shell boiler is hard to beat.

Regarding water tube boilers, I do not think Mr. Bonner has laid sufficient stress on the almost absolute safety of this type of boiler, as the greatest damage that could result in the event of a rupture of the boiler would be to injure the attendants by scalding, whereas in the case of explosion of a shell boiler the usual result is the complete destruction of the building and great loss of life. The only part of the Babcock boiler liable to deterioration is the tubes, and in the event of their giving away from over-pressure, they act like a safety valve or a fusible plug, and the damage can be easily and cheaply repaired. I never heard of a drum wearing out or bursting. As the tubes form the principal part of the heating surface of a water tube boiler, the drums can be built of extra thick plate without lowering the heating capacity as would be true in the case of a cylindrical boiler in which the shell forms a large part of the heating surface. I think, therefore, where fuel is expensive, where high pressure can be used and where absolute safety from explosion is of great importance, that a Babcock & Wilcox boiler is preferable to any other.

Mr. Leckie—I was not arguing against the Babcock & Wilcox boiler. They were points to be kept in view. The water tube may be better than even the Lancashire with good fuel and water, but there is a good deal in the nature of the fuel that is used. For instance, you take a boiler of the Babcock & Wilcox type where your heat has to be localized more, anthracite coal is best, but where you use bituminous coal, or wood giving a long flame and diffusive heat, the Lancashire is the most economical. The conditions of use have to be considered. As for safety, the water tube boiler certainly ranks highest. Not many months ago at Fairfield, where they were examining boilers intended for the new torpedo catchers, there was a very serious explosion in which there were four men killed. The boilers were not in the vessel. They were merely making an experiment upon them. I think they were Babcock & Wilcox boilers, if I remember right.

MR. BONNER—I happened to see a report of that explosion as it was given out by the Board of Trade, and I must say that the English Government have a very complete system for investigating and reporting every accident of that kind. It seems they were making a preliminary shop test of the boilers before installing them aboard the ship. In order to save time, I presume, the tubes were not all put in, which required certain tube holes to be plugged up temporarily. This was done by expanding into the tube holes some short nipples with the outer end plugged, naturally a very imprudent method. As there was nothing at the outer end to counteract the pressure on the inside of the tubes, the result was, several of the nipples blew out, resulting, as Mr. Leckie says, in the death of four men. I haven't the details before me, but I remember the official inspectors appointed to investigate the accident reported that no blame should rest with the manufacturers of the boilers, as the accident was due solely to carelessness on the part of the men in charge of the test.

I am glad that Mr. Sword has spoken out regarding the matter of safety, although I purposely avoided extended reference to the subject in my paper, assuming that you already understood our claims in that particular.

I presume everyone present will recall the horrible disaster at Detroit last November, caused by the explosion of a horizontal tubular boiler, where 37 people were killed, 7 or 8 wounded, and over $100,000 worth of property destroyed. You will also recall the terrible explosion at King & Sons' saw mill, opposite St. John, N.B., last spring, where several people were killed, and upwards of $40,000 worth of property destroyed. Then another very disastrous explosion in Toronto three or four months ago, where a handsome new four story brick and stone building was completely demolished. And what caused it? The explosion of a little 10 h. p. vertical boiler. Fortunately the employees had all gone home, so that no lives were lost, but it is recorded that miraculous escapes were very numerous. These are only a very few of the disasters that are constantly occurring right in our midst, and if we could but know the true condition of these volcanoes of energy which surround us on every hand, accident insurance and safety boilers would soon be in great demand. But consider, if you will, the record of the water tube boiler and of all the more successful makes, having thousands of boilers in use, not a single disastrous explosion has occurred. This is perhaps more noticeable in the case of the Babcock & Wilcox boilers, for the reason that their record extends over a period of nearly 30 years, during which time they have installed considerably more than 1,500,000 h. p. This vast array of boilers is distributed all over the world, and they are being used for every conceivable purpose by men whose knowledge of mechanics is certainly not lacking in variety.

The Babcock & Wilcox water tube boiler has all the elements of safety in connection with its other characteristics of economy, durability, accessibility, etc. Being composed of wrought-iron tubes, and a drum of comparatively small diameter, it has a great excess of strength over any pressure which it is desirable to use. As the rapid circulation of the water insures equal temperature in all parts, the strains due to unequal expansion cannot occur to deteriorate its strength. The construction of the boiler, moreover, is such that should unequal expansion occur under extraordinary circumstances, no objectionable strain can be caused thereby, ample elasticity being provided for that purpose in the method of construction.

In this boiler so powerful is the circulation that as long as there is sufficient water to about half fill the tubes, a rapid current flows through the whole boiler, but if the tubes should finally get almost empty, the circulation then ceases and the boiler might burn and give out ; by that time, however, it is so nearly empty as to be incapable of harm if ruptured.

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The Canadian Pig Iron Industry.

By Mr. G. E. Drummond, Montreal.

To review the young and growing Canadian iron industry, without "taking stock" of rival markets, is an impossibility in these days of close competition. The American iron-masters especially must be reckoned with, for they have succeeded in displacing the iron and steel producers of Great Britain in the western, or most important portion of the Canadian market, and have now narrowed down the fight for supremacy in that section to a question of the product of American labor as against the product of Canadian labor. The British iron-masters frankly admit that they are out of the fight in so far as the trade of Western Canada is concerned. The splendid equipment of the American furnaces, together with their close proximity to the Canadian market, puts the Scotch and English iron-masters at a great disadvantage, and it is therefore an acknowleged fact that the competition for the iron trade of Canada must now and for the future be solely and alone between American and Canadian producers. It has been said that our neighbors to the south "want the earth," and if one is to judge by the opinion of so eminent an American authority as Mr. Andrew Carnegie, it would seem that in so far as the Canadian iron market is concerned, they imagine that they have it. Mr. Carnegie, in a glowing article recently contributed to the "40th Anniversary" number of the *Iron Age*, in writing of the iron producers of the United States, of which body he may well be termed "king," says they "have become the largest, best disciplined and most effective army of iron-masters in the world. They have wrested their home market from the grasp of the foreigner, they supply the Canadian market upon equal terms with him, and are beginning to conquer territory which never before was theirs."

The foreigner referred to so aggressively by Mr Carnegie is the British iron-master, for no other competitor of consequence, aside from the Canadian, ever fought for the iron trade of these British North American provinces. It is quite true that the British makers have been driven out of the greatest and most desirable portion of this market, and they have been driven out, to a large extent, by American makers. In that Mr. Carnegie is right. Our Canadian ocean steamship owners can bear testimony to this by the consequent loss of tonnage for their steamers plying between British and Canadian ports. The British iron-master has passed away, probably never to be reinstated, in so far as the western Canadian market (the greatest we possess) is concerned, but Mr. Carnegie is mistaken if he imagines that American iron-masters are left in sole possession of the field. If he will glance at the statistics of the imports of pig iron into Canada versus the domestic production for the fiscal year ending 1893-4, he will be convinced that Canadian-made pig iron is making a steady and sure headway. Quoting from a late number of the *Canadian Manufacturer*, in which figures taken from official sources are given, the increase of output from Canadian furnaces for the fiscal year ending 30th June, 1894, was 200% over that of the fiscal year ending 30th June, 1891 (three years).

1893-4 marked an epoch in the history of the Canadian iron industry, because the domestic production for that year, 62,522 tons, meant that Canadian workmen were producing from purely Canadian material 58% of all the pig iron consumed in the country. The official statistical year-book gives the percentage of home-produced iron to the total consumed as 45.4%, but this is incorrect, inasmuch as the imports group together the following material:—pig iron, iron kentledge, scrap iron and steel, giving the total as 75,275 tons. The total quantity of pig iron imported for that year was 45,262 tons, the Canadian iron exceeding the importations by 17,240 tons. The statistics down to the close of the last fiscal year, June, 1895, will show (the "ebb and flow" of trade being allowed for) a proportionately steady advance, and this will be still more marked in the coming year, when it is probable that the output of the new coke furnace at Hamilton, Ont., will be sufficiently large to replace what is now imported from the United States, and beyond what may seem desirable in mixtures, may be calculated upon to do so.

The *Canadian Manufacturer* places the value of the pig iron production of 1893-4 at $965,968.77, and when it is considered that almost nine-tenths of this has been paid out for labor to Canadian workmen, the value of the industry will perhaps be better appreciated. A continued encouragement of the industry will mean that Canadian pig iron will yet form a basis for many articles of finished iron and steel not now produced in this country. It has been well said that the production of pig iron is one of the best tests of a country's metallurgical greatness. This has been particularly true of Great Britain and the United States. The statistics referred to above evidence the fact that Canada is on the "right track." The Dominion may rank low as yet in the scale of iron producing countries, but she is on record along with such nations as Great Britain, the United States, Germany, France, Sweden, Russia, Austria and Spain, and the Canadian percentage of the world's output, though small, is steadily increasing, and must increase if the industry is encouraged as the circumstances of the case demand.

The American Trade.

1895 has been a year of surprises. As one authority puts it: "1895 iron trade was like a sandwich, the meat, or best part of it, was in the middle." Opened badly; surprisingly good during the summer and autumn months, and surprisingly bad at the close On the whole, however, a year fairly prosperous, and with few, if any, failures of importance attending its operations. In this respect an improvement on 1894, and a marked contrast to 1893.

As an evidence of the great fluctuation of prices during the year, Bessemer pig iron was quoted at $10 at Pittsburg, equal to $9.35 at Valley furnace, in the early part of the year. Later on in the season this iron went up to $17.50 at Pittsburg, but receded again before the close of the year to $11.00 per ton. On some lines of finished goods the prices advanced fully 100%, but again receded. While the actual figures of the output of pig iron in the United States to the close of the year have not yet been compiled, it will aggregate almost, if not quite, 9,500,000 tons, and 1896 opens with the enormous output of almost one million tons of pig iron a month, and with but a very light demand for steel and finished material This would not seem to be an encouraging position of affairs, yet it is safe to say that the actual conditions are quite as favorable as they were along in the summer and autumn of last year, when buyers were "tumbling over" one another in their anxiety to get orders filled. The great railways and other large corporations have not by any means supplied their legitimate wants. Speculators have rushed the market during 1895, and many of them are carrying stocks today which were purchased at fairly high prices. The legitimate buyers, at least the larger ones, notably among the railways, have held back, but they must come into the market sooner or later, and there is good ground for believing that even the present immense output will not be, at least for some little time to come, too great for the legitimate demands of the country, when the unsettling war scare, combined with the drawbacks of a presidential year, have permitted trade to settle down into ordinary grooves.

Natural conditions will all tend more or less to keep prices steady through the coming year. With advanced prices on ore and coke, Bessemer pig cannot be made for $10.00, or anything like it. Labor is 30 per cent. higher than it was a year ago, and it is now costing more to make iron than it did last season. It is therefore probable that the present low prices are more or less temporary.

The New York *Journal of Commerce* says that the ore shipments of the lakes have been about one third greater than the previous year, and they have exceeded by more than 10 per cent. the shipments of the banner year, 1892. A significant feature is that ever since 1892 a surplus of about 2½ million tons of ore has been lying on the docks, while now the supplies are down to a point that there are fears of an ore famine, and prices have advanced accordingly. The Mesaba mines commenced shipping in 1892, but the amount that year was nominal. In 1893 there was a considerable shipment, and this was tripled in 1894, but the shipment of 4,000,000 tons in 1895 has a good deal more than doubled the shipments of the previous year. It is notable that at the beginning of last season only ten mines in the Mesaba range contemplated making shipments, but at the close of the year 22 mines were in operation, and a dozen more are making arrangements to ship as soon as spring opens. There is considerable activity in the other ore-bearing districts, and on the Gogebic range it is deemed probable that there will be a repetition of the boom of six years ago.

There will be no lack of ore, yet many of the best authorities agree that prices will be well maintained throughout 1896.

Great Britain.

It is too early to give full returns of the British output for 1895. The production of pig iron, however, for the first half of 1895 was 3,721,870 tons, which is at the rate of 7,443,740 gross tons, against a production in 1894 of 7,427,342 tons It will be seen that the output in the United Sates shows a steady and marked increase over that of the rival market, Great Britain.

In marked contrast with the excited fluctuations of the American iron market during the past year, the course of Scotch pig iron has been of an extremely placid and uneventful description. Opening at 41/7 with a quiet market, Scotch warrants closed at the close of 1895 at 45/7, without any special features of interest. The price at which they opened at the beginning of the year was very low, and the market gradually recovered during the spring and early summer, until in the month of September, when the American boom was at its height, they reached the high figure of 48/10, which, however, was maintained for only a short time. Prices then began to settle again, and they continued gradually to recede until the close of the year, when 45/7, as we have stated, was the ruling price. It was expected at one time during the course of the year that the Scotch and English markets would follow the lead of the American, but the collapse of the boom on this side of the Atlantic effectually stopped this.

Another incident happened to further depress the buoyant feeling which was prevalent in Scotland during the month of September, and that was the unfortunate trouble which arose in the ship-building yards on the Clyde, and also at Belfast and in England, in connection with the wages of the ship-building hands. A large quantity of tonnage was placed in the latter part of 1895, and it was expected that the Scotch and English ship-building yards would be fully employed, and the demand for steel would thus be considerably increased. The disputes, however, between the ship-builders and their employees has undoubtedly sent a large quantity of this tonnage to foreign ship-building yards, and consequently the large demand for steel that was expected has not developed. It is understood that these disputes have now been satisfactorily settled, and it is not expected that the prices will decline further than they are at present.

The fluctuations in the warrants market are of course largely of a speculative character, and are often due more to condition of the money market and other outside causes, than to any special increase or decline in the demand for pig iron or consumption. In order, therefore, to judge of the actual condition of the consumptive pig iron market it is necessary to look at the figures of Scotch shipping brands, such as "Summerlee," "Coltness," "Calder," "Gartsherrie," etc. In looking at the prices of these brands, the extremely placid nature of the market during the past year is especially noticeable. No. 1 "Summerlee" was quoted f.o.b. Glasgow in January, 1895, at 52/6, and the quotation at the close of the year was 51/-. The lowest price quoted during the year was 50/- on several occasions, while the highest was during the months of September and October, when 53/- was asked, and possibly a little higher may have been the ruling price for a short time, but the margin of fluctuation during the whole year was never greater than about 3/6, or under $1.00 per ton. This is rather different from the course of the American market, for the same grade of pig iron, such as is made in northern Ohio, No. 2 American Scotch, was sold as low as $9.25 at the furnace, while during the boom it went as high as $14.50, showing a margin of fluctuation of over $5.00 per ton on this grade.

The figures in connection with the production, consumption and exportation of British iron have not come to hand, but it is safe to say that the British production during 1895 will not fall short of the previous year, and will approximate the figures mentioned above.

With regard to foreign iron imported into Canada, statistics show a great falling off in the imports of pig iron from Great Britain as compared with the United States. The returns for the fiscal year ending June 30th, 1895, show importations of 33,944 net tons, of which only 6,346 tons came from Great Britain, while 27,550 tons are credited to the United States. 1894 was certainly a most exceptional year, as the iron market in the United States was at the very depths of its depression, and sales of American iron were made at prices very much below the average of previous years, and without doubt below the actual cost of production. Now that matters have been somewhat more equalized it is expected that the British iron-master will be better able to compete for a portion of the Canadian trade, with their American rivals, than during the past year, and particularly in the Montreal and eastern seaboard markets. With the advent of the new Hamilton furnace the Canadian iron industry will make it more and more difficult for British and American producers to secure any portion of the Canadian trade, beyond what little iron may for a time seem desirable or necessary for mixtures. In due course even this moderate market may be lost to the foreign producers.

Cleveland iron import returns, issued at Middlesboro', Eng., show an increase in stocks of 4,000 tons for November. There have been previously uninterrupted decreases since April. The production was 245,000 tons, 120,000 tons being Cleveland iron, and the remainder hematite, etc. The total stock of Cleveland iron is 271,000 tons, 93 furnaces in blast—one increase. The total stocks twelve months since were 200,000 tons. The condition of affairs at the close of the year will probaby remain relatively the same, the stocks being greater than they were a year ago.

Germany.

The German production for the first ten months of 1895 was 4,788,571 metric tons, as against production for a similar period in 1894 of 4,579,180 tons, an increase in production of 209,391 metric tons.

Canada.

It is an acknowledged fact that a time of depression in the United States is nearly always followed (generally speaking, a year later), by a period of dull times throughout Canada. 1895 has been no exception to this general rule, but thanks to the moderate dividing wall afforded by our system of protection to native enterprises, we have been preserved from any such panic as the markets of the neighboring republic experienced in 1894, and the solid financial condition of Canada has been the subject of favorable discussion in the money markets of the world. This has been true of all important Canadian industrial enterprises. In the iron department our operations have been carried on upon a safe basis. Most of the furnace companies have restricted themselves during the year to comparatively short campaigns, being wise enough to suit the output to the times. In the face of this the record for 1895 is creditable, and now, starting the new year, 1896, with comparatively light stocks at the various furnaces, and with a knowledge that the new 100-ton per day Hamilton furnace can be depended upon for the coming year, it is safe to predict that 1896 will prove the banner year of the iron industry in Canada, so far as the past is concerned, and the beginning of a new and more vigorous existence in the metallurgical history of our country.

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Notes on the Behaviour of some Gold Solvents.

By F. H. Mason, F.C.S., Halifax.

This paper, I wish to say at the outset, is, as the title implies, a few notes made on experiments I have been carrying out in my laboratory, and is intended purely as a preliminary to a later paper dealing more fully with the subject. It will serve the purpose of showing you the lines on which I am working, and will thus I hope bring about a lively discussion when I read my next paper on the same subject. My experiments are not sufficiently advanced for me to draw many conclusions from them as yet, so I intend mainly to give you just the results of the experiments, drawing only a few hypotheses on them. Secondly, I should like it to be clearly understood that with regard to the experiments I have made on the action of potassium cyanide on gold, I had not the slightest idea at the time that Mr. J. S. MacClaurin, B.Sc., of Auckland University, New Zealand, has been and is also working on the same subject. I received the Journal of the Chemical Society towards the latter part of last month, and I find that in some respects our experiments have been identical.

"Train up a child in the way he should go," is an exceeding good old proverb. I have been taught from my earliest experiences with regard to the treatment of tailings and concentrates with potassic cyanide, to exclude as much air as possible, and that sufficient was safe to get in to complete the solution of the gold; while an excess of air was likely to reprecipitate the gold in the ore, owing to the carbonic acid gas it contained, and owing also to its power of oxidizing potassium cyanide to a cyanate. I should probably not have departed from this idea but for an accident. I proposed making some experiments on the precipitation of gold from its solution in potassic cyanide as a double cyanide of gold and potassium. To do this I decided to dissolve some pure gold-foil prepared for me by Messrs. Johnston & Mattley, of London, in a solution of potassic cyanide. As luck had it, part of the gold-foil was not immersed in the liquid and I noticed after two or three days that on the surface of the liquid action was going on much more rapidly than in the

The Manufacture and Uses of Wire Rope.

By Mr. F. H. Hopkins, Montreal.

The manufacture and application of wire ropes, composed of metallic filaments, or wires, appears to have originated in Germany about the year 1821, and in the year following this we find records concerning their utilization as supporting ropes for the Geneva suspension bridge. These were, however, of the Salvagee type of construction, that is, composed of a series of parallel wires bound together by an external serving of finer wire.

Shortly afterwards, formed or stranded wire ropes were manufactured on this continent; but the industry was not taken up in Canada until about twenty years ago, when the very latest and most modern machinery was obtained, combined with the very best quality of specially tested wire drawn to specification in England to fill the requirements of this country.

This, as well as a thoroughly experienced superintendence in charge of the works, has placed the Canadian manufacturers on a footing with all competitors, and thus saved a great deal of experimenting usually necessary in these new industries.

The wire rope business in Canada today is pretty much confined to two manufacturers, viz.: The Dominion Wire Rope Company, Ltd., Montreal; the B. Greening Wire Company, Hamilton.

In the earlier days when the Germans inaugurated this new extensive and important industry, charcoal or B. B. iron wires were almost entirely used, but during about the last twenty years steel wires have almost entirely superseded their employment, excepting where very soft, pliable and tough ropes are specially required for fast running and quick bending, such as electric and hydraulic elevators.

Here it may be desirable to give a few particulars concerning the construction of different kinds of rope, as are sometimes described by conventional names in the trade; for example, a laid rope consists of 6 strands of 7 wires each, twisted from left to right, which are in turn closed around a hempen or a wire heart, in the opposite direction. These the production of articles on which human life depends, such, for example, as railway car wheels, structural work for bridges, buildings, etc. Anyone will recognize that it is in the interest of all that the best of metal should be used, and nothing done to operate towards bringing into use poor material.

The Encouragement of Quebec Legislature.

It is worthy of special note that the Legislature of the Province of Quebec evidenced, during the last session, a desire to encourage the iron industry in this Province, by passing the Hon. E. J. Flynn's Assembly Bill No. 21, entitled, "An Act respecting colonization of certain parts of this Province, and for promoting the mining industry therein." By this Act the C. L. F. Co. are created a Colonization Society, and 30,000 acres of wood lands are set aside or reserved for the purposes of colonization by the employees of the company. The industry is thus protected against speculators in wood lands, and assured of a constant supply of fuel. The Act is an eminently wise one, and great credit is due to the Hon. Mr. Flynn, Commissioner of Crown Lands, for this fresh evidence of good-will towards the mining industry of the Province. It will be well for the Provincial Government to grant similar privileges to any furnace company starting work in the Province of Quebec, for while the Act does not go so far in the matter of encouragement as did the Act of the Ontario Legislature, yet it shows good-will on the part of our local legislators. It will be well for the people of Canada generally to give this whole question of the development of the iron industry more careful thought, consideration and sympathy.

We have "wars and rumors of wars" these days. Is it not well to feel that we are self-sustaining in this much abused iron trade?

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and marketing of the harvest of the deep. This subject has hitherto received only a fair attention from the Dominion Government, and it is to be hoped that a comparison with the efforts of other countries as viewed at the Imperial Institute, will lead to a more vivid interest in this great source of wealth. Of the lumber industry it may be said that while it is more directly connected with the local Government, its representation at the Institute will form part of the general Canadian collection. It is expected, however, that before long arrangements will be made for a small but complete exhibit of our woods and their products.

The minerals of Nova Scotia have, owing to their retention by the Crown, proved an important and increasing source of revenue, and are naturally that resource in which the Government is directly interested. This obviously led to the selection of a mineral exhibit as a means of giving the Province of Nova Scotia a distinctive position at the Institute.

I have been engaged for some time past in collecting samples of our ores and minerals for the space allotted to the Province. Naturally the collection sent to Chicago was utilized as far as it went, but I have fortunately been able to supplement it, and to replace some of the material by better specimens. No system has been followed in forwarding the minerals. They have been boxed as collected and sent to the Provincial agent. Much yet remains to be done, and as soon as the spring opens further attention will be given to the work. It will be understood that, as this collecting process is in addition to my regular departmental work, I am unable to do it either quickly or as satisfactorily as I could if left free to give it undivided attention for a short time.

I am not going to give you the geological history of each sample or its composition, etc., as that would lead me into a mineralogy of Nova Scotia, and I would be repeating much that is well known to all of you, and many of your members are experts in all that I would refer to, and much better qualified to instruct you than I am.

A prominent place in the exhibit is taken by the iron ores. This may be explained by the considerable interest which has been taken in iron making during the past few years. There are about seventy-five specimens of limonite, bog-ore, magnetite, specular, red hematite, and various carbonates representing the principal deposits. This is added to by specimens of the slack washed, and unwashed, and coked, used at Ferrona, and by the the fluxes used at this place and at Londonderry.

amount of pyrite boulders, carrying some galena, were found in the surface before reaching bed-rock. In the west shaft (No. 2) no ore was found, though a cross-cut was driven to the south for 21 feet.

As the Dominion S. & R. Co., was distinctly a commercial undertaking, it was manifest that the first thing it had to ascertain was whether there did, or did not, exist on the property a defined vein, bed or deposit of lead ore of sufficient magnitude and value to warrant development, and the subsequent erection of a proper mining and smelting plant. To this end the company were advised to purchase a coring drill. During the summer of 1895 holes were bored by this drill at various points on the property, and one of the oldest shafts was unwatered and subjected to a careful and thorough examination of its headings.

None of the cores obtained showed galena, excepting in one instance, and in this one case subsequent tests showed the core to be from a boulder. It was found that there were several beds of dolomitic limestone that carried pyrite, but the deepest borehole failed to reveal any deposit of galena

An examination of the old workings confirmed the view obtained from surface examinations and from the cores, viz., that the galena occurs in decomposition cavities in the limestone, associated with a reddish clayey gonge which is doubtless colored by the iron occurring in the limestones. The ore in these cavities varies in size from mere strings or nodules the size of a walnut to masses containing several hundred weight, which rarely are connected with each other

It would appear that the pyrite in these deposits was formed before the galena, as a specimen obtained from No. 1 shaft showed three globular nodules of pyrite cemented together by a fine-grained galena. A section of the pyrite nodules showed concentric structure.

In a cross-cut driven 32 feet across the strata were seen exposed beds of fine-grained dolomite impregnated with pyrite, in some cases to the extent of 20 per cent. Also beds of dolomite entirely barren of mineral.

In this cross-cut were clearly seen two ore-zones (if they can be dignified by such a name), in each of which it was observed that the small deposits of galena found lay in a limestone pocket associated with a stiff red clay or gonge.

Goshen Iron Mine
Middle Caledonia
Fault
2

(*k*) "A considerable quantity of galena was discovered in the limestone overlying the Devonian at the head of Arichat Harbour"

(*l*) "The pyrolusite of Loch Lomond is probably of the same nature and origin as the hematite, and forms at times a cement for the pebbles of the conglomerate. 'As already remarked many of the lower carboniferous limestones hold traces of galena. At Pleasant Bay near the mouth of McKenzie river, calcspar veins in a dark bituminous limestone, surrounded by the underlying gneiss hold galena, which is also disseminated in the limestone and grit, contains both silver and gold, and is associated with copper pyrites, iron pyrities, fluorspar and bitumen.' 'The copper ores of Cheticamp are situated in the vicinity of the trap and sandstone of the base of the carboniferous.'"

Coming now to reports of more recent date having reference to Nova Scotia proper, Mr. Fletcher remarks :—(*m*) "At Brierly Brook on the Ohio river and near Beaver Meadows, copper ore is found at the contact of the carboniferous limestone and conglomerate, good specimens of yellow and purple copper pyrites being obtained at many points."

"At Smithfield, (*n*) Colchester county, galena, pyrite, blende and calcspar are intermixed in what appears to be a brecciated vein at the contact of the limestone with quartz-veined Devonian rocks. At Pembroke, galena is in fossiliferous limestone, also near the contact with red and grey Devonian slates."

"In the neighborhood (*o*) of the iron mines at upper Brookfield a vein of reddish and white baritie, said by Prof. How to be 15 feet in thickness, is exposed on the side of the hill, mixed with iron ore."

. . . "Next to the gypsum in Hants county the most interesting member of the carboniferous limestone formation is the red basal limestone along which the manganese ores are found. . . . Boulders of pyrolusite (*p*) found one mile north of Kennetcook Corner, perhaps indicate a contact with the carboniferous limestone now concealed by drift." . . . "Nearly all the other worked deposits of manganese, however, occur in or near the limestone described above as lying at the base of the carboniferous formation, the ore being near the top at Chev-

(*k*) G. S. C. Rep., for 1878-80, pp. 55 and 123 F.
(*l*) G. S. C. Rep., for 1882-83-84, 92 H.
(*m*) G. S. C. Rep., for 1886, p. 121 P.
(*n*) G. S. C. Rep. for 1889-90-91. Part P., p. 186. (*o*) P. 192.
(*p*) G. S. C. Summary Rep. 1893, p. 41.

Calling half-tide level zero, and ascending *gradatum* to a convenient "bench mark," or to two or three of them, as the extent of the district may warrant, their respective elevations should be marked by painting on an exposed outcrop of rock, or on the stump of a tree or other fixed point, "B.M." in feet and decimals of a foot, such as their elevations above half tide may be.

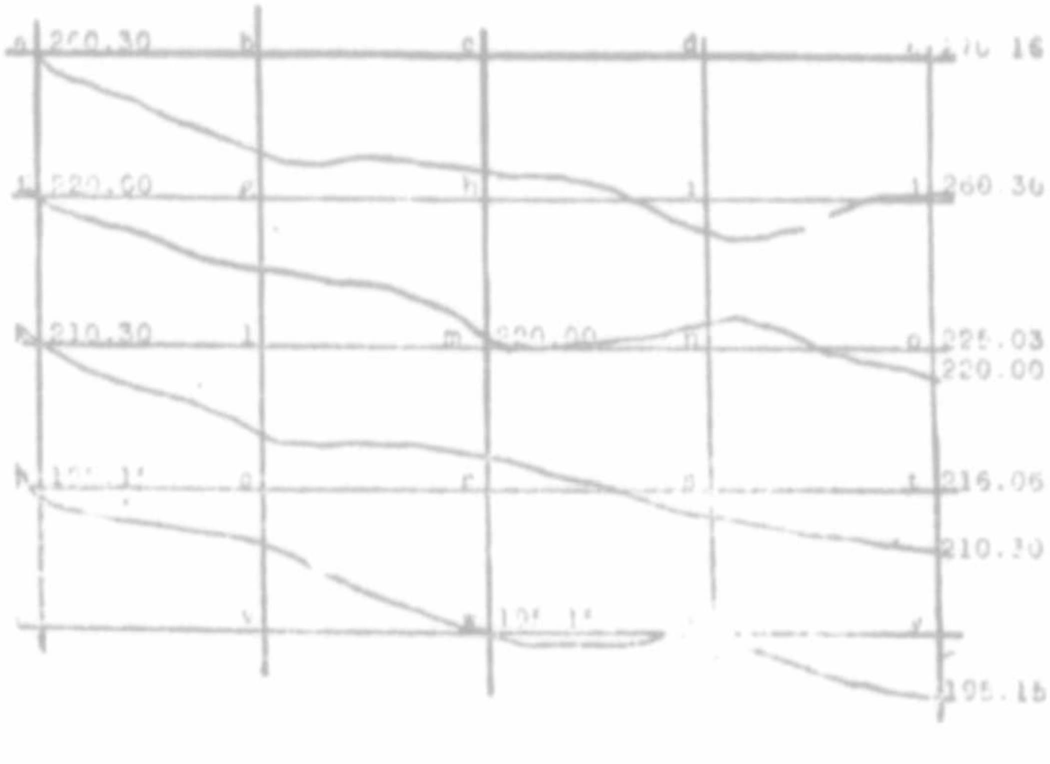
As all sections or profiles of railway location in Nova Scotia is in like manner connected with levels of tidal-water, and changes of gradients noted thereon by "reduced levels" and by what is termed "formation level" of the finished surfacing to receive the ballast bed, and also by bench marks placed by the engineers for their use and convenience; and as these profiles are on file in the provincial engineer's office, or, in the case of lines surveyed by the engineers of the Federal Government, in the offices at Moncton and at Ottawa, elevations above tide level can be readily obtained at points easily accessible, and easily found at every change of gradient on lines of railway touching or being within easy distance of the gold mining operations. For instance, the profile of the recent location of the Nova Scotia Southern Railway touches the Malega gold district. A mere glance at the profile would give the elevation on any stake (the stakes are placed 100 ft. apart) above the tide level at Shelburne. Two or three hours' work would extend the levels from present line of railway survey to any desirable point within that district.

Assuming the levels above tidal water to be established and noted on the plan or survey as well as on the bench marks within each district, the next course to adopt would be, to instruct any party sent to extend boundary lines to connect the levels on every boundary, or dividing point, at which he would set or place a stake, and to mark on the stake and on the plan of survey the reduced level of that stake, showing the height in feet and decimals of a foot that their position would be above tidal water. In the interests of all concerned it might be deemed advisable to place levels at every stake within the gold mining district, where lines of survey have been run and where stakes have been already placed, or at least in such districts as the mining operation now being carried on might warrant the expenditure of having it done.

Now, with respect to the expenditure that would be required to carry out the work suggested by this paper to successful completion. Any ordinary engineer or fairly educated land surveyor should, with the stantly in contact with the fulcrum The aneroid is used by the following rule: The sum of the reading at two stations, is to their difference, as 55,000 (or twice the height of the atmosphere in feet) is to the elevation required. Thus, if the reading at the foot of a hill is 30.05, and at the top 29.44, we have the following: 59.49; 0.61; 55,000 feet; 564 feet. Generally speaking, the fall of one inch in the barometer indicates a rise of about 900 feet in elevation, and the intermediate tenths and sub-divisions of tenths, are in proportion to the rise.

917	feet above sea level	the barometer	falls	1 inch.
1860	"	"	"	2 inches.
2830	"	"	"	3 "

By the intelligent use of this barometer, the scope of enquiry may frequently be much narrowed at the outset, and labor and expense greatly abridged. If, as we have so far considered the blocks of areas are marked by stakes on their respective corner boundaries (according to the present practice) and their elevations above the sea level also indicated thereon and referred to on the plan of survey, so that these data can be readily ascertained by inspection, contour lines may be run between them by the barometer with a sufficient degree of accuracy for all practical purposes. Suppose, for example, that stakes have been so fixed at the points *a*, *b*, *c*, *d*, *e*, etc., etc.



Assuming the strike of the vein, if taken at the plane or level of the dotted line *m*, *n*, to have a straight direction, all veins, no matter whether vertical or inclined, would have the same bearing.

If the dip is vertical, the inequalities of the surface will not interfere with the course or bearing, no matter on what rugged or undulating surface it is taken.


M I N A S
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Walton
Stephens Mine
Whale Creek Mine
Johnson Pit
Goshen Iron Mine
Tomlinson Mine
MANGANESE MINES
Hants County
LEGEND
Trias
Upper Devonian
Lower Carboniferous
Contact
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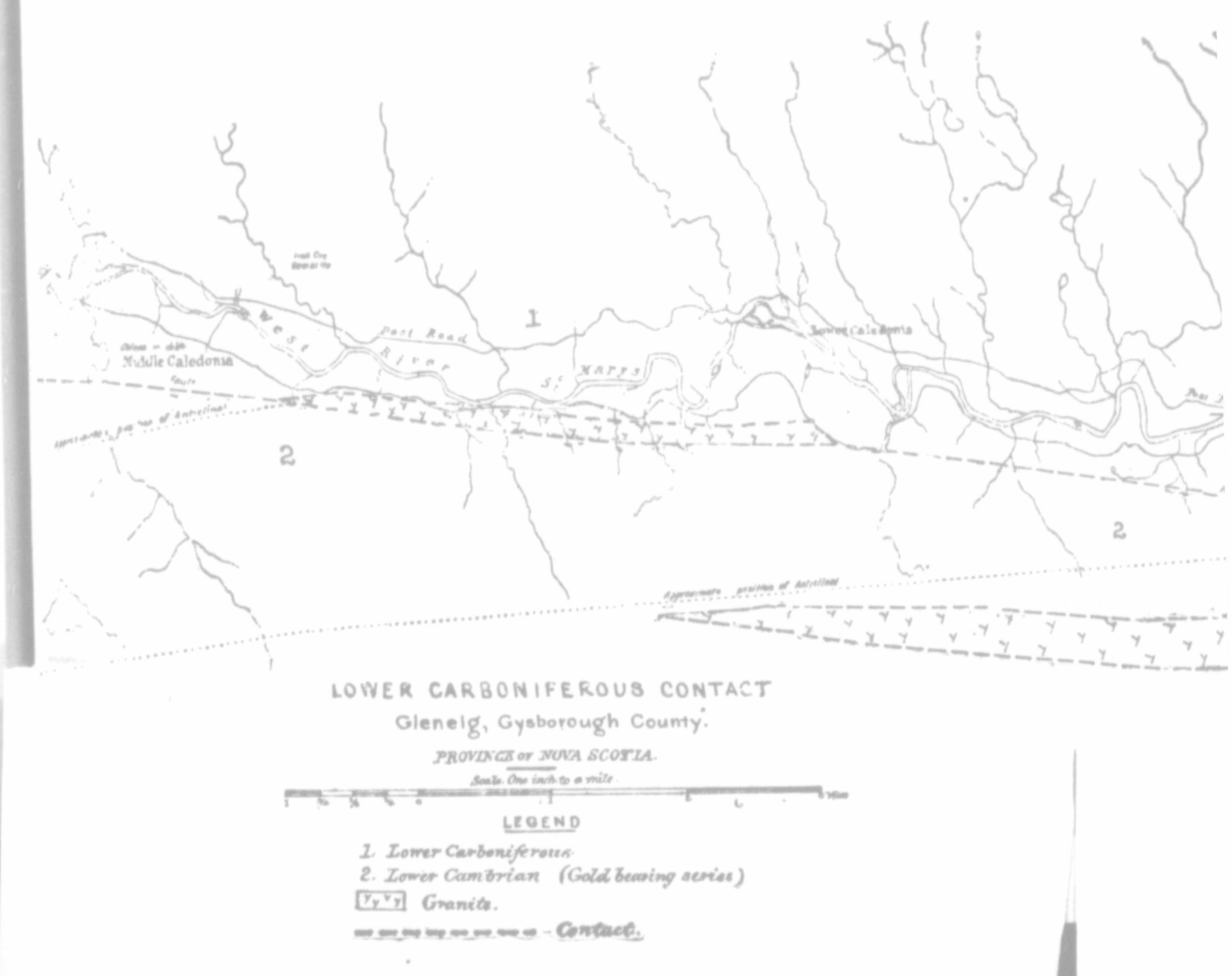
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West River St. Marys
Post Road
Middle Caledonia
Lower Caledonia
LOWER CARBONIFEROUS CONTACT
Glenelg, Gysborough County.
PROVINCE OF NOVA SCOTIA.
Scale. One inch to a mile.
LEGEND
1. Lower Carboniferous.
2. Lower Cambrian (Gold bearing series)
Granite.
Contact.

around the side of the fan to " D," and is then exhausted up the évasée chimney.

If it is decided to change the fan to a blowing fan, the following operations are all that are necessary. First see that reliable men are placed at each set of St. Andrew's cross roads to open and shut the necessary doors at a given hour. At the same hour open the shutter " B " at the fan and close " A." Throw open the doors " E " and " E." The latter will then close up the opening to the shaft, and the fresh air going in at the opening " D " will be blown down the shaft into the workings.

DISCUSSION.

Mr. R. H. Brown—We have at the Sydney mine such a fan as Mr. Dick describes. We have the Guibal fan, 30 feet in diameter and ten feet in width, and we have also the Murphy fan. It has a revolving head and you can alter the ventilation in the mine in five minutes. We have not operated it because we use the exhaust.

Mr. A. Dick—At the Uniontown, Pa., mine there is quite a distance between the two shafts, and they found it an advantage because one set of cross-roads did for the five splits of the mine. The Murphy fan is favorable to this reversing idea. There is nothing original in it. It is a home-made system of shutters.

Mr. Hayward—Why is it necessary to change the air from upcast to downcast?

Mr. Dick—Ice forms in the downcast shaft in winter time.

Mr. Hayward—Would you advocate it in a mine worked for years?

Mr. Dick—I would not reverse the air through the workings. This saves you from doing that. It would not be advisable to do it where there is a large distance between the shafts.

Dr. Gilpin—If you had shafts a mile apart you would have to have two miles of airway.

Mr. Dick—I don't want a discussion as to whether it is necessary to reverse the air, because I personally would prefer exhaust. It is only on account of difficulty from ice that I would change the air. If you require to make the hoist shaft an upcast in the winter time, you have to reverse the air; and in this way you don't reverse the air in the general was not considerable; about 10 square feet per day in favor of the Ingersol. The Harrison was far behind, averaging only 440 feet per day, as against 549 and 539 respectively for the Ingersoll and Yoch; but it is only fair to say that this difference does not represent the actual difference in the merit of the machines, because the Harrison was unfortunately hampered with defective valves, which have since been remedied, and was also worked by a much smaller and lighter man; and while I do not think that a moderate difference in this respect would materially affect the result, I do think that the difference in this case was sufficiently considerable to do so. I may say that the operator of the Ingersoll machine weighed 220 lbs; the operator of the Yoch, 200; and the operator of the Harrison only 150.

To compare the result achieved by these machines with the work done by an ordinary coal cutter with a pick shows a considerable difference; for where—as in the test under consideration—the machines averaged 134 tons per day, a pair of cutters, who load their own coal, would produce in the same seam about twelve tons per day; but assuming that the process of loading represents half the labor (an excessive estimate), their cutting could not be taken to represent more than twenty-four tons, which is between a fifth and a sixth of the work done by each of the machines. It must not, however, be forgotten that whereas the man who cuts the coal by hand carries all his paraphernalia with him, walks into his working place, cuts and loads his coal, and goes away without any further trouble, the man who cuts by machinery requires a great deal of attention both before and after the process—the sharpening of picks, constant attention and frequent repairs to a machine, piping up of rooms every day as the work progresses, in addition to the great question of motive power.

After carefully watching the test, and summarizing the results, I came to the conclusion that the machines had done all that we had expected of them, and had fairly demonstrated that under the conditions that existed in Dominion No. 1 mine, they were capable of producing a larger tonnage of coal in a given time, and at less cost, than by any other method with which I am acquainted. The advantages are apparent, viz., more rapid development of the mine, and procuring a larger output in a shorter time than would be possible by hand labor. The restricted area of workings to produce a given output, and consequently an important saving in the maintenance of roads, air ways, and working not wish to change the direction of the current in the general workings. As the fan is blowing the air down the shaft "F" we will start from the bottom of that opening and follow the current until it reaches the hoisting shaft "H." Here it is that the St. Andrew's cross roads come into play.

Take section 1 again. The air leaving the fan shaft crosses the air bridge at *f*, and its course to the workings is stopped by the door at *e*. It is obliged, therefore, to turn down the only available opening, *k*, by which it reaches the main haulage level at *l*. Its passage to the hoisting shaft "H" is impeded by the two doors *c c*, and the only course left for it is to take the old journey around the workings as shown by the arrows, until it reaches *e*, there it turns to our left to *m*, and thence by the over bridge to the hoisting shaft and thence to daylight.

Now let us take section 3. The air leaving the fan shaft "F" passes by the over-bridge *a* to the main haulage heading. It is prevented from making its way to the hoisting shaft by reason of the doors *c c*, and therefore travels as before, around the workings as indicated by the arrows, until it reaches the point *n*. From there it goes by the under-bridge at *a*, and the other under-bridge at *f*, to the hoisting shaft.

Having described the arrangements underground, let me now show you how the change is effected at the fan. And here let me say that the whole thing is done without requiring the fan to be even stopped for one instant.

I present here a plan and sectional elevation of the fan arrangements. The fan is of the ordinary Guibal type. You will observe that the fan is placed close to the shaft, and that the circular casing is projected by means of an epicycloidal curve to embrace the top of the shaft on the one side, and the évasée chimney on the other. There are two shutters marked "A" and "B." These shutters run in channel-ways similar to a roll-top desk. The shutter "A" is raised to open a passage by means of a similar balance-weight, and it retreats, on being lowered, into a close compartment in the side of the shaft, as shown in the drawing. This type of fan receives its air at the side as at "D" on the plan, and discharges it at the tips of the blades.

Suppose the fan is intended to act as an exhaust fan. The shutter "A" is opened and "B" is closed. The doors "E" and "E" are closed, as shown on the plan. The air coming up the shaft comes

The Capacities of Coal Cutting Machines.

By W. Blakemore, M. E.

The subject of coal cutting by machinery has become increasingly important during the last few years, both by reason of keener competition in the production of coal and in consequence of serious disturbances in the labor market. Inventors and manufacturers have exercised much ingenuity, and expended large sums of money in endeavoring to produce a machine which, on practical and economic grounds, would enable the colliery proprietor to increase the yield of his mine without additional manual labor, and at the same time, if possible, to reduce the cost of production. The result achieved has uudoubtedly been a success regarded from the standpoint of praticability. Machines are in the market which are adapted to all kinds of coal cutting, which can easily be handled by the workman, and which in the hands of an average cutter will yield an increased tonnage, beyond what it is possible to procure by hand cutting, fully proportionate to the reasonable expectations of the mine owner, and the claims of the manufacturer.

The other question, as to the economic result, requires more careful handling, because there are important considerations outside the mere question of coal cuttting, which have a bearing upon the subject, and which must be taken into account before it is possible to arrive at a final conclusion in the matter.

I have recently had an opportunity of conducting a careful test trial of three machines, under conditions which precluded the possibility of any unfairness or partiality, as the trial was made under the control of the officials of the Dominion Coal Company, who had no interest to serve except to ascertain the capacity of the several machines ; and while I wish at once to disclaim the reliability of a test run as affording any criterion of the actual amount of work which can be expected under ordinary circumstances, it is none the less interesting and reliable as illustrating the relative values of the machines, and the maximum amount of work which they will perform under given conditions. The trial took place in the Dominion No. 1. mine of the above company, and extended from the 29th of July until the 10th of August. The cutting was done on the Phalen seam, which is about 8 feet thick, and a fairly strong semi-bituminous coal. The roof is a silicious rock bine, and the floor a strong

Following are the items of cost :—

	Total Cost.	Cost per foot.
Freight	$130.28	$0.044
Labor and teaming	503.59	0.172
Wood	419.80	0.143
Lumber and drill supplies	205.24	0.070
Renewals and repairs	200.30	0.068
Diamonds	898.06	0.307
Fireman	496.21	0.169
Superintendence	1,017.03	0.348
Total	$3,870.60	$1.324

For purposes of comparison, samples from actual experience have been procured, showing the cost of boring with diamond drills under like circumstances elsewhere. It is true that differences in the cost of labor, transportation, fuel, and especially in the hardness of the rocks through which the borings are made, are likely to make such comparisons of doubtful value, unless these differences are taken into account. Nevertheless, the figures given above for the working of the Government diamond drill will on the whole compare very favorably with those for operations carried on in other countries under conditions as nearly alike as can be cited. In the New York *Engineering and Mining Journal* of September 22 and 29, 1894, details are given of the cost per foot of boring nine holes on one of the iron ranges in Michigan, the aggregate depth being 2,091 feet. The total cost in this case was $2.374 per foot, as compared with $0.986 per foot with the Government drill at Glendower. No particulars are given, however, as to the character of the rock penetrated on the Michigan property. The items at the latter place are as follows :—

	Cost per foot.
Labor on drill	$0.606
Fireman	0.206
Fuel	0.182
Camp account	0.722
Repairs on drill, bits, core barrels, etc	0.126
Repairs on boiler and machinery and sundry supplies	0.097
Carbons	0.239
Superintendence	0.196
Total	$2.374

In the *Engineering Magazine* for March, 1896, Mr. J. Parke Channing gives details of the cost of boring 18 holes to a total depth of 5,046 feet in iron ore properties at various places in Michigan. His figures are summarized as follows :—

	Total Cost.	Cost per foot.
Labor on drills	$3,580.27	$0.709
Firemen	1,387.24	0.275
Chopping wood	1,266.01	0.251
Camp account	3,208.44	0.636
Bits and repairs on drills	585.47	0.116
Supplies and repairs on machinery	440.51	0.088
Carbons	1,660.97	0.330
Superintendence	1,006.38	0.199
Total	$13,141.29	$2.604

The material encountered in the holes consisted of iron slates, diorite, jasper, quartzite, etc.

In the same article the expense of operations conducted by Mr. E. J. Longyear, of Hibbing, Minn., comprising 21 holes and an aggregate depth of 4,684 ft. is given. The figures are as follows :—

	Total Cost.	Cost per Foot.
Labor	$5,569.74	$1.189
Fuel at boiler	735.97	.157
Camp account	2,416.49	.516
Bits and repairs on drills	722.24	.154
Supplies, boiler and pump repairs	226.28	.048
Carbons	3,201.09	.684
Superintendence	1,211.51	.259
Total	$14,083.32	$3.007

The strata passed through consisted of jasper, iron slates, sandstone, and marble.

In the East New York mine at Ishpeming, Mich., 28 holes were bored to a depth of 3,746 ft., of which 193 ft. were in hematite, 646 ft. in jasper, 986 ft. in mixed ore, and 1,921 in dioritic schist. The record of cost as given by Mr. Channing is as follows :—

In 1894 the Legislature of Ontario passed an Act relating to Mines and Mining Lands, which provided among other things for the purchase by the Government of two diamond drills to be used in the exploratory drilling of ores or minerals in the Province, and in the same session the sum of $15,000 was appropriated to carry out the provisions of the Act. Only one drill has yet been bought, the preference being given after careful investigation to the machine manufactured by the Sullivan Machine Company, of Claremont, N.H., and Chicago. A drill of the "C" class made by this company was purchased in August, 1894, at a cost, including certain extra equipment, of $3,760. A 15 h. p. boiler mounted on wheels, and a duplex pump, both of Canadian manufacture, together with the customs duty paid on the drill, brought the total cost of the outfit up to $4,275. By the tariff law of Canada, diamond drills for mining purposes are admitted free, but the operation of a law depends a good deal upon the interpretation of it. The view was taken by the customs authorities at Toronto that the diamond drill—and consequently the only part of the machine entitled to free admission—was the bit in which the diamonds are set, a circular piece of steel perhaps a pound and a half or two pounds in weight. All other portions, including the framework, gearing, pulleys, etc., were classed as "motive power," and so chargeable with a duty of 15 to 35 per cent. ad valorem, amounting to $350.41 in all. Duty on this basis had to be paid before the drill could be released from bond. On reconsideration of the matter, however, the department at Ottawa refunded $230.90 of the amount, leaving the net duty on the machine $119.51. The drill has a capacity to bore 1,200 to 1,500 ft. in depth, and takes out a core $1\frac{3}{16}$ in. in diameter. It has proven itself a serviceable and satisfactory machine. Certain parts, such as bits, core lifters, etc., are subject to severe wear and tear, and frequently require to be replaced, but as duplicates can be quickly procured from the company's works at Chicago, where they are kept constantly in stock, no delay or interruption of the work need arise from this cause.

The regulations governing the control and management of the drill, as approved by His Honor the Lieutenant-Governor in Council, September 15th, 1894, and amended by Order in Council April 9, 1896, provide that it may be supplied to owners of mineral property or others desiring its services, upon their furnishing a bond for payment of the costs and charges of working it, including freight, fuel, labor, etc. In order, how-the core shell had twisted off at the core lifter ring and left the ring in the lower half of the shell. The recovery tap entered the ring, which was so hard that the tap would not catch it, and yet it would twirl round with the tap, preventing the tap from advancing and catching the inside of the shell. After cutting several portions from the end of the tap, it finally caught the top of the broken shell with one thread and pulled it out.

" When casing or rods are fast in a hole near the bottom, that portion above the construction can be removed with a left-hand tap. In using left-handed taps the right-handed rods must be pinned at their joints to prevent unscrewing. Fishing for broken rods is much complicated in cases where the ground is soft or caving, and large chambers have been washed out in which the end of the rod may rest and the tap pass by it. It sometimes happens that a diamond is wrenched loose from its setting and remains at the bottom of the hole, either unbroken or in several fragments, when the rods are withdrawn. In cases of this kind the bottom of the hole should be cleaned out by a mass of soap or wax attached to the end of the rods and lowered in the hole. The fragments of rock and carbon will adhere to the sticky material when it is withdrawn. If caving ground catches the rods above the bit, they may be released by drilling down a casing outside of the rods and cutting away the bound rod with a steel rose bit.

" Overcoming difficulties at the bottom of a deep hole will tax the ingenuity of a good runner and show his capacity. No man should undertake a deep hole—one over 750 feet—who has not had a good experience with shallow holes." *

Where the object of drilling is to determine the presence and situation of bodies of ore, it is essential that a record of the borings should be systematically kept. For this purpose the cores as they are brought up should be carefully laid away for reference and examination, which is usually done by placing them in shallow boxes not exceeding in depth the diameter of the core, a foot or so in width and 8 or 10 ft. long. The various sections of the core should be divided from one another by longitudinal strips of wood, and should be labelled with the number of the hole and depth from which they are taken. The drill manager

* " Prospecting with the Diamond Drill," by J. Parke Channing, in *The Engineering Magazine* for March, 1896, pp. 1085-6.

Several samples of ordinary brick clays are shown, and the Acadia Coal Company contributes samples of fireclay, raw, ground, and made into firebrick.

There are also samples of the Rawdon antimony, of lead ore and other less important minerals. Mr. Mason has kindly given me samples of copper ores, notably of the sulphides and carbonates from Waugh's river, Colchester county. The ores of Ohio and Polson's lake and Coxheath are represented. I have also sent, more as a curiosity than as an indication of economic value, 7 samples of native copper from the North Mountain trap, the largest weighing about 5 lbs. I regret to say I was unable to lay my hands on some large and very interesting native copper samples, holding notable amounts of silver from the College lake, Antigonish county, I had some years ago.

I have also secured about 30 specimens of the agates and other trap minerals, some of which are polished. Several boxes with views of Nova Scotia scenery have been forwarded.

There remains yet the gold exhibit ; for this I have the small but rich samples now in the possession of the department, and hope to purchase a few more, so as to have a small but rich set of gold samples that can be shown under a glass case. The gypsum exhibit requires to be completed, and there are a number of miscellaneous minerals, such as pyrites, fluor spar, molybdenite, etc., which I hope to gather up as opportunity offers.

I would feel under great obligation for any assistance that could be given in this matter by the Society as a body, or by its members ; as well as for any advice that may help the work. I have already stated that I am not advancing as rapidly as I would wish, but have to make the most of my opportunities.

A good example of this form of stadia surveying may be seen in the Mines and Works Office here, by a plan of survey made by Mr. W. B. Dawson, west of Halifax, under the direction of Dr. Gilpin in 1882. The map is only 18 miles by 12, its only fault being that there is not more of it. Since then it has been frequently consulted by the author of this paper, for estimating the area of water-shed, receiving rain fall, for water supply, and in selecting the most suitable lines of railway location. It has recently been a guide to the engineers of the Intercolonial Railway, in finding the most desirable location of the line of railway now being constructed between Halifax and Windsor Junction, and if consulted by the mining engineer may be found no less useful. One can truly say, its use has already well warranted its cost.

Within and around the city of Halifax, contour lines of level at elevation of 25 feet, have been carefully embodied in a map by the survey corps of Royal Engineers for defensive purposes, with such precision, that without previous reconnaissance I was able by mere inspection of the topography to make a plan and profile in the office, and with the data thus obtained to walk over an ascending line of gradient and railway location from Richmond station to the cotton factory. The instrumental railway survey that followed showed no perceptible deviation on the ground. These lines of contour are projected in the same manner as suggested by this paper; their connection would, however, be more convenient having stakes, at fixed points, marking the respective elevations in the gold mining districts.

If the lines of survey pass over such hilly or undulating ground, that considerable differences of level are necessarily encountered in its path, valuable aid may be derived from a pocket aneroid barometer. This instrument consists of a flat cylindrical box exhausted of air, the top of which is thin metal corrugated in concentric circles so as to render it quite elastic. As the atmosphere pressure increases, the elastic top of the box is forced in or down, and as it decreases it is forced out or up. This movement in the top of the box (due to changes in the atmospheric pressure) is conveyed by multiplying levers and a small chain, to an index needle, moving over a circular scale, graduated to correspond with the standard mercurial barometer. The spiral spring by its tension raises the long arm of the lever when the pressure on the top of the box is lessened, thus keeping the short arm of the lever con-

S I N
Moose Brook
Minesville
Faulkner Mine
Lanes Mine
Goshen Iron Mine
Middle Caledonia
2

assistance of one man to hold the levelling rod, run three miles of levels each working day, and if he would not be capable of performing this service in a reliable manner, he should not be employed. There are men connected with the Mines and works office, with the Crown Lands office and with the Provincial Engineer's office, quite capable of performing such work. If we place the rate of progress (for levelling over lines already cleared, chained and marked by stakes) at two miles per day, and the wages of the surveyor and his assistant at seven dollars per day, the cost per mile for running levels would be three dollars and fifty cents, say four dollars per mile. The extent to be levelled over in each district can be readily and quickly ascertained by the mining engineer, conversant with the surveys already made, or by inspection from the map of the district, so that, if we take the data given as factors of cost, —and we know from long experience the figures are ample—one can easily estimate the outlay required to develop from the ordinary surveys at present customary in our gold fields, to the more desirable and modern method of topographical surveying. The system proposed would, as before stated, be a very correct one—the work would check itself.

Firstly, because the boundary lines of property and their sub-division into rectangular areas, must necessarily check at the point of departure.

Secondly, because the levels repeated from stake to stake and closing on the completion of the circuit, must also check, and, because long distances cannot with the same degree of accuracy be taken by a transit with the so-called stadia wires, and a telemeter or stadia rod. The errors by this stadia method may be estimated by feet, whilst by the method proposed by this paper the error could not, with any degree of care, be computed by so many inches.

Although the new stradia methods of topographical work, such as described by Mr. George J. Specht, C E. Prof. A. S. Hardy and others in the "Van Nostrand Science Series," have found much favor and is the best known system, where the configuration of the ground over extensive surface areas is required for examination and research. Nevertheless, taking into account what work, from ordinary line surveying, is at present available in our gold fields, and that the method suggested by these remarks, would more directly connect and could more conveniently be adapted to local requirements, being less expensive and more expedient than the stadia method, we might be led to infer it would be the more advisable to adopt.

erie, at the bottom at Walton, and in 37 feet near the bottom at Tenny Cape Mines. (*q*) . . . Devonian sandstone or quartzite forms the floor or footwall of the mine. . . . The ore of this belt has been traced for a great distance east and west and is also found in small outliers among Devonian rocks."

The Goshen (*r*) iron mine is situated at the contact of this limestone with the Devonian, just as are those of Clifton, Selina, Brookfield and the East river of Pictou. Here a mixture of limonite, hematite, barite and calcite is found in a dark grey limestone. Barite occurs in considerable quantity in veins in limestone at Walton and Pembroke."

The red hematite of Newton Mills is a deposit at the junction of the carboniferous limestone and conglomerate with the Cambrian gold-bearing series, and similar ores may be expected at other points along the line of contact . . . The limonite of the Brookfield iron mine is also at or near the base of the carboniferous. At the same horizon, probadly, are the manganese mines of Tenny Cape, Walton, Cheverie and East Onslow. . . . A careful survey of the Devonian rocks and carboniferous limestone of the East mountain of Onslow and Penny's mountain, in Clifford's and Farnham's brooks, has shown that the latter rests in small patches on the former, with the most complete and satisfactory evidence of unconformity, and unconformity scarcely less evident is seen also at Walton and Cheverie. (*s*)

Mr. Faribault remarks:—"A belt of fine grey limestone at Gay's river corner carries a good percentage of argentiferous galena; it runs east and west and rests unconformably upon the lower quartzite group." . . . "This lower auriferous conglomerate is wholly composed of debris of the adjacent lower Cambrian rocks, apparently in an old river bed, and rests on the lower graphitic ferruginous slate group. Beds of conglomerate similarly situated along the northern boundary of the gold-bearing rocks may prove sufficiently rich to be worked, but the great excitement caused two years ago by exaggerated reports of discoveries of gold in various places remote from the gold-bearing rocks, have led a great many to take up valueless ground."

Dr. Gilpin also wrote in his Mines and Mineral Lands: "At the mouth of the Shubenacadie river, the lowest visible carboniferous bed is

(*q*) P. 42. (*r*) P 43.
(*s*) G. S. C. Summary Rep. 1890, p. 40

The extensive beds of magnetites and hematites in Annapolis county, stretching from the Kings county line to Clements Port, passing through Torbrook and Nictaux, are, from their numerous fossils, evidently of upper Devonian age, but the carboniferous has not yet been found in this locality, so far as I am aware.

The marvellous auriferous deposits of the Transvaal are not veins, but extensive and regular deposits of fine conglomerate. I do not know to what geological horizon these beds have been relegated by local geologists, but coal is worked at no great distance from the gold mines, and it may be that these conlomerate beds occur at or near the contact of the two formations to which Mr. Poole so ably and practically calls attention.

It was also noted that these small stringers and nodules of galena were more frequent near the surface than in depth, but the rarity of their occurrence at all was a more striking fact.

The mode of occurrence of these small and widely scattered patches of ore, their irregularity, and the failure of any of the deep bore-holes to locate any deposit at depth, led to the conclusion that the property does not possess lead ore in quantity sufficient for a commercial venture.

The similarity of this occurrence of galena with the deposits of lead ore in south-western Missouri might lead one to expect larger and perhaps profitable deposits along the line of these mineralized strata in Colchester and it is possible that extended exploration may yet discover them, and form the basis of a lead industry.

DISCUSSION.

Mr. F. H. Mason—I regret that I was out of the room when Mr. Hardman's paper was read, but I have had an opportunity of reading the paper since and there is one statement which might be misleading to those not acquainted with the lead smelting industry. Mr. Hardman refers to Mr. Edwards (the metallurgist who superintended the erection of the furnace and working of the same when the Southfield mine was in operation) as having had considerable experience in Swansea. From this remark it might be inferred by the uninitiated that Mr. Edwards was using Swansea methods. So far as I have been able to learn Mr. Edwards came to Nova Scotia directly he had completed his apprenticeship at a Swansea smelter establishment. But be that as it may one thing is certain, Mr. Edwards was not using Swansea practices at Southfield. In 1891 I paid an extended visit to the Swansea and Llanelly smelting works, and except in one or two cases where Piltz furnaces were being experimented with, the Reverbatory furnace alone was used in the smelting of lead there. As Mr. Hardman states in his paper the furnace at Southfield is too dilapidated to get a very accurate idea of its canstruction, but so far as I was able to judge it appeared to me to be a modification of the Scotch Hearth. I took some samples of the pile of roasted ore when I visited Southfield, and as far as I can remember they averaged a little less than 30% of lead. I venture to state that no experienced Swansea smelter would operate on raw ore of less than 60% while as a rule they like it dressed to 80% lead.

In the Flintshire lead district of North Wales, it is no uncommon thing to find large boulders of galena often associated with blende in the carboniferous limestone, and at the Halka mine in that district, a mine which paid its shareholders from 100 to 125 per cent. for several years, a deposit of clay containing boulders of galena was profitably worked. The true veins in Flintshire are usually found at the junction of the limestone and chert, but a considerable amount of mining for boulders in limestone has been carried out there.

Notes on the Collection of Nova Scotia Minerals being prepared for the Imperial Institute, London, by the Govt. of Nova Scotia.

By Dr. Gilpin, Halifax.

Mr. President, I find that my promise to give your society a paper on the above subject has landed me in a very big contract, if I am to attempt to do justice to the minerals. I shall therefore not attempt to do more than convey to you in a general way the amount of work that has been done and what remains to do.

As you are all aware, the Imperial Institute in London is an ambitious scheme. No other country but England, however, could undertake it, as it is to be devoted to the exhibition of the resources of the Colonial Empire. In this vast building it is proposed to make an economic exhibition of everything that each colony can offer to the investor, the experimenter and the capitalist; to bring together under one roof the products of the Indies, and of the islands of the south, as well as those of the colonies lying near the north pole. By degrees each colony is accumulating there samples of its flora, new woods, grasses, etc., all its varieties of food fish, its minerals—in brief, reproducing itself in everything that assists man in accumulating wealth or ministers to his comfort. The Canadian Government has been engaged in forwarding the necessary samples to enable this country to make a proper showing. The Government of Nova Scotia, desirous of maintaining as far as possible the identity of the Province, which would under ordinary systems of exhibition become lost in the representation of the great territorial area of Canada, undertook to make an exhibit in the line in which it was most directly interested. The subjects most directly appertaining to Nova Scotia in connection with the Institute are fish, minerals and lumber. The fish resources of Nova Scotia are, as you know, varied and extremely valuable. No study of the present day is, perhaps, equally fascinating, and few researches are more directly profitable to a government and a nation than those directed toward the propagation, protection the fact that Canadian founders use not only Southern coke iron, but also higher priced Northern coke iron, as well as Scotch coke and American charcoal pig iron. If our politicians, before making such statements, would simply refer to the official statistics on record at Ottawa, say for the fiscal year ending 30th June, 1895, they would find that the *importations* of pig iron for the last fiscal year were 33,944 net tons, of which the entered invoice value was $370,574. Figured out at the price per standard ton of 2,240 lbs., this means a value at the furnace of $12.13, to which add an average freight rate of $4 per ton for delivery to any point in Canada, *i.e*, from the furnace in Scotland or the United States to point of destination, and it brings the average cost per ton to $16.13. The specific duty on this at $4 per net ton is equivalent to an ad valorem protection of just about 27¾ per cent. As a matter of fact the present figures, taking into account the high class charcoal iron used in this country, as well as the lower grades of Southern coke, will aggregate fully $18 per ton, which would mean a protection equivalent to 25 per cent. ad valorem on the average freight, etc., for delivery at any point in the Dominion.

Specific as against Ad Valorem Duty.

As far as pig iron is concerned, a specific duty is the only fair and sensible basis. In the first place it is the simplest to apply, and does away with possibility of fraud. It would simply be impossible for an appraiser, expert or not, to determine whether a pig iron was worth $12 per ton or $25, so that there would, as far as high grade iron is concerned, be a wide opening for entering at fraudulent figures, if an ad valorem duty was applied. Then again, an ad valorem duty would mean a tendency to lower the grade of iron imported, and therefore the class of work produced in this country.

In the case of food, clothes, etc., the argument against specific duties, that the poor man suffers, as he pays an equal tax on his necessity to that paid by the millionaire on his luxury, may hold, but this does not apply to iron, where the quality of pig iron to be used is determined not by the class of people the finished article is to be sold to, but by the purposes to which it is intended to apply it, and a costlier iron, for example, goes into the poor man's stove than into the rich man's furnace. The highest and most expensive grades of iron are used for

I have found in every case in my experience where I have been placed in possession of facts, as above described, that I have never had a complaint of any rope furnished, and the goods have given entire satisfaction.

liquid itself, while in another day the gold-foil was completely cut off at the surface of the solution, and that part which had previously been outside now fell into the liquid. I made a mental note of the fact and left the gold to go on dissolving for over a week. As the gold was still undissolved I decided to see if I could hasten matters by passing a stream of air through the liquid, and this brought about the solution of the gold rapidly, at the same time a slight precipitate was formed of a white gelatinous character, looking much like either aluminum hydrate or silica. I may say the air was drawn through the liquid with a filter pump, and the air of a laboratory, as you all know, is liable to contamination from many sources. With a view to eliminating this source of error as much as possible in all subsequent experiments, I first passed the air through a strong solution of caustic potash.

In 1846, Elsner, I believe, for the first time enunciated the equation representing the reaction which takes place when gold is dissolved in potassic cyanide.

$An_2 + 4\ K\ C\ N + O + H_2\ O = 2\ K\ An\ (C\ N_2) + 2\ K\ H\ O$, and in the face of that equation which we believe today represents the reaction, and the fact that the cyanide process has been running for some years under patents, the validity of which I do not propose to discuss, as I consider comment needless, it does seem strange that up to now everyone appears in working the process to have left the supply of oxygen entirely to chance. My next experiment was a comparative one. I took two pieces of gold-foil, each weighing ·1 gramme; one piece I placed in a stoppered bottle with an eighth of a litre of a 2% solution of potassic cyanide; the stopper was removed from time to time and the bottle shaken. The other piece of gold was placed in a flask with a similar amount of cyanide solution and of the same strength, and air was first drawn through a solution of caustic soda and then through the solution into which the gold was placed. I must here state that the arrangements of my laboratory are such that it is not safe to allow water to run on very frosty nights, so the filter pump which was asperating the air through the solution had on some occasions to be stopped at night. The gold in the flask was completely dissolved in 72 hours, out of which air was passing through the solution for 45 hours. The gold in the stoppered bottle was now removed, washed, heated to redness and weighed, the weight being .0770, showing a loss of .023 grammes, or 23%.

laid ropes are also made at times, for special purposes, of what is known as Lang's or Albert lay, in which the wires forming the strands and the strands comprising the rope are laid in the same direction. The advantage of this construction is that a longer continuous surface of the individual wires is exposed to wear, and the crowns of the strands are less pronounced; therefore, whilst more uniform wear is promoted, the cutting tendency of the wires is correspondingly reduced, and the durability of the rope very much increased.

A formed rope comprises 6 strands laid around a heart as just explained, but each strand contains a larger number of component wires, viz.: around the seven wires laid from left to right before mentioned, a further outside layer of 12 would be laid, thus making a 19-strand rope.

A cable-laid rope consists of 6 complete laid ropes closed together to form one cable, as in ordinary hemp roping, and is also sometimes known as tiller-laid.

Hawser-laid ropes would be made at the Dominion Wire Rope Co's works of 6 strands of 12, 18, and 24 wires to the strand, independent of the hempen centres used in the centres of each strand, as well as in the heart of the rope.

The flexibility of wire rope is mainly dependent upon the multiplicity of their component wires and strands, and the manner in which they are laid together, and at the works at issue ropes are constantly being made of all sizes and of their respective types, composed of few as well as of a greater number of wires.

It is comparatively easy to manufacture a rope containing few wires, but considerable skill and experience is required as the number increases, in order to arrange the wires and their respective spiral pitch of lay corresponding to that required of a rope of a given size and for a certain purpose, so that each and every component wire shall bear its due and proportionate amount of working strain, also work with one another and reduce in place of increasing friction.

Every hour of the day wire ropes are rendering some important service, from which the community at large is enjoying most substantial benefits, some of which are in connection with our railways for plough trains and switching purposes, as well as for underground haulage, shaft and slope purposes, in our coal, gold and copper mines, combined with their uses in our asbestos, phosphate, and iron mines. This, coupled

The Pictou Charcoal Iron Company contribute a complete set of specimens in a neat case, showing their ores, fluxes, fuel and manufactured product. Samples of Bessemer, forge and foundry pig are included, as well as a finely finished set of samples of steel shafting, rails, angles, etc., made by the Nova Scotia Steel Company.

It is interesting to note here the fact, which I believe to be correct, that Nova Scotia is the first of the English colonies to make commercially steel from native ores. Of course steel was made from charcoal pig a number of years ago at Londonderry, but the process was discontinued some years before the starting of the New Glasgow steel works.

Samples of coal are shown from various mines in Nova Scotia proper, and it is expected that the Cape Breton coals will shortly be represented. A few samples of marble are shown, but the East Bay stone will be included as soon as rock is available away from the surface.

The samples of building stone number 22, and comprise several varieties of granite, sandstone and freestone. These samples are nearly all cubes of from 6 to 12 inches, polished, dressed, etc. Several ochres are shown from Halifax county. The large number of deposits of "mineral paint" in Nova Scotia invite investigation. While a poor paint brings hardly any price permitting of its elaboration, search may show that our carboniferous limestones may yield some of those valuable umbers which bring a good price. In this connection fineness of texture and clearness of color are, I believe, important requisites. Two samples of barytes are shown. I have no sample of the Cape Breton barytes, which occurs at several places.

The collection of samples illustrating the gypsum of Nova Scotia is not yet complete. I have forwarded 11 samples, illustrating the various fibrous, crystallized and other forms. I have yet to get samples of the mineral as it occurs in the Windsor and other quarries, so as to show it from its economic standpoint.

There are 12 samples of manganese, principally from Hants county, although Halifax, Colchester and Cape Breton are represented. The ores as shown by the samples are high grade. It is probable that we have here deposits of this mineral adapted for the steel makers' processes, and their mining would probably prove quite as profitable as that of the higher grades.

should also keep a daily record of the work done by the drill, and note all items of interest, causes of delay, etc., from which he should make daily or weekly reports of progress to his employers.

A curious fact in connection with diamond drill holes is that they tend to vary from the direction in which they are begun. Vertical holes are liable to take a spiral course, due probably to the fact that there is a natural inclination on the part of the suspended rod to describe an eccentric curve with the free end at the bottom of the hole. Inclined and horizontal holes will also be deflected more or less, according to the nature of the ground and the condition of the boring tools. A case was noted at one of the Cliff shafts in Ishpeming, Mich., where a vertically-started hole at a depth of about 400 ft. was some 15 or 20 ft. out of plumb. At the Scotchman's United mine, Victoria, a diamond drill hole 370 ft. deep was deflected 37 ft. 3 in. At the Oriental Company's mine a hole 425 ft. deep was 60 ft. 9 in. out of its proper course. Nine holes were drilled in Michigan by Mr. Channing, the writer mentioned above, at angles varying from 15 to 60 degrees from the horizontal, and the variations at the bottom were from 11½ to 42 degrees. It was invariably found that this variation was in the line of flattening. Captain Peter Pascoe, of the Republic iron mine, reported that in his mine "horizontal holes invariably raised as they gained in length." The rods and core barrel lie on the lower side of the hole, while the bit fills the end. This causes the line of boring at any period to make an angle with the axis of the hole in which the tool is rotating, thus making the line of advance an upward curve. In estimating the results of boring by the diamond drill, this deflection should be taken into account.

The cost of work with the diamond drill depends to a very large extent upon the nature of the rock strata being penetrated, being greater in dense and broken and less in the softer and more compact rocks. Distance from means of communication and transport is also an item of importance. It frequently happens that operations are carried on in some remote spot where the roads are bad and where supplies of any kind are hard to get. Under such circumstances, the cost is somewhat increased, both on account of the difficulty in hauling in the plant, and the necessity for starting a camp for the accommodation of the men engaged on the drill.

—	Total Cost.	Cost per Foot.
Labor—400¼ days' setter at $3.00....... $1,200.75		
372¼ " runner at 2.25........ 837.00		
230¼ " " at 2.00........ 460.50		
4½ " laborer at 1.75........ 7.85	$2,506.10	.669
Carbon, 68⅜ carats at $15,144........................	1,035.47	.276
Bits, lifters, shells, barrels and repairs	433.81	.115
Oil, candles, waste and supplies........................	128.09	.033
Estimated cost compressed air	374.60	.100
Total..................................	$4,478.07	$1 195

Two instances of underground drilling are given in the same article, in both of which the cost was much less than in the operations conducted from the surface. The first is from the records of the Minnesota Iron Company, and covers a period of twenty months, from May 1, 1894, to December 31, 1895:

—	Total Cost.	Cost per Foot.
No. of feet drilled, 13,312.		
Carbons	$4,587.82	$0.340
Supplies and oils.......................................	939.84	0.070
Fuel..	547.39	0 40
Shop labor and material	679 01	0.050
Pay roll	3,694.83	0.273
Total..................................	$10,448.89	$0.773

This drilling was all done in the back stopes, almost every foot being in the ore. The drills used were the Sullivan make, "E" size, the holes being 1½ in. in diameter, and from 10 to 40 ft. deep, the machines being operated by compressed air.

The second instance is from work done at the Cleveland mine, Ishpeming, Mich., in 1892. It consisted of 6,075 ft. of underground drilling and 1,414 ft. of surface drilling, with 470 ft. of standpipe sunk.

—	Total Cost.	Cost per Foot.
Carbon	$1,887.00	.237
Supplies and oils.......................................	134.13	.017
Fuel	360.73	.045
Shop material, etc.	663.36	.083
Pay-roll	4,000.03	.502
Total..................................	$7,045.25	.884

ever, to encourage the opening up of properties by means of the drill, the Bureau of Mines undertakes to bear 45 per cent. of these charges in 1896 and 1897, leaving the party employing the drill to pay the remainder or 55 per cent. only. In 1894 and 1895 the proportion payable by the Bureau was 50 per cent., and from 1898 to 1900 inclusive it will be 35 per cent. The Government supplies a mechanical manager of the drill and a fireman, the former being paid at the rate of $1,000 per annum while the drill is at work, and the latter $500. The only additional labor required is the help of a workingman to cut wood, assist in moving the drill, etc. The present manager is an experienced drill operator and miner, and quite capable of selecting the sites for borings on any location, but the practice hitherto pursued, which is the most satisfactory to both parties, is for the owner of the property to employ an engineer or expert to consult and advise with the manager in the location of the holes, the angle at which they should be bored, etc. It is easily seen that the successful and economic defining of a vein or body of ore depends very largely upon the judicious choice of sites for the borings, the inclination at which they should be made, and the depth to which they should be carried. In deciding upon these points, the skill and experience of the trained miner are most valuahle, but they lose nothing of their worth by being reinforced by the conclusions of a scientific mineralogist carefully formed upon the spot. An extra charge of $50 per month is provided for when the services of the drill are retained after the property has been shown by means of the drill to be a valuable mineral property. The cores are not to be exhibited to any unauthorized person, nor information acquired during the working imparted to any one not entitled to receive the same.

The first property on which the diamond drill was employed was the Glendower iron mine, situated on lot 6 in the second and third concessions of the township of Bedford, in the County of Frontenac, on the shore of Thirty Island lake, and is connected with the Kingston and Pembroke Railway by a spur about four miles in length. It is the property of Mr. Joseph Bawden, barrister, and Messrs. Folger Bros., of Kingston. The ore body where exposed has a width of about 20 ft It occurs in metamorphic rocks which have a strike about north-east and south-west and dip at an angle of over 80 degrees. The rock on the upper side of the deposit is crystalline limestone, while that on the lower with some difficulty, owing to the rough country through which it had to be taken from the railway station, and was placed about 70 feet from the foot wall side of the vein, the first hole being made at an angle pointing 60 degrees to the south. The conditions were found to be very different from those at Glendower. The hardest kind of granite was encountered for a distance of 138 feet, when the quartz was struck and drilled through a distance of 65 feet, the hole ending in the hanging wall at a total depth of 205 feet. The second prospect was located on the line of the vein 350 feet away from the first, the drill being placed 38 feet south of the foot wall, and the hole pitched at an angle of 78 degrees pointing to the north. The drilling was begun in quartz and ended in granite at a depth of 91 feet. The quartz, granite and syenite penetrated by the drill afforded the most difficult sort of boring. The rate of progress was consequently slow, and the cost per foot between four and five times as high as at the Glendower mine. The loss in weight of diamonds was 23.070 carats, and the cost of this item per foot of boring was upwards of seven times as great as at Glendower, showing conclusively the obdurate nature of the strata pierced. Following is a statement in detail of the cost of work :—

	Total Cost.	Cost per foot.
Freight	$ 66.70	$0.225
Labor and teaming	109.87	0.371
Wood	111.82	0.377
Lumber and drill supplies	43.00	0.145
Renewals and repairs	118.35	0.400
Diamonds	403.72	1.363
Fireman	141.49	0.477
Superintendence	284.47	0.961
Total	$1,279.42	$4.322

The drill was at work on this property from 5th August to 23rd October, 1895, 69 working days in all, the average rate of progress per day being 4 ft. 3 in.

Combining the operations of the drill at both places it is found that a total depth of 2,922½ ft. in eight holes has been bored by the machine since it was placed in the field, in 249 days actual work, at an aggregate cost of $3,870.60, or $1.324 per foot.

dark batt. The seam lies at an inclination of 1 in 14. The system of working is pillar and room, with the rooms advancing on the full face of the coal, and almost on the crop. Three machines were used, the Ingersol," the Yoch, and the Harrison. The conditions were that each machine should be worked by the same runner for the whole of the test, that each runner should be allowed a helper to shovel away the coal and to assist him in moving the machine from room to room, but that the helper should not be allowed to touch the machine whilst it was in operation. The compressed air which worked the machine was turned on every night at seven, and turned off every morning at four, the cutting all being done at night to furnish an opportunity of taking away the coal in the day-time. The Ingersoll and Harrison machines were moved from room to room by the cutter and his helper; the Yoch machine, being heavier, was by arrangement moved around by the help of a horse and driver. In order to give the full particulars of the machines, their dimensions, weight, etc., I now append tabulated statement No. 1.

DESCRIPTION OF MACHINES IN DOMINION NO. 1 MINE

No.	Name.	Diameter of Cylinder.	Length of Stroke.	No. of Strokes per Minute.	Working Pressure in Lbs.	Weight.
1	Ingersoll....	4 in.	11 in.	200	80	750 lbs.
2	Yoch.......	6 "	14 "	120	80	1,100 "
3	Harrison....	3¾ "	12 "	200	70	700 "

No. 2 statement shows the amount of work done on each shift during the fortnight that the trial lasted, and from the summary you will notice that in the eleven working days a total of 5,635 square feet were undercut, being an average per day for each machine of 509, and an average per hour for each machine of 57.30, and that they produced during that time a total tonnage of coal equal to 4,460, being an average daily of 403 for 3 machines, or 134 for each machine. This, so far as I know, establishes a record in this class of coal. To give a clearer idea of the work done I may say that as the rooms were 20 feet wide, it represented the under-cutting of about 5 rooms each shift, the depth of under-cutting being 5 feet. Two of the machines, the Ingersoll and the Yoch, worked very evenly all through, and at the finish the difference


N A S
B A S I N
Burntcoat
Whale Creek Mine
Walton
Davis
Stephens Mine
Johnson Pit
Parker Mine
Tennycape
Tennycape Mine
Moose Brook
Minasville
Faulkner Mine
Hibernia Mine
Fry's Mountain
MANGANESE MINES
Hants County
Scale 40 chains to an inch
(as drawn)
0
Miles
LEGEND
Contact


Lower Caledonia
Mary's
West River
1
2
Glenelg
Melrose
LOUS CONTACT
gh County.
SCOTIA.
(ld bearing series)
tact.

by parallel headings driven from the hoisting shaft. Each of these four districts is ventilated by a separate split of the air current.

I may say that in presenting this plan I am not presenting any particular system of mining. For my present purpose such is entirely unnecessary, and I only ask you to look at the plan from a ventilation point of view.

Suppose that the fan at "F" is acting as an exhausting fan, the air will go down the shaft "H" and will take the following course. I will only describe the course of the current in sections 1 and 3, as section 2 is ventilated in the same way as 1, and 4 as 3. Let us take section 1 first.

The air leaving the bottom of the shaft "H" travels to the left along the main level. You will observe two roads in the first pillar in the form of a St. Andrew's cross. One of these roads crosses the other at the point *a* by an air-bridge. In each of these roads, both of which communicate directly with the fan shaft "F," are doors *b b* opening towards the hoisting shaft. These doors prevent the air from getting to the fan shaft directly without first circulating through the entire district. You will also observe that there are two doors *c c* on the main haulage road which open readily with the current. There are also doors *d d d d* at the foot of each gate road leading to the working stalls. The air, therefore, coming down the hoisting shaft "H" travels along the main haulage road and following the course indicated by the arrows, arrives at the point *e* close to the fan shaft "F," and crossing the haulage heading by the air-bridge at *f*, reaches the fan shaft up which it is exhausted.

We will now consider section 3.

The air when it leaves the hoisting shaft "H" is split at *g*, and the portion of the current in which we are now interested travels up the heading to *h*, part of it going straight forward to ventilate the headings to the rise, while the balance turns to the left along the level road in section 3. From this point it follows the course of the arrows until it reaches the centre heading at *i*, where it joins other splits on its way to the fan shaft "F."

These are the courses which the air takes in the case of a fan acting as an exhaust.

We will now suppose that the fan has been suddenly reversed, and is now acting as a blowing fan, remembering, that while this is so, we do workings. I certainly would object to changing the air if it could be avoided, but it cannot be avoided in some cases. In Pennsylvania they have the reverse fans.

Mr. Blakemore—It is absolutely necessary to reverse the air in our shallow pits in Cape Breton. There is a great difficulty in maintaining a temperature a little over freezing point. We used the Bond system, but it did not succeed. This winter we applied this frame system, not exactly in the way sketched there. In the Caledonia mine, an old one, we made a cross over 100 ft. from the shaft on either side, and reversed the air only between the shafts. It was successful. I should say with Mr. Dick that there is the greatest possible objection to reversing the air current throughout the mines, but there is no danger in reversing it for 100 ft. or so near the shaft. It would not be advisable, however, to do it in deep shafts. I call to mind a case six or seven years ago where we decided to reverse the air current and make the downcast an upcast. We had everything outside the mine—men, horses, etc. The shaft was 1,200 ft. deep. It took us an hour before we could get the air reversed in the two shafts and roads connecting them. I don't think any man would care to take that risk. You cannot afford to suspend the ventilation for an hour. The reversing of air should be confined to shallow mines. There is no danger if you reverse the current just in the immediate vicinity of the shaft.

Mr. Dick—You had a Waddle fan at Caledonia.

Mr. Blakemore—We had no fan in before that. The fan we are using in the Caledonia is a Murphy fan, 12 ft. in diameter.

Mr. Dick—I am glad to hear that Mr. Blakemore has had some experience in this matter. I did not know that such a thing was in operation in Cape Breton. I only heard of one case in Uniontown, Penn. I should like to repeat that it is not a question for one moment as to the advisability of reversing the air either in the shafts or in the workings, but it is a question of fans operated on this principle. They change the direction of the air all through the workings, and when the change is made they have to have duplicate doors opening in opposite directions. In this case you do not require duplicate doors. You may have to change the air, and it is a question which is the best way to do it. If you reverse the air right through the mine and bring your foul air places. Greater resources for producing coal in an emergency; and in a well equipped mine, an undoubted saving in the cost of production. On the other hand, it must not be forgotten that this paper deals exclusively with coal cutting machines and their work, and we must not forget that before this work can be done a large expenditure is necessary in providing motive power and conducting it to the working places; and it is not until the cost of supplying this, together with the cost of maintenance, and a fair allowance for depreciation of plant and machinery has been added to the cost of mining, that we are able to compare it with the labor method.

I think it may be interesting to refer to the subject again in the future, as I shall no doubt be in a position to speak more definitely in the course of a year or so.

Dominion No. 1 mine is laid out to be worked entirely by machinery, and no coal is cut by hand. It will be, therefore, much more reliable to refer to the working cost after a longer experience, than to base opinions upon a trial test; but I may say that while the ordinary work has fallen below the test above referred to, the net result has been to confirm the practicability and economy of cutting coal by machinery.

STATEMENT No. 2.

DOMINION NO. 1.

	INGERSOLL				YOCH.				HARRISON.			
July & Ang.	Rooms	Cuts	Sq. ft.	Hours.	Rooms	Cuts	Sq. ft.	Hours.	Rooms	Cuts	Sq. ft.	Hours.
29.....	4	1	504	7½	4	2	540	9	4	—	470	9
30.....	4	2	571	8½	4	1	509	9	4	—	402	9
31.....	4	2	558	8½	3	2	467	9	4	—	417	9
1.....	4½	1	535	9	4½	1	638	9	4	—	425	9
2.....	4½	1	574	9	4½	—	524	8½	4	—	411	9
3.....	3	—	332	5	3	—	351	5	2	—	231	5
5.....	4	3	565	9	4½	—	486	9	4	—	441	9
6.....	5	—	537	9	4	—	463	9	4	—	460	9
7.....	5	—	541	8½	5	—	538	9	4	—	450	8½
8.....	5	—	477	9	5	—	543	8½	4	1	578	9
9.....	5	—	523	9	4	1	508	9	4	—	447	8½
10.....	3	—	321	5	3½	—	362	5	3	—	268	5
	51	10	6038	97	49	7	5929	99	45	1	4940	99

(Only worked from 7 a.m. till 12 a.m. Saturdays.)

of usefulness for it in proving some of the many undeveloped copper-nickel deposits of the Sudbury region. The demand for both magnetic and hematite ore to supply the new blast furnace at Hamilton should and doubtless will induce owners of iron properties conveniently situated to examine them with the view of transforming them into producing mines. In the Lake of the Woods, Rainy Lake and contiguous regions are many gold locations of promise, some of which are at the present time being explored by diamond drills in the hands of private parties. If the holders of others were equally desirous of ascertaining the quality and extent of the quartz veins on their lands, the assistance afforded by the Government would very materially lessen the cost to them of acquiring this information. We can hardly hope to find in our ancient Huronian rocks, benuded by glacial action as they have been, either coal seams or beds of auriferous gravel, such as are encountered under ground in Australia and California, however deep or assiduously we may bore for them; but in exploring for copper, nickel, iron, gold, or stone of any kind, the use of the Government drill might well be extended with advantage to the holders of mining lands and to the Province at large.

of the ground being passed through, the "wash" water, as it is called, indicates by its flowing freely or scantily the favorable or unfavorable progress of the work at the bottom of the hole.

An important part of a diamond drill outfit, and one which enters largely, both into its first cost and the expense of operating it, is the diamonds, or carbons, as they are sometimes called. They are veritable diamonds, procured mainly from Brazil, and are of precisely the same chemical composition as the white and more highly priced gems used for jewelry and ornamental purposes, differing only in color. They are black, or nearly so in shade, occasionally of a reddish tinge, and are found in various sizes. A stone recently got in the old diamond district of Brazil weighs 3,100 carats, and is by far the largest diamond ever known. It is now in the hands of the jewelry firm of Messrs. Kahn & Co., of Paris, and the Government of Brazil is negotiating to purchase it for the national museum of that country. Uncertainty as to how so unusually large a stone would turn out has made the dealers somewhat chary of handling it, and the price demanded is considered too great. The probable value is about $40,000, or 52s. 6d. per carat. When stones are found of larger size than can be conveniently used in the diamond drill, they are broken into pieces of about two carats weight, which is the size ordinarily employed. They are of a hardness quite equal to that of the white or colorless variety, and as the abrading action is largely done by the edges and angles of the stones, there is room for considerable skill on the part of the operator in setting the diamonds so that they may do the greatest amount of work with the minimum of loss. The price of black diamonds fluctuates a good deal according to the conditions of supply and demand, and also to the ability of the combinations which control the black diamond mines to rule the market. In the summer of 1894, when the department purchased the diamond drill plant, the market price was $17 per carat, and at that time and a little later a supply of diamonds was laid in amounting to 82.605 carats, at a cost of $1,356.16, or an average price of $16.40 per carat. Since then the market in the autumn of 1895 advanced to $19 per carat, and again in the following November to $21 per carat. An exceedingly brisk demand set in from the South African gold fields, and in January, 1895, the price rose to $25 per carat, in March to $30, and in April to $36, by far the highest price ever known. Almost the whole production through a barren stretch and exhibit a core altogether worthless; producing a record in one case unduly flattering, and in the other unjustly condemnatory of the property. Such results, however, are only to be feared where variable and irregular deposits—as gold veins are occasionally found to be—are being examined by the drill. This drawback is absent where large bodies of ore or mineral, such as deposits of iron, copper, nickel, or beds of lithographic stone or marble, or similar masses are being examined.

There are various makes of diamond drills, but the principles on which they are constructed are substantially the same in all. The boring tool is an annular steel bit set with diamonds, which is attached to the end of a series of hollow rods, and being rotated under pressure wears away the rock upon which it bears, the core rising up in the hollow of the rods, or rather of the core barrel forming the terminus of the series As the hole is put down additional lengths of pipe are screwed on, and when it is desired to bring the core to the surface the rods are raised and the core taken out. In this way a continuous section of the ground from the time the drill enters solid rock can be obtained, the boring capacity of the machines varying from a few hundred up to two thousand feet. Some of the smaller drills are made to work by hand, but the majority are operated by steam power, or in underground workings by compressed air. For surface work the engine is usually attached to the drill, both being mounted on a waggon for convenience of transport. The boiler for the same reason is also set on wheels. A supply of water is essential to the working of the diamond drill, and a steam pump forms part of the outfit, the duty of which is to send a constant stream through the rods down to the bottom of the hole where the bit is at work, and so bring the cuttings to the surface by means of the ascending current, which comes up between the rods and the casing or walls of the hole. It may occasionally happen that in porous or broken rock some fissure or jointing affords the water a subteranean passage, and it is "lost," or ceases coming to the surface. This is far from a desirable state of affairs, and it is necessary for the driller to recover the water. He usually seeks to do so by sending down to the bottom of the hole a supply of cement sufficient when hardened to stop the leak. In some cases bran or similar material is resorted to. Besides bringing the cuttings to the surface, and so keeping the drill runner constantly informed of the nature

The record of the various Canadian furnaces during 1895 is as follows:—

NOVA SCOTIA STEEL CO., NEW GLASGOW AND FERRONA, N.S.

	Tons.	Lbs.
Coke pig iron made	19,410	1,440
Ore charged	38,783	1,520
Fuel	28,110	1,560
Flux	16,304	1,920

	Men.
Labor employed in steel works	450
In ore production	100
In furnace work	250
	800

This company manufactures all grades of agricultural implement steel, forgings, etc., the basis of which is very largely "Ferrona" iron, made from Canadian ore, so that the utmost possible amount of labor is secured to the country in the special lines now made by this company.

LONDONDERRY IRON CO., LTD.

	Tons.	Lbs.
Coke pig iron made	17,744	320
Ore charged	41,557	1,200
Fuel charged—coke	25,264	1,920
Fuel charged—coal	3,088	1,920
Cast iron water and gas pipe produced	2,110	160

Average number of men employed, 425.
Furnace output of 1895, campaign 8 months.
Pipe foundry campaign, 7 months.

It is a notable fact that the tariff revision of session 1894, by which a duty (on a sliding scale), was imposed on wrought scrap iron, has already resulted in the Londonderry Iron Co. making contracts with Canadian manufacturers of bar iron which is enabling them to start up their rolling mills. The work is just commencing in this department, and will afford steady employment to a large number of Canadians.

CANADA IRON FURNACE CO., LTD.

Charcoal iron produced in 1895, in a campaign of nine months:

	Tons.	Lbs.
Ore made	6,598	420
Charcoal consumed	654,361 bush.	
Ore "	16,203	
Lime "	1,500	417

Average number of men employed, 600.

for the payment of a bounty of $2 per ton on all steel billets manufactured in Canada from Canadian pig iron.

THE HAMILTON IRON AND STEEL CO.

The new furnace with a capacity of 100 tons per day goes into blast immediately. At the start a large proportion of this company's ore will be the product of American mines, but they look to the Act of the Legislature of Ontario, Session 1894, (which provided for the payment of $1.00 per ton on the pig metal products of iron ore, raised or smelted in the Province of Ontario) to bring about an almost immediate development of the mines of the Province In the meantime the Hamilton Iron and Steel Co. will naturally have to waive claim to the Dominion bounty of $2 per ton, so that it is entirely in their interest to push forward the exploration and development of Ontario mines, and thus give the real benefit of the industry to Canadian labor. Under present circumstances, Ontario not possessing coal mines, and the question of the economical transportation and handling of Lower Province coal being as yet unsolved, the Hamilton Iron and Steel Co. will have to use American fuel, which unfortunately means that one-half of the labor benefit of the industry will go to a rival market. Under these circumstances the Dominion Government will probably restrict the Federal bounty to a sum proportionate to the amount of Canadian labor employed in the industry; this as a protection to the coal miners and charcoal burners of the other Provinces.

REMARKS.

The time is perhaps very opportune to draw the attention of the leaders of the contending political parties of this country to the fact that the interests of the industrial enterprises of Canada should be as sacred to the one party as to the other. The workmen employed in the respective enterprises are just as deeply interested in the success of the operations as the capitalists who have risked, and must continue to risk their money in establishing the work.

The iron industry has perhaps greater claims to the good-will and support of the statesmen and people of Canada than any other of the great industries of the country, because the raw material used is wholly Canadian, the product of Canadian labor. It is eminently an industry for which nature has fitted the country, and it is therefore well that it moved 171 feet south from the site of prospect No. 5 and 100 feet east of the vein. The hole was drilled at an angle of 85 degrees, and limestone was chiefly gone through for a distance of 425 feet when the ore body was struck. This hole was finished in quartz on 17th June, 1895, at a depth of 525 feet. The aggregate depth of the six borings was 2,626½ feet, and the time consumed was 180 days of actual boring, or at the rate of 14½ feet per day. The rock formations pierced were limestone and granite, with bands of hornblende and quartz. In some places the strata were found to be more or less broken up and obstructive to the drill, but on the whole the ground, especially the limestone, was easily drilled through, and good progress was made, the drill frequently going as much as 30 feet in a day.

The result of the operations was to show that a very considerable body of good ore existed between masses of mixed ore.

The total cost of the work was $2,591.18, or $0.986 per foot of boring. The various items of expense were as follows :—

	Total Cost.	Cost per foot.
Freight	$63.58	$0.024
Lumber, hardware and other supplies	162.24	0.061
Wood	308.07	0.117
Teaming and labor	393.72	0.150
Repairs and renewals	81.95	0.031
Diamonds	494.34	0.188
Fireman	354.72	0.135
Superintendence	732.56	0.278
Total	$2,591.18	$0.986

The cost was divided between the Bureau of Mines and the owners of the property in the proportions provided for by the regulations. The total weight of diamonds used was 28.428 carats, worth as stated above, $494 34.

After work was concluded at the Glendower mine, the drill was removed to lot number 2 in the 2nd concession of the township of Maclennan, near lake Wahnapitae, the property of the Bonanza Nickel Mining Company, where a white quartz vein of great width had been discovered, which, though carrying no visible gold, had shown by assays a value of as high as $100 per ton. The drill was got to the location

The last two tables are given in order to show the cost of exploring for ore bodies in working mines, but they are not strictly comparable with the cost of work done by the Government drill, or with surface operations generally, as the latter embraces items of expense, such as freight and teaming, which are absent in the former case.

The Government of New South Wales, Australia, employs diamond drills for exploring purposes, the cost apparently being divided between the Government and the property owner. In 1894 the total depth bored was 557 ft., and the cost for boring, exclusive of reaming, was £468 2s., or 16s. 9½d per foot, equal to $4.07 of our money. This cost seems large and may be partly accounted for by the small extent of boring. In 1893, however, the depth drilled was 1,903 ft., 7 in., at a cost of 12s. 4⅞d per foot, equal to $3.01 per foot. The rate of boring in 1894 was 12.55 in. per hour, and the diameter of the bore was 4 in., much larger than that of the Ontario drill. The expenditure for diamonds was 9d. per foot—almost exactly the same as at the Glendower mine—and the work appears to have been done in basalt interbedded in clay. In 1893 the cost for diamonds was 3s. 3 11/16d. per foot—more than four times as great as in 1894. The reason for this difference is not explained.

In the colony of Victoria extensive borings have also been carried on by the Department of Mines for several years in search of auriferous deposits and in prospecting for coal. The aggregate depth bored for gold in 1894 was 28,347 ft. 9 in., and the total cost £10,663 12s. 9d. Of this distance 21,148 ft. 11 in. was put down by means of diamond drills at a cost of £9,673 17s. 6d., or 14s. 3¼d. per foot, equal to $3.47 per foot. Other boring machines on contract drilled 7,198 ft. 10 in at an expense to the Department of £989 15s., or 3s. 6¾d. per foot, to which apparently a like amount is to be added for the share of the cost borne by the private individual or company. In prospecting for coal two types of drill were employed, the diamond drill and the calyx machine. The last mentioned is said to be an entirely new invention, working with steel cutters instead of diamonds, at an expense much less than that of the diamond drill. The cost of operating the latter in the coal measures was 11s. 6d. per foot, while for the calyx machine it was 6s. ½d., a marked difference in favor of the new machine. The following reference to the work of the calyx drill is made in the report of the Superintendent of drills for 1894:—

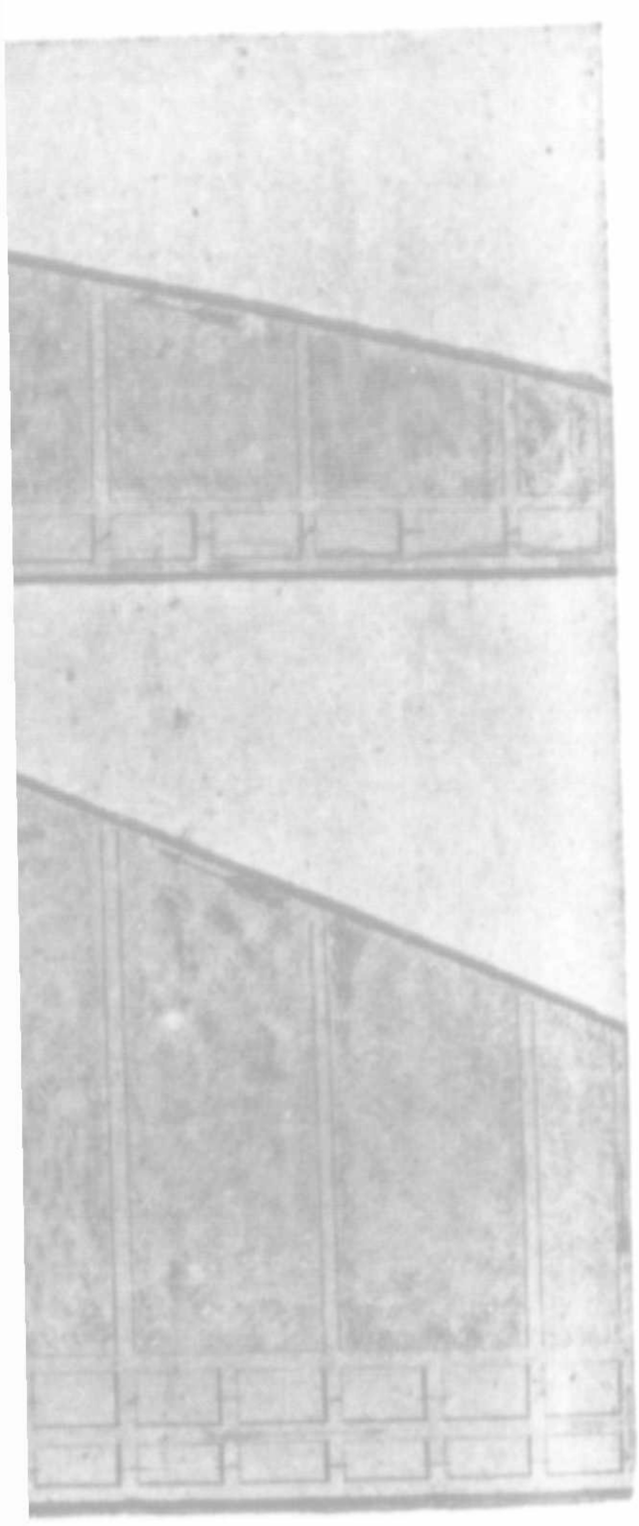


FIG. II.

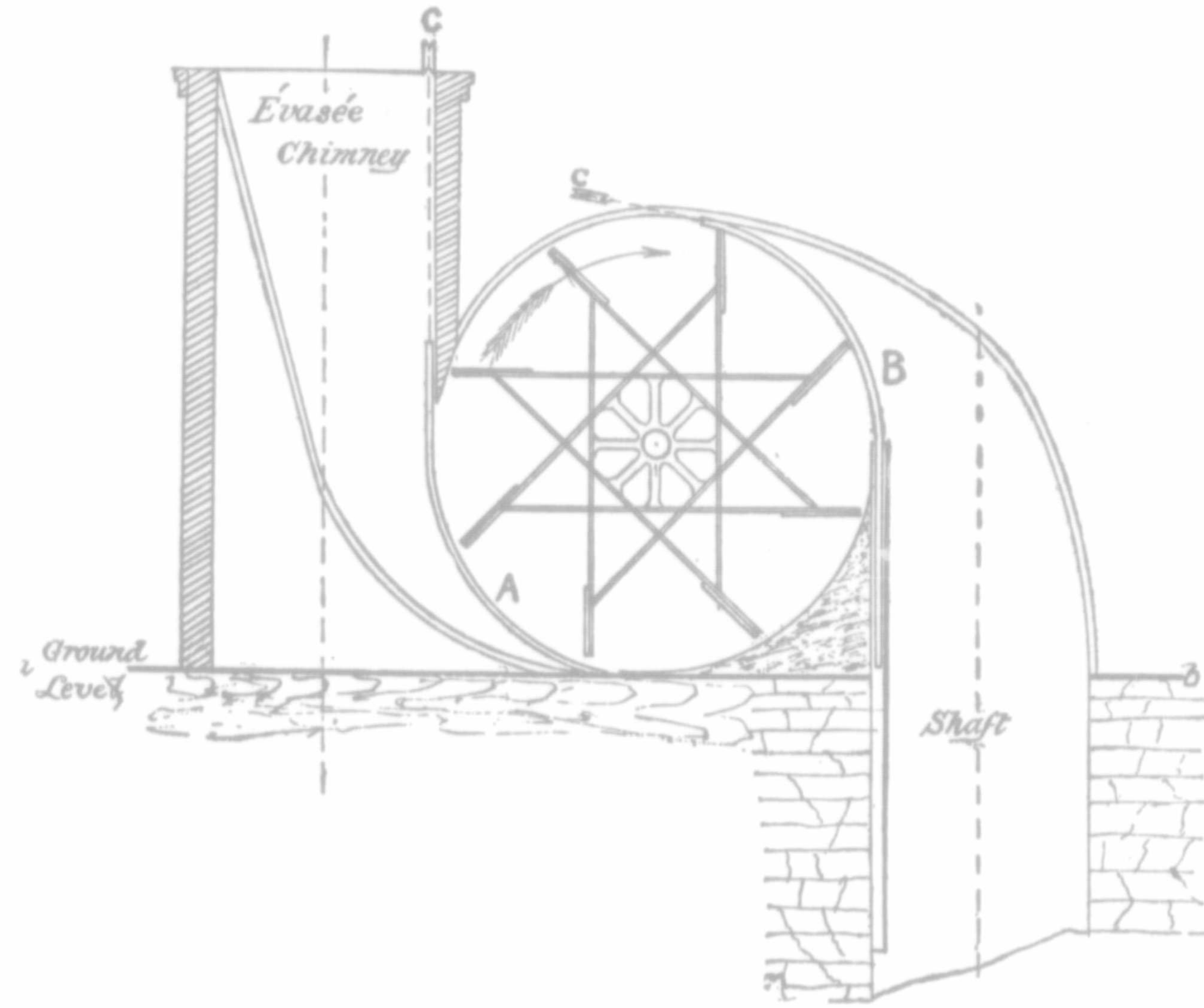
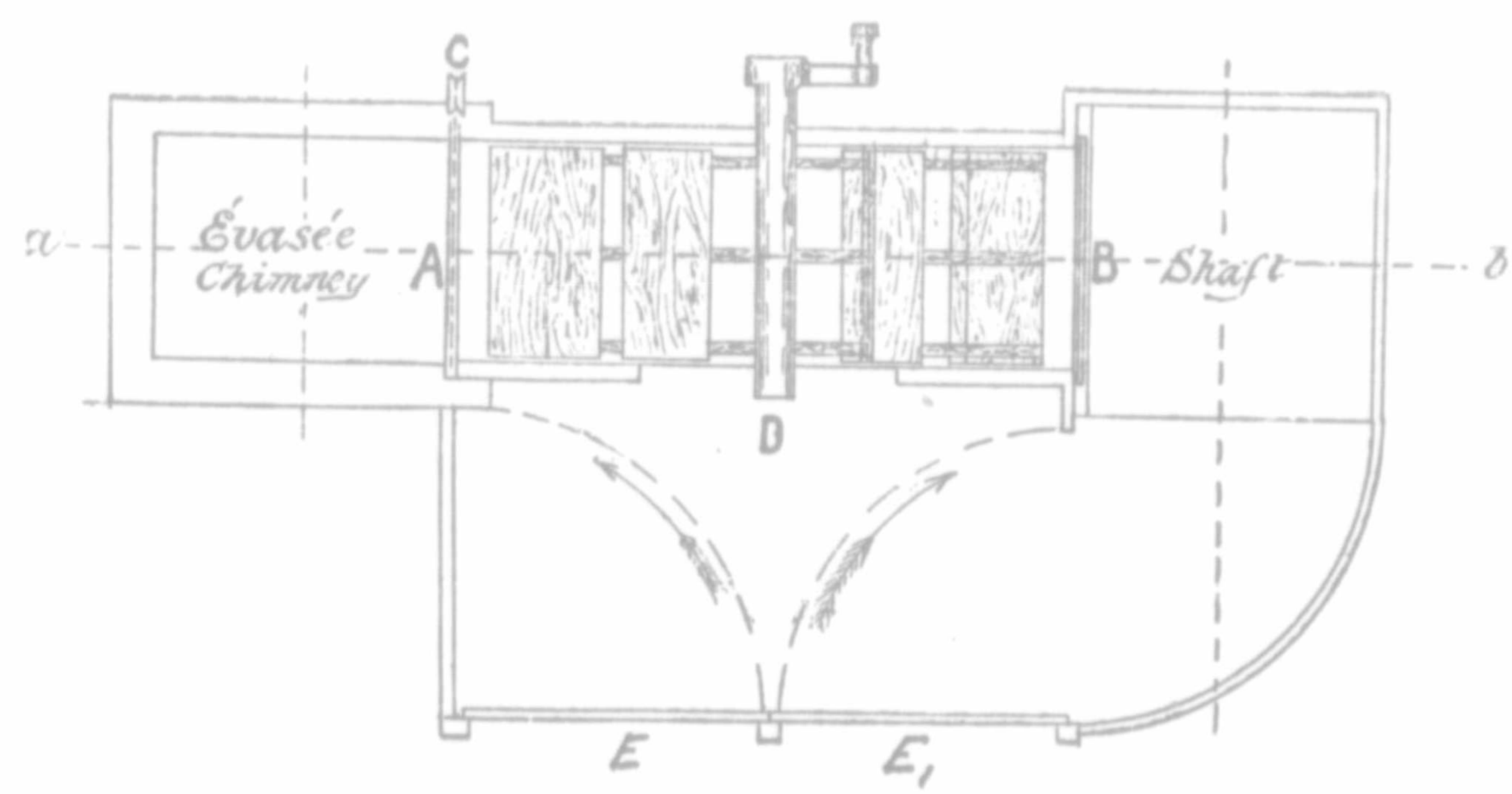
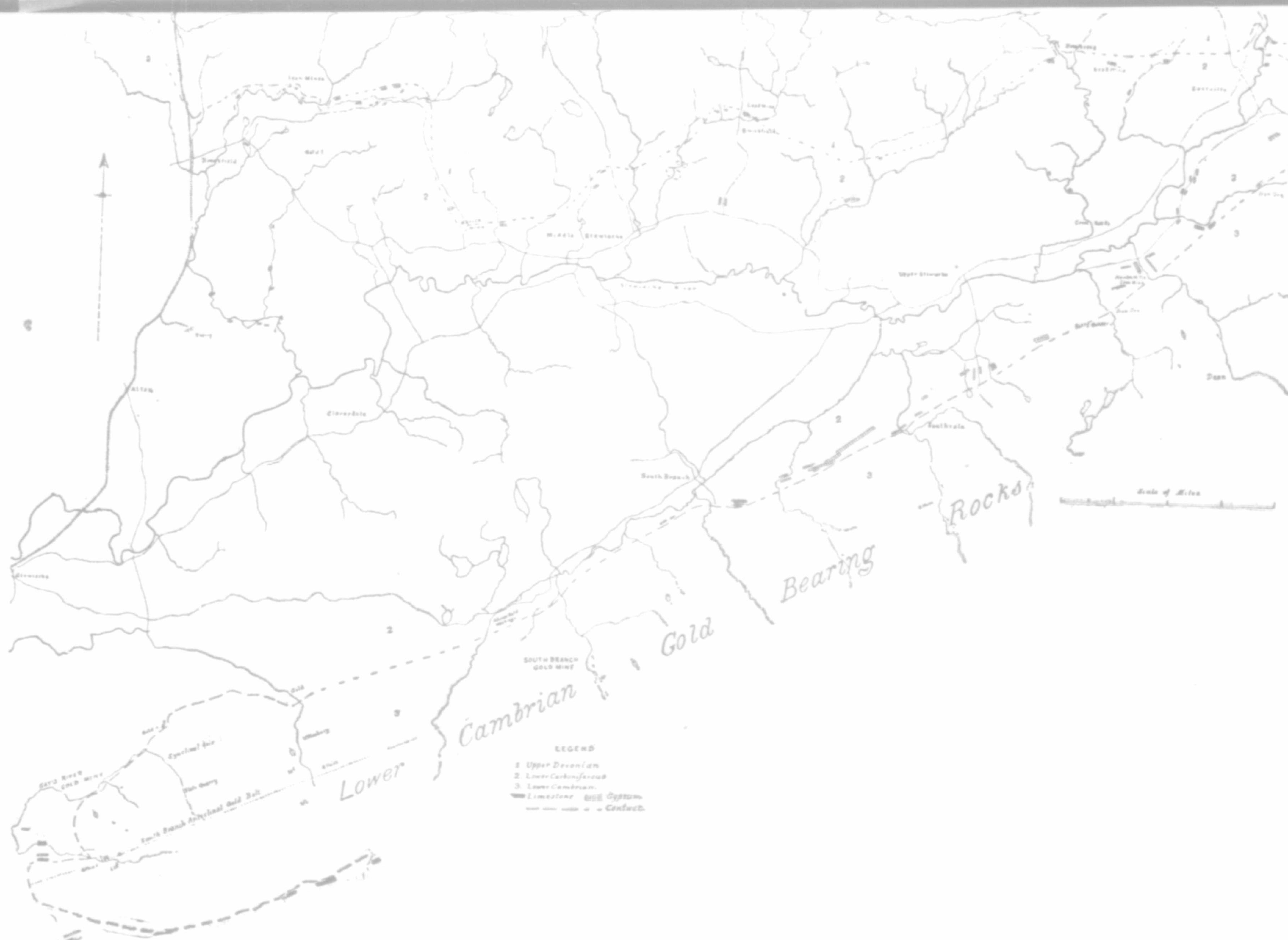


FIG. III.




Lower Cambrian Gold Bearing Rocks
SOUTH BRANCH GOLD MINE
South Branch
Scale of Miles
LEGEND
1. Upper Devonian
2. Lower Carboniferous
3. Lower Cambrian.
Limestone
Gypsum
Contact.

along the main haulage ways it is a great mistake. Under this system you don't have to do that.

MR. BAIRD—I think your plan is a saving and could be carried out in certain places.

MR. DICK—In old mines, where there is a considerable distance between the shafts, it would be a difficult matter to adopt it. Where it is put in there are only some hundreds of yards. The idea is simply to save the expense of duplicate doors, and do away with the reversing of the air-current in the working places.

MR. BROWN—If the shaft is making ice, why not heat the air going down? Would that be objectionable?

MR. DICK—I suppose there would be no serious objection. Heating might retard ventilation.

DR. GILPIN—They had steam pipes at the Foord pit, Albion mines, and the air passed through them.

MR. DICK—Raising the temperature would not have an appreciable effect on the ventilation. In Pennsylvania they have a fad for reversing the air.

MR. FERGIE—The mines are shallow, are they not?

MR. DICK—Yes, at an easier inclination.

MR FERGIE—I think that ought to be taken into consideration, and also as to whether they are gassy mines or not. I would not like to reverse the air in some of the Pictou mines.

This reversal of air has, however, its disadvantages, as follows:—

(1) The fouled or impure air is turned into the main haulage roads, where all the traffic of the mine is concentrated and where naked lights are almost invariably used.

(2) All the doors which were used to obstruct the air when travelling in one direction are utterly inoperative when the air-current is reversed, and either duplicate doors have to be supplied or those in use have to be re hung so as to shut in the opposite direction.

(3) The free gases which in fiery mines are constantly being exuded from the coal face are kept back by the pressure of the ventilative current, and, far fetched as the argument may seem, it is nevertheless perfectly understandable, that at the moment of reversal there will be a cessation of pressure which will permit large bodies of free gas to obtrude into the airways and general workings, and when the current again begins this gas will be carried through the workings and afford excellent opportunities for an explosion.

Suppose then we have a colliery where we are troubled with ice in the winter, but we are in favor of exhaust ventilation. Is there no way by which we could combine the merits of the two systems? I say there is, and I will now present to you a method by which the air can be allowed to travel through the workings in a given direction by an exhausting fan, yet if it be suddenly changed to a blowing fan, the air, while it is reversed in the shafts and their immediate vicinity, will not be altered in direction in the general workings. By this means the hoisting shaft will be kept warm in winter, and the three objections which I have just cited will be overcome, namely:

(1) The main haulage roads will be almost entirely in the fresh air as before the change.

(2) The same doors will do for either an exhaust or a blowing fan.

(3) There will be no cessation of ventilative pressure.

For the purpose of explaining this method I have prepared a plan of a mine consisting of four sections worked by two shafts. The hoisting shaft "H" is sunk on the main level, while the fan shaft "F" is situated to the rise of the shaft's pillar.

The coal is worked simultaneously from four districts, one of which is situated on the main level on each side of the hoisting shaft, while the other two are similarly situated on an upper level which is approached

On Surface Surveys and the Necessity of Contour Surveys in the Gold Districts of Nova Scotia.

By Dr. M. Murphy, Halifax.

The surface surveys in the gold mining districts of Nova Scotia have been, so far, confined to the running of, or projection of lines over the surface to determine the boundaries of gold mining areas, or blocks of areas, as they are called. When the discovery is of sufficient magnitude to warrant a survey of the blocks, or of the areas within a district being made, the Commissioner of Public Works and Mines, under whose general supervision and guidance the laws relating to mines and minerals are observed, will send a surveyor to run lines, showing the metes and bounds of the properties of the respective prospectors or lessees, as the case may be.

The blocks, or their subdivision into rectangular areas of 250 ft. by 150 ft., are run off from a line arbitrarily selected to follow the general direction or strike of the lead or lode, as it may appear at the surface outcrop. Such has been the practice in laying off the principal gold districts. Recently, however, this practice has been altered in laying out new districts, and the line of the magnetic meridian has been adopted instead, the general strike of the auriferous slate belt along our Atlantic border being nearly east and west, magnetic.

It is not the purpose of this paper to offer any remarks touching the present practice, so far as the adoption of base lines or the subdivision of properties is concerned. The object in view is to point out the desirability of extending the work of such surveys, not beyond the district boundaries, but within them, by utilizing the work already being performed towards the greater object in making a topographical survey over each of our gold mining districts.

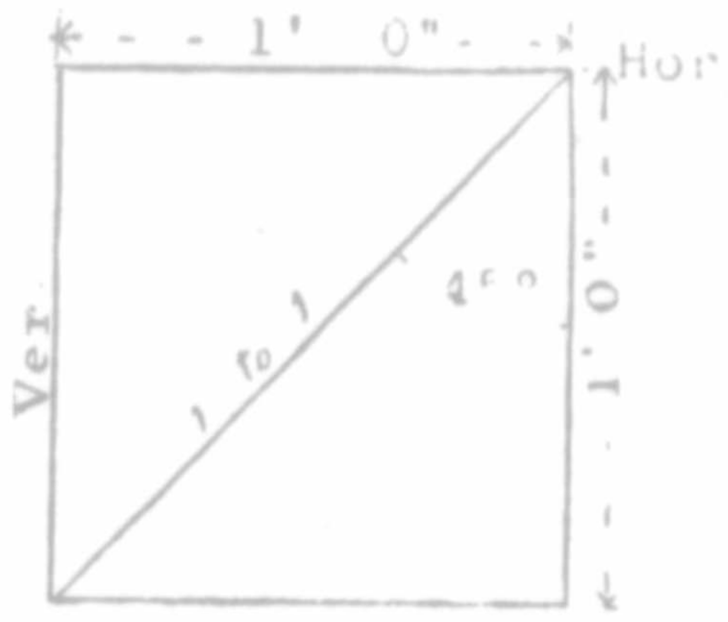
All mining engineers will agree that topographical maps, if properly made to represent the configuration of the surface, are of the greatest convenience and of much value in mining work where so frequently the

The error due to barometric measurements would be reduced to a minimum in these instances, the distance being so short between the boundary stakes where the altitudes would be so correctly noted.

This is not submitted to the Mining Society of Nova Scotia as a geological paper. I may, however, Mr. President, be permitted to refer to some principles of rudimentary geology, so far only as may be necessary to illustrate my paper on topography and its use.

The auriferous belt of quartzites and slate bordering the Atlantic shore, present in many places a considerable uniformity of strike, generally, between West and South, N. E. and S. W. is about the average prevailing course. The beds undulate in synclinal and anticlinal folds, often of no great magnitude, as in the neighborhood of Halifax and its vicinity. In other places, such as Goldenville and its neighborhood, there is much more uniform dip. The country is generally low, rugged and broken, or boldly undulating. The course of the glacial movement has been transverse to the line of strike and has furrowed the valleys forming

Fig 3.



the beds of the principal streams, evidences of which may be observed at the falls of the Port Medway, Liverpool and Jordan rivers. Frequently along the sea coast, and occasionally inland, granite bosses, varying from miles to a few acres in extent, protrude through the slate, so that, in endeavoring to discover the limits of successive beds of sedimentary deposits, other planes are met with, and it is often difficult to decide which is the true plane of stratification and which is the plane of cleavage. All these causes and others, such as faults, denudations, etc., tend to create a diversified hilly or rolling surface sometimes bare, and often covered with drift or boulder clay. However, when these disturbing forces are studied by the mining expert in his own special line of research, the mechanical effects must be better understood, and in these respects surface surveys may be of some service.

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The experience here given as exclusively Nova Scotian, seems also applicable to the Magdalen Islands, where manganese ores also occur in lower carboniferous limestone at the contact with brecciated red sandstones and shales probably of Devonian age.

DISCUSSION.

MR. R. G. LECKIE—I regret very much that I have had time only to give a very hurried reading to Mr. Poole's excellent paper. It must prove of much practical value to those engaged in exploration for mineral deposits and to those charged with their development.

The Devonian formation in many parts of the world is rich in a variety of minerals of immense importance, notably in Somersetshire, England. Near its contact with the lower carboniferous in the Mendip and Brendon hills extensive deposits of iron ores, both spathic and limonite, have been long worked, and lead ores are said to have been raised there before the advent of the Romans. In Derbyshire and Cumberland both lead and iron ores occur in considerable abundance in these formations, and also in the Upper Ward of Lanarkshire at Leadhills.

In this Province extensive deposits of iron ores are traced continuously for many miles in the geological horizons to which Mr. Poole calls attention. The great deposits worked at Acadia mines are met with in the upper portion of the Devonian, and within a few hundred yards of its contact with the lower carboniferous. Indeed, at East Mines a coal seam, much faulted and broken, was opened within four hundred yards of the iron ore, but by an overturn it dips toward the Devonian and is soon cut off.

From below Economy, in Colchester County, eastwardly to the Pictou line, the limonite and spathic ore can be traced with much regularity, preserving a distance of about 300 yards from the contact of the two formations. On the opposite side of the Bay of Fundy the limonites found at Old Barnes, Selma and Goshen, appear to be confined to the lower carboniferous limestones, but near the Devonian slates and sandstones, but the red hematite of Big Pond, Cape Breton county, is apparently a contact vein of very irregular width.

An irregular deposit of manganiferous iron associated with gypsum occurs at Doherty Creek, Cumberland county, at the base of the carboniferous limestone.

a dark laminated limestone, which, with the overlying sandstones and marls, contains small veins holding specular ore, with ankerite, barite, calcite, goethite, manganite and siderite. In the same formation . . at Clifton, similar ores are found." . . . "In Cape Breton, near McDougall's Point, Big Pond, a limited deposit of excellent quality was seen at the junction of carboniferous conglomerate with syenite; at McNeil's mill on the Glengarry road, similar traces have been met and large boulders occur at Loch Lomond post office."

On discussing this subject with Mr Fletcher, he added: "I have no doubt about the lowest limestone being nearly always more or less mineralized, even when, as at Brierley Brook and Washaback in Cape Breton it has a great thickness of the conglomerate beneath it. There seems to be always at this horizon a great unconformity. But in Nova Scotia proper I think no good deposits are found at the base of the conglomerate. It is not, however, well developed until you come to the Cobequid hills, after leaving Antigonish; and the Cobequid conglomerate is of doubtful age."

Suggestive as the foregoing extracts and comments are they fail to convey so clear an idea of the concentration of mineral deposition along the line of lower carboniferous contact as a glance at a plan of any of the districts will do, and the accompanying outline maps of well known districts will illustrate the more forcible the point it is desired to make. Sheet No 1 shows the chief source of their manganese in county of Hants at many places along the line of contact. Where mines have been opened away from the contact they are in outliers of the carboniferous limestone that have been left in depressions of the older rocks out of the general course of the contact line. Much of the ore mined is of great purity and brings high prices, analyses of the various kinds and mention of the associate minerals, are given in How's Mineralogy of Nova Scotia, and in the Transactions of the Nova Scotia Institute of Science, and the mineral statistics published by the Geological Survey gives data between the years 1868 and 1882 of 4,560 ton of an invoice value of $117,831.00

Sheet No. 2 is of the Stewiacke Valley where lower carboniferous rocks are flanked by upper Devonian on the north and lower cambrian on the south, deposits of barite, gypsum, iron, lead, copper and gold occurring along the contact. The iron near Brookfield is in the form

As to the age of some of the older series of rocks in contact with the limestones, plaster, and associated beds of the carboniferous limestone division, there has been and probably is still a difference of opinion among geologists, but whether the rocks in question are members still lower in the carboniferous system, or whether they are of the highest series of the Devonian system is of small importance to the miner, so long as he is able to distinguish them apart by their physical characteristics alone. This is not difficult to do after studying some well defined locality; and an examination of the upper series will show the presence, besides plaster, which does not occur in quantity in the lower beds, of flaggy and well bedded sandstones and grits, suitable, if not for building purposes, at least for foundations; while the sandstones of the older series, it will be seen, cannot be dressed under the hammer, but breaking with a cross fracture, are unsuited for any but the roughest of walls.

Great disturbance and faulting have taken place in both groups, but the older has been shattered and brecciated to a very marked degree. When the argillaceous and clay beds in both are compared together, especially when hand specimens are taken, the difference is not so easily seen, but in mass the red shales of the older series have a slatey appearance, and most of them will be found to break into knife-edged fragments, a form which those of the newer or carboniferous limestone series are not found to take.

The value of the contact of the rocks of two geological systems as a sight of metalliferous deposits has long been recognized in several localities; and, without attempting to follow the history of this recognition it will be sufficient to mention the following instances:

Sir William Dawson, in his Acadian Geology, 1868, page 272, quotes Mr. Barnes and Professor How, of King's College, as reporting a deposit of fibrous brown hematite at Brookfield, at or near the junction of rocks probably of Devonian age, with ordinary lower carboniferous shales and limestones which would seem to be unconformable to them.

Mr. Donald Fraser, of Springville, who conducted explorations for iron along the East river of Pictou, dwelt on tha importance of the "juncture"; and Dr. Gilpin, writing in 1874 of the same locality, said: (*b*) "As far as investigations have been carried thelimonitehas been found

(*b*) N. S. Instit. Trans. Vol. 17, p. 141 Ibid, Honeyman, p. 461.

	Grammes.
No. 1—Weight of mercury..........	12·1917
" gold...........	·0116
Equal to....................	·0951%
No. 2—Weight of mercury..........	7·0710
" gold...........	·0068
Equal to....................	·0961%
No. 3—Weight of mercury..........	7·5883
" gold...........	·0073
Equal to....................	·0961%
No. 4—Weight of mercury..........	7·4340
" gold...........	·0071
Equal to....................	·0953%
No. 5—Weight of mercury..........	7·1165
" gold...........	·0069
Equal to....................	·0962%
No. 6—Weight of mercury..........	6·2140
" gold...........	·0059
Equal to....................	·0965%

From these results it is clear that mercury becomes saturated with about ·096% of gold at a temperature of 60° F.

The amalgam in the bulb tube was next dealt with; this was of a crystalline nature with mercury adhering to it. I took a quantity of this and ran it over clean silver-foil to get as much mercury as I could away. I took a weighted quantity of this and placed it in boiling nitric acid. When action ceased the mercuric nitrate was decanted off and the gold placed in a porcelain crucible and heated to a bright red heat for a considerable time; it was then weighed, the result being that the amalgam contained 19·964% of gold. The gold thus obtained was of a semi-crystalline nature, and viewed through a microscope is extremely beautiful. From their appearances I should judge that they are not crystals, but the skeletons of a crystalline amalgam from which the mercury has been dissolved. This amalgam appears to nearly agree with the compound $Au_2 Hg_4$, which contains 19·78% of gold.

Now, it appears to me that what really happens is, that first of all the mercury chemically combines with the gold and then this compound dissolves in the excess of the mercury.

The question which now arises is: Are the chemical properties which exist in mercury with regard to gold, sufficient to explain its power

On the Occurrence of Galena at Smithfield, N.S.

By John E. Hardman, S.B.

At intervals, during the last dozen years or more, public attention has been drawn to the attempts which have been made to imbue with economic importance the deposits of galena found at and near Smithfield, in the County of Colchester, N S. Numerous examinations and reports have been made by different men, but these reports, to the writer's knowledge, have never been published in full, only garbled or incomplete extracts having been given to the local and the mining press.

During the past summer the writer has had opportunities, as consulting engineer for the Dominion Smelting and Refining Co. Ltd., for a somewhat extended examination of these deposits, and, by the courtesy of the directors of that company, he is enabled to lay before you the following brief account of the deposit and its history.

Beginning about a mile or more west of the settlement known as Smithfield, and extending easterly as far as the settlement of Pembroke, both in Colchester county, there have been found along the line of junction of the lower carboniferous shales and limestones, numerous pebbles, boulders and occasional masses of both coarse and fine-grained galena, accompanied with pyrite, and occasionally with sphalerite or zinc blende. Many of the shales are gritty and are interstratified with sandstones, and much of the limestone is dolomitic, and impregnated with small cubes of pyrite. Little or no quartz is seen in place, and no structure resembling veins can be observed.

The large quantity of float galena, and its comparative purity, found at Smithfield, early drew attention to the locality, and a considerable amount of lead ore was seen in the first openings made. The dip of the rocks at this point varies from 60 degs. to 80 degs. to the southward, occasionally reaching 90 degs. or vertical ; the strike of the measures is not uniform, but the general trend is east and west. The limestones overlie the shales and sandstones, and are conformable. The country is remarkably free from faults or dislocations of the strata.

with the extensive use which wire ropes are being put to for river dredging and general contracting work carried on today, proves to us the number of purposes to which wire rope can be successfully applied.

In order to fully illustrate the greater uses to which wire ropes have been put, I wish particularly to refer to the stupendous and beautiful suspension bridge across the Niagara river, and that from New York to Brooklyn, as well as the prominent part played in the recent official test made at Tonawanda on October the 26th, before the 3,000 spectators, of the Lamb electric canal-towing cableway.

This canal-boat line has recently been thoroughly tested under the supervision of ex-Governor Flower, and its construction is built with brackets erected on posts or supports placed 135 feet apart, upon which bracket saddles are placed, having insulated material between them. The saddles are designed to prevent short circuiting of the electric current by rain. A bracket is also provided to support the lower or traction cable, which is not insulated, but at intervals along the line some of these brackets are grounded. A $1\frac{1}{4}$ inch steel cable is supported upon the upper side, and a $\frac{5}{8}$ inch steel traction cable upon the lower.

The bearing cable is placed at an elevation of 16 feet from the ground, and the traction cable 3 feet below.

The motor truck is made with two deep grooved wheels to run on the main cable, having a horizontal axle between them, and below their centre line. Upon the axles is suspended a hanging-frame, having attached to it an elliptically grooved sheave, which is revolved by means of a worm or wedge gearing, driven by a 15 Kilowatt electric motor, with vertical shaft, all attached to the swinging-frame of the car.

By taking three turns of the $\frac{5}{8}$ inch steel cable around the elliptical grooved sheave, when the electric motor revolves the gearing, the sheaves wind up and at the same time pays out on the $\frac{5}{8}$ inch cable—thus pulling the car along. The motor in this way gets its tractional friction independent of the weight of the apparatus.

The current is returned through the steel traction rope, which is grounded at intervals, giving a combined ground and metallic conductor for the return current. A 500 volt current is used and the motor is run at 1240 revolutions per minute. This current is taken from the main $1\frac{1}{4}$ inch cable, and thence through the wheels and axle to the axle box of the hanging motor trolley.

In the next experiment I took the same quantities of gold, and in fact in every way repeated the previous experiment, only using a one-half instead of a two-tenths per cent. solution of potassic cyanide.

The gold became completely dissolved in the flask in 74 hours, of which air was passed for 64 hours, while in the same time the piece of gold in the stoppered bottle lost .0252 grammes. It will be noticed here that the half per cent. solution appeared to be more active than the two-tenths per cent. solution without the air and less active with the air; this difference I account for by the fact that the gold became more broken up in the early stages of the process in the second case, and becoming distributed over the bottom of the flask the air was longer in reaching it. To prove this I started another experiment in which the tube delivering the air was bent round and drawn out to a point, a piece of gold was suspended close to this point by iron wire soaked in boiled oil to prevent corrosion and precipitation of the gold on the iron; thus a stream of air was allowed to pinge against the gold plate, while suspended in a two-tenths per cent. solution of potassic cyanide; the result was that the plate was completely pierced where the air pinged against it, and was grooved where the air went up the sides, thus clearly showing that the presence of air coming actually in contact with the plate of gold while suspended in potassic cyanide solution considerably increased its rate of solution.

The fourth experiment which I intend to bring to your notice was made with a plate of gold which had been previously coated with mercury. A two-tenths per cent. solution of potassic cyanide was used, and air passed through for twenty-four hours; the plate was then removed, washed and heated at a white-heat for several minutes, and weighed. It lost ·1888%, clearly showing that mercury protected gold from the action of potassic cyanide; and this, I assume, may account for the failure of the process in some concentrates which contain amalgamated gold.

I have also made experiments with concentrates, and find that air increases the rate of solution of the gold contained in them while in contact with cyanide of potassium. Difficulties have been met with which will have to be overcome before I can place any results before you. The air has a tendency to come up the sides of the vessel containing the cocentrates, on account of the reduced friction there, and also when it does find its way through the centre of the concentrates it zite left between the granite of the south side of the river and the overlying carboniferous conglomerate."

Professor How, in his Mineralogy of Nova Scotia, 1868, page 45, referring to the report of Mr. H. Poole to the Government in 1860, remarked: "Mr. Poole found a conglomerate, resting unconformably on slates near Avour's Head, Digby county, which contained gold and native copper."

These references are sufficient to show that the mineralized character of the base of the carboniferous system at several localities had been noted years ago; but these and similar records of isolated spots were not sufficient to warrant any general conclusion respecting the value of the contact beds of the lower carboniferous, nor to have them classed as the exclusive mineral zone of that system, nor indeed, so far as known, was any general deduction respecting it either published or suggested. Now, however, in the reports and in the unpublished works of the Geological Survey we have in addition, available for generalization, a mass of data from which a few extracts bearing on the subject in question may be taken.

On turning to the official reports referring to Cape Breton we find Mr. Fletcher remarks: (*i*)" Mention has already been made of a number of places showing traces of copper glance, oxydized to carbonate, impregnating a conglomerate, often at its contact with an overlying bed of limestone, as at Irish Cove, East Bay, Washaback, Middle and North Rivers. At Loran, two or three miles east of Louisburg, coarse red carboniferous conglomerate overlies the older rocks. The matrix of this conglomerate sometimes consists of hematites which also discolours the underlying felsites."

Everything (*j*) tends to prove that the iron ore (of Big Pond) is a deposit at the contact of the carboniferous and precambrian formations like those seen near McDougall's Point and elsewhere; and in mining these deposits this circumstance should be kept in mind and the ore followed along the line of contact. . . . Further explorations have been made in Cape Breton county and elsewhere by persons interested in the contact deposits of red hematite."

(*i*) G. S. C. Rep., 1876-77, p. 450.

(*j*) G. S. C. Rep., 1879-30, p. 122 F.

terest and depreciation, which a cent per cubic yard would probably cover.

The hoisting engine used is 8 x 12 inch, main cable for big span, 2 inch diameter, main cable for short right angle span, 1½ inch diameter; hoisting ropes, ¾ inch; traversing ropes, ⅝ inch, and button ropes, ½ inch diameter; all of our special cableway make and quality.

The tramway business being comparatively in its infancy in Canada, I am unable to say much on this subject, excepting that the Bleichart system of tramway is the one we are now advocating for this country, owing to its efficiency as regards the carrying of large loads, up to and sometimes over 1,000 pounds to each individual carriage, as well as being free from accidents due to the slipping of the cables from their supports, and also being able to reduce the number or buckets or carriers to accomplish the same output.

This improved ropeway uses separate stationary cables, on which run the carriages supporting the carriers or buckets, the motive power for which being transmitted through a light-moving endless cable called the traction rope, to which the cars are attached by patent grips.

A most important advantage which this system possesses is the comparative low cost of maintenance and operation. This is due not only to the substantial manner in which these lines are constructed, and the better distribution of the wear of the ropes, but also to the fact that the greater capacity of these lines does not require any extra labor at the stations, excepting in cases where the rails extend to distant points of loading or discharging.

In regard to the ordering of ropes for mining and all other purposes, I might say that it would be of the greatest assistance to all rope manufacturers if the parties ordering would only rely on the judgment of the manufacturer for the most suitable rope to accomplish a given purpose.

What I wish to convey to this meeting is that when certain work is to be accomplished by wire rope, if the consumer would place the full particulars before the manufacturer, giving what he expects the rope to fulfil, and the manner and travel of the same, as well as the diameters of drums and sheaves, and their respective angles, the manufacturer then being in possession of these facts, will be able to supply a rope which he knows from experience to be the most suitable for the purpose required.

Special attention is drawn to the fact that the Order-in-Council passed at Ottawa, Nov. 22nd, 1894, entitled, "*Re* drawbacks on imported goods used in Canadian manufactured articles, and exported," still remains in force, despite the protests and explanations of numerous Canadian manufacturers, who are debarred from doing business with the western Canadian agricultural implement makers on account of this order. The order in question, as is well known, was passed with a view of encouraging the exportation of agricultural implements to foreign markets, and provided for a rebate of duty on the material used in machines so exported. It was so framed, however, that the effect has been to compel the Canadian agricultural implement makers to purchase foreign material before they can avail themselves of the drawback. The result has been considerable loss of trade to the manufacturers of Canadian pig iron. To be consistent with their policy of encouraging the native industry, the Federal Government must so frame the order in question as to leave the agricultural implement maker free, if he so chooses, to use Canadian material. So much for the present Government's consistency.

On the other hand, the leaders of the Liberal party evidently do not appreciate the iron trade as they should, and do not understand it in a broad sense. They have shown this by the repeated attacks that the leaders, notably the Hon. Wilfrid Laurier, have made upon the pig iron industry of Canada. In several of his speeches Mr. Laurier has stated that the Canadian iron furnacemen enjoy a protection, aside from the bounty, (which all admit was granted for the special purpose of defraying the work of development in mines, forests, and at the furnace) equivalent to an ad valorem duty of from 40 to 60 per cent. To prove his argument he takes the selling price of Southern American coke iron (the very lowest and poorest quality made in the United States) at $6 per ton at the furnace, and to this he adds a freight of $4 per ton, so as to arrive at what he terms the "tax" on the Toronto buyer. This is wholly incorrect inasmuch as the lowest price at which Southern iron can be bought today is say $10.25 per gross ton, and the freight to Toronto from Tennessee or Alabama is $4.60, making the cost in bond at Toronto, $14.85, upon which a specific duty of $4 per net ton would be equivalent to an ad valorem duty of less than 30 per cent.; but Mr. Laurier entirely overlooks the fact that there is iron and iron, and that to arrive at a fair average of the duty he will have to take into account

A Novelty in Mine Ventilation.

By Mr. Alexander Dick, Halifax.

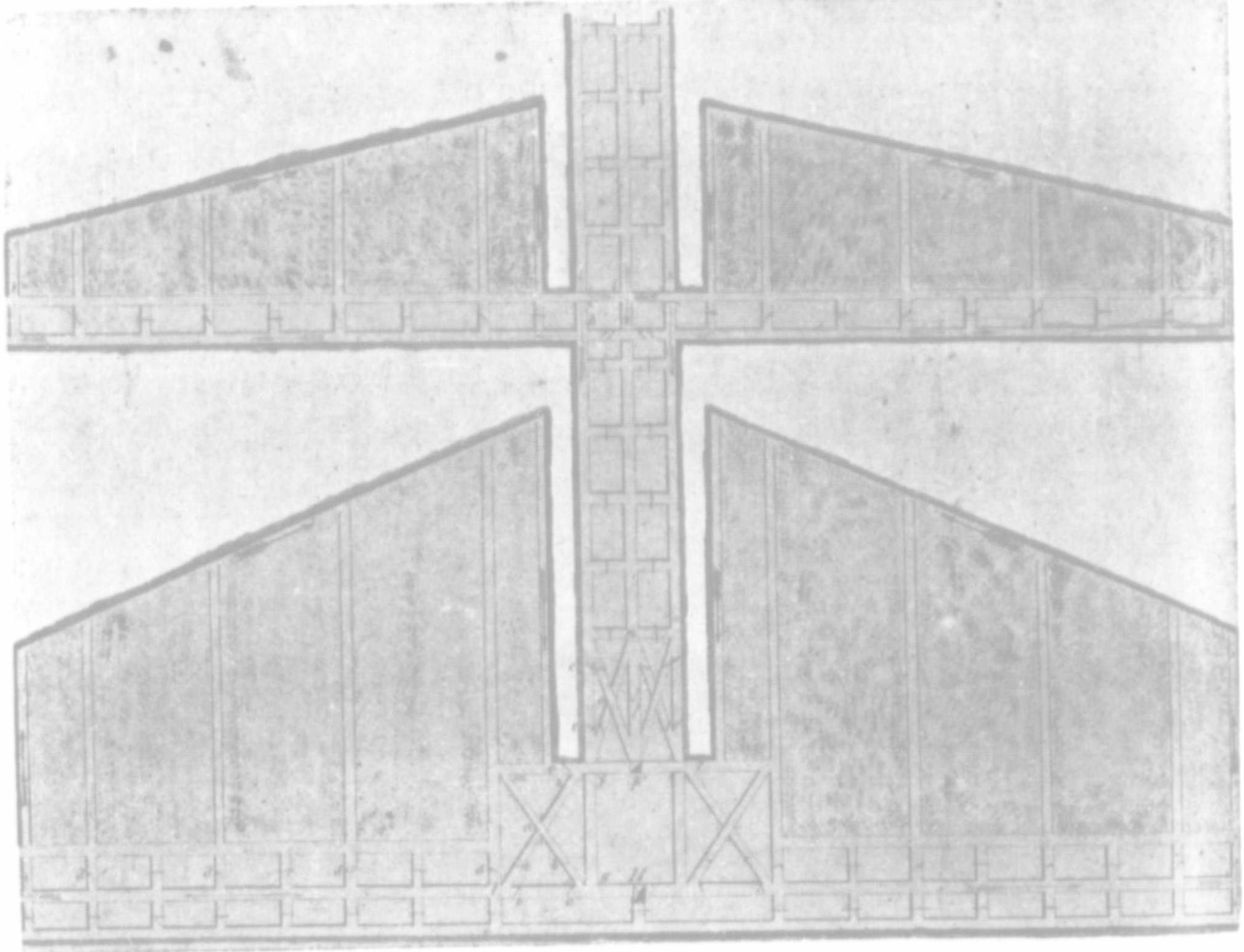
It is almost impossible to say anything on the theory of the ventilation of coal mines which could consistently be called a novelty, as writers by the dozen have so thrashed out the subject, since the days of Atkinson, that one is almost inclined to endorse the old saying that "there is nothing new under the sun."

The particular point which I wish to make at present has, however, nothing to do with *theory*, but is a description of a new departure in the practical ventilation of a coal mine, which I hope may be of interest to all mining men who have fans at work at their colliery.

We, Nova Scotians, know that in winter considerable trouble is caused by the hoisting shaft—which is commonly the downcast—becoming sludged up with ice. And all the world this ice difficulty has been one of the greatest inducements to mining men to prefer a blowing to an exhaust fan.

There are many arguments, pro and con, which have from time to time been presented in the technical press, and before learned societies, as to which type of fan was preferable, and I do not intend to trouble you with a recital of them. It is sufficient for the purpose of my paper to say that I think the choice of fan—either blowing or exhaust—depends greatly on the climatic conditions of the mine. If an exhaust fan is adopted, the hoisting shaft is used for a downcast, and the fresh air on entering the mine travels first along the main haulage roads where naked lights are used, if anywhere, and the fouled air passes through some return airway where travel is *nil*, and danger of explosion is minimized. If, however, the mine is situated in a locality where frosts are frequent and severe, the cold, frost-laden air in going down the hoisting shaft often impedes work and commonly stops operations altogether. The remedy for this has been hitherto to reverse the air, and instead of sucking it down the hoisting shaft, to blow it down the fan shaft and up the hoisting shaft. By so doing the warm air in going up the hoisting shaft has kept it free of ice, and thus advantaged the working of the colliery.

Fig. I.



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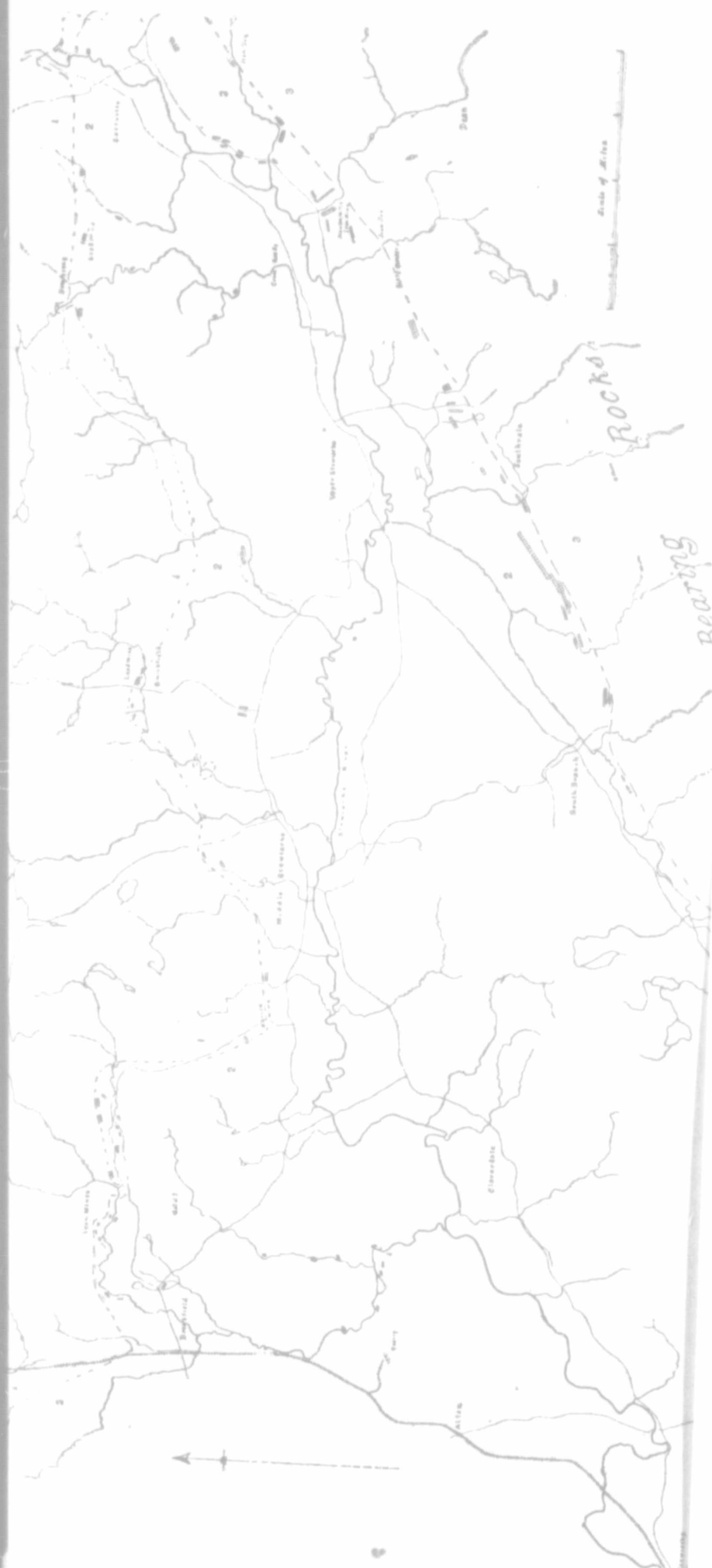
Bearing
Rocks
Scale of Miles

"In the trial bore the calyx drill demonstrated its capabilities in a decisive manner. The drill as a whole was certainly not much to look at, but its performances were somewhat astonishing. It cut a 5½ in. bore to 700 ft. deep, and produced a perfect core by manual labor and horse gear at less than half the cost of average diamond drill work in similar strata." The superintendent adds that he considers it "possible to evolve from the primary principle of this system the most economical and generally useful boring machine that could be devised" No account is given of the construction of the calyx drill, and no opinion can therefore be formed as to the likelihood of its usefulness in piercing the dense strata of, say, the Huronian system of Ontario. Its use in Victoria seems to have been so far confined to the softer rocks of the coal measures.

In his report for 1894, the Secretary of Mines for Victoria remarks upon a change of principle which was introduced during the year as regards the employment of Government diamond drills. On several grounds, among which that of economy was prominent, it was decided that future borings, whether for gold or coal, should, unless in cases of purely national character recommended by the departmental officers, be done only when the persons requiring it paid one-half the expense. "This change," the Secretary states, "has been productive of much good. The work done by the drills has been restricted to cases where some tangible result might be foreseen, and cases have almost ceased where applications for diamond drill service were made and pressed, apparently in view of the local expenditure of the drill expenses."

It will be observed that the system in use in Ontario, so far as the sharing of the expense between the Government and the party obtaining the services of the drill is concerned, is practically the same as that now in vogue in Victoria after trial of a plan by which the work was done entirely at the cost of the public chest. Under the liberal terms upon which the use of the drill is offered to miners and owners of mineral properties, it would seem that there is plenty of room for its employment in the Province. Should there be an improvement in the nickel mining industry, either by the springing up of an increased demand for the metal or the introduction of new methods in the treatment of the ore, such as the substitution of pyritic roasting and reduction for the expensive roast-heap and coke smelting processes, there would be a large field

It may be explained that the operations of this company, involving the working of bog and lake iron ores, and the making of wood for charcoal, extend over a considerable territory. The labor is largely drawn from the farming class, and is therefore naturally of a more or less intermittent nature, which accounts somewhat for the large number of men employed.

A portion of the output of the furnace is used for the manufacture of the highest class of railway car wheels, at the company's auxiliary works at Lachine, Que., where a further staff of about 150 men are employed, and in addition it may be said that all the railway companies in Canada are now using the Canada Iron Furnace Co's metal as the basis of mixtures for standard car wheels. It will be gratifying to Canadians to know that the high quality of this special metal, as demonstrated by its great strength and splendid chilling qualities, has so far attracted the attention of foreign engineers that the company has been enabled to open up a foreign trade during the past year, and it is now shipping iron regularly into the Pittsburgh market, where the metal is used for very special qualities of work. In addition to this, important shipments have recently been made from Radnor Forges to the European market. While this trade is not a large one as yet, it proves that the quality of the iron made in Canada is unsurpassed, and is another reason why we should carefully build up our national industry.

DRUMMONDVILLE.

The campaign was short, but the output will be about the same as 1894. The whole of the production of this furnace is used in the manufacture of car wheels at the company's works in Montreal. The campaign is always more or less regulated by the requirements of the car wheel department.

PICTOU CHARCOAL IRON CO., BRIDGEVILLE, N.S.

The returns of output have not yet been filed, but a very notable point in connection with the operations of this company is that it is just on the point of installing a steel converting plant, and will use the largest portion of the output in that way, finishing it into the highest quality of agricultural implement steel for the home market. This is a striking illustration of the effect of the Dominion Act of 1894, which provided has been described as hornblende schist. The ore itself is a coarse magnetite, and in places is well crystallized and shows a well-defined parting. Mixed with the ore there is considerable hornblende in large pieces. The mine was opened in 1873, and about 12,000 tons of good ore were raised and taken to the United States. Operations were then suspended, but were afterwards resumed by another company, and carried on upon an extensive scale for four or five years. It is estimated that about 75,000 tons of ore in all were taken out of the mine. At a depth of about 180 feet considerable sulphur was encountered in the ore, and work was discontinued. Some drilling was done, 300 or 400 feet in all, and it is said that good ore was again obtained The object of the work undertaken by means of the Government drill was to test the correctness of this statement, and to ascertain whether the quality of the ore in the lower portions of the deposit was good enough to warrant the re-opening of the mine.

Work was begun with the drill on 10th November, 1894, at a point about 75 feet south of the old workings, the hole looking to the west and being pitched at an angle of 80 degrees. Crystalline limestone, hornblende, granite and quartz were successively pierced to a depth of 182 feet 6 inches, when the large drift from the old shaft was struck and the hole abandoned. For the second prospect, the drill was removed to a distance of 100 feet west of the shaft, and the hole was bored at an angle of 75 degrees pointing to the southeast. The depth reached was 702 feet, but as the angle of dip of the vein nearly coincided with that of the boring and was in the same direction, the ore body was not struck. The drill was then placed 213 feet south of the main shaft and 100 feet east of the ore formation, the hole being drilled at an angle of 70 degrees pointing to the north. At a distance of 197 feet from the surface the ore formation was struck and drilled through for 83 feet. The fourth hole was put down on the same site, the angle being changed to 78 degrees, but in the same direction as the last At a depth of 270 feet the ore formation was struck and drilled through for a distance of 175 feet. For No. 5 prospect, the drill was kept in the same place, but turned about 10 degrees more to the northwest. The hole was bored at the same angle and in the same direction as the last, and the ore body was again encountered at a depth of 295 feet. It was cut clean across, and the hole finished at a depth of 450 feet. The drill was now

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Exploring with the Govt. Diamond Drill.

By Thos. W. Gibson, Bureau of Mines, Toronto.

One of the most important aids to mining yet invented is the diamond drill, which has been widely adopted since its invention by Leschot, and is now in almost universal use. Its value consists in the opportunity which it gives the miner at a minimum of expense of actually seeing and handling a section of the material whose character it is all-important for him to ascertain, yet which is concealed from his gaze by a covering usually of rock, scores, perhaps hundreds of feet in thickness. This the diamond drill enables him to do without sinking shafts or excavating drifts and tunnels, which, after all, might turn out to be so much time and money wasted. It is equally of service in testing new ground and in exploring for bodies of ore in working mines. By its means the prospector may satisfy himself at a comparatively small cost whether the property he is investigating contains ore sufficient in quality and quantity to warrant regular mining operations. If he finds that it does, he knows beyond peradventure where to sink his shafts and how to lay out the work to be done; if it does not, he is saved further trouble and loss. The mining manager is enabled on the one hand to locate masses of ore in advance of actual drifting, and on the other to prove what parts of his territory are dead ground from which no returns can be hoped, and so to conduct his operations in either case intelligently and economically. In almost every large mine diamond drills for exploratory work are part of the regular plant and are constantly in operation. There can be no guess work as to the strata penetrated by the drill; the cores brought to the surface speak for themselves, and, what is no small advantage, supply samples large enough for detailed examination and analysis. The only point open to question is whether the cores themselves are thoroughly representative of the strata or deposits from which they are taken. As to this, in the matter of gold ore, for instance, there is sometimes room for doubt. The drill may pierce a rich pocket in a gold vein and so bring up a core showing a value quite out of proportion to the average contents of the vein, or it may run

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The practice in operating a drill is to keep a sufficient supply of diamonds on hand for at least two bits, so that one may be set while the other is in use Usually eight stones are set in the bit. Some are placed directly on the face of the bit, some are made to project a fractional part of an inch on the outside of it, and some to project similarly on the inside, the object being to cut an annular ring out of the rock a little greater in width than the bit itself, thus allowing the latter and the rods to which it is attached free play. If for any reason it is desired to enlarge the diameter of the hole after it is put down a "reaming" bit is employed, in which the diamonds are set wholly on the outside. The wear on the diamonds varies greatly according to the hardness and compactness of the rock which is being drilled. In comparatively soft rocks, such as limestone, slate or shale, the loss is insignificant, while in such material as quartz, diorite or granite, the wear is very much greater. In the same way, the rate of boring varies widely. Where the rock is solid and not too hard, a hole may be put down 30 or 40 feet in a day of ten hours, but where greater resistance is met and drilling operations are interfered with by seams and fissures, perhaps the utmost diligence on the part of the drill runner will not suffice to gain more than 3 or 4 feet in the same time.

Numerous difficulties are likely to present themselves to the operator of a diamond drill plant, and as his work is so largely hidden from view, only native ingenuity and skill born of experience can enable him to overcome them. The following extract from an excellent article in a recent number of *The Engineering Magazine* of New York deals with this practical aspect of diamond drill work :

"The mishaps that may occur in drilling are many. The most common is the parting of the rods while in a hole. This may come from a fracture of the rods, the stripping of a thread, or the unscrewing of a coupling. The last is more liable to occur when pulling the rods than at any other time, and may result in smashing a set of stones. If rods are simply uncoupled, they can usually be caught by gently lowering and entering the top piece, and turning it to the right. In cases of fractures various sizes of inside and outside recovery taps are provided. The writer once spent two days in recovering a bit in a flat hole where at the point of contact of lower carboniferous with upper silurian strata. Sir William Dawson referring to the same ground, wrote: (*c*) "At the line of junction of the carboniferous and older rocks on the east side of the East river of Pictou occurs the great limonite vein of the district, forming a vein of contact of exceeding richness and value. It follows the sinuosities of the margin of the older rocks, and varies in thickness and quality in different places." In the following year Dr. Gilpin notes the importance of the limonite at the contact and writes: (*d*) "From Springville for several miles up the East river the line of contact of the marine limestone and silurian follows closely the course of the river. At several points the ore has been proved to rest on the silurian clay slates and has limestone on the hanging wall, and in places holds notable quantities of manganese."

The writer (*e*) in his report for 1874 in referring to the galena deposit at Gay's river, said the limestone beds in which the ore is disseminated "lie horizontal on the irregular surface of the unconformable silurian (cambrian) rocks, and judging by the fossils found in the extension of the beds farther west, are lower carboniferous, and contemporaneous deposits with the auriferous conglomerate worked five miles away to the eastward."

The auriferous conglomerate here referred to was spoken of in his previous report as a contact deposit in a district that was described in 1866 by Dr. Honeyman. (*f*)

At Smithfield, in Guysborough county, explorations 1875-77 on a vein of galena, led the writer to remark (*g*) that hopes were entertained an improvement would be found "at the intersection of the vein with the change of formation, which is presumed to be near at hand." This locality is fully described by Mr. Faribault in his report for 1886. He goes on to say; (*h*) "Galena was found in large quantity at Smithfield on the south bank of the West river of St. Mary's, two miles west of Glenelg, where it occurs in small veins cutting the narrow belt of quart-

(*c*) American Assoc. 1879.
(*d*) Mines and Mineral Lands of N. S., 1880, p. 65.
(*e*) Report of the Department of Mines, 1874, p. 55; for 1873, p. 35; for 1875, p. 64.
(*f*) N. S. Instit. Trans. Vol. II, p. 76.
(*g*) Report Department of Mines, 1877, p. 47.
(*h*) Geol. Sur. C. Rep. 1886, p. 162 P.

of the bank, when he slacks off the hoisting rope so as to lower the bucket to the desired place on the ground, and is left there until the carriage has been run further out to a sufficient distance to cause the hoisting rope to the bucket to make an angle of about 45 degrees. A man at the bucket sets certain connecting levers, seizes the handles, and the engineer is then signalled to and winds up on the hoisting rope, so that the scoop-bucket is dragged up the slope of the bank, filling itself readily in ordinary sand. The bucket is then hoisted to a convenient height, when both hoisting and traversing ropes are operated so as to take the carriage to any required position. The engineer then, by reversing his drums, returns the bucket to the bank to be again filled. As the bucket is being drawn in toward the engine, it is slowed down just before it reaches a stop, which serves to throw an auxiliary bar on the bucket, thereby unlatching it and permitting it to revolve and dump into the screens, the coarse material running into one car, and the fine into another.

The bucketman has merely to guide the bucket, possibly lifting it so as to direct the teeth on the edge of the bucket into the sand, but the effort is only for a moment, and he has nothing to do until the bucket has returned again, therefore giving him practically only a quarter of a minute's work out of each minute, as one trip is made about every minute.

A visit to the pit showed that there was one bucketman, one extra man with pick breaking down the sand, and one man standing on the bank, who acted as foreman and signalman, and besides these there was the fireman and engineer, and this constituted the labor force for one plant.

The plant was handling, at time seen in full operation, 400 yards per day, making a trip a minute, although the average time was a little longer than that.

The men's wages are about as follows:— Engineer, \$2.50; fireman, \$1.50; bucketman, \$1.75; a man for breaking down, \$1.50; foreman, \$2.50. The services of the fireman could probably be dispensed with, as one man could ordinarily run the engine alone.

The cableway therefore pays a handsome profit in carrying out this work for about three cents per cubic yard, not taking into account in-should be encouraged and developed, because it will afford a greater amount of employment to labor for the money invested than any other industry that the country is fitted to sustain.

The progress made should also now be sufficient to prove to capitalists and men of affairs generally, that the enterprise of iron making in Canada can be made a very decided success, affording a splendid field for safe investment. It is no longer in an experimental stage, and if many of the investors who are now putting their money into the silver mines of the west, not only of their own country, but of the adjoining republic, would turn their attention to the production of the most useful of all metals, iron, right here at home, and for the home market, building up every kindred provincial interest, the future of this Province and of Canada would be most promising. What is wanted now is sufficient capital invested in the various enterprises to enable the iron-masters to keep abreast of the times in the matter of modern appliances and methods. Nature provides all the material, it remains for men to utilize them by the best and most economical methods.

The industry has naturally suffered from uncertainty with regard to the tariff question. Barred out, as Canadian iron manufacturers are, from the American market, by the customs tariff of that country, and handicapped as all iron industries are in infancy, when a very heavy initial expenditure has to be made in construction of plant, prospecting, securing and developing of mines, woodlands, quarries, shipping docks, etc., it is imperative that the Government of the country should give stability to the protective tariff, and thus give confidence to capitalists. Statistics prove that the present protection and bounty granted by the Government of Canada, if well maintained, will result in the development of the Canadian iron industry, but the history of the work done in the United States, as well as the past history of England proves that the encouragement granted is not by any means too much for the earlier years of the work. This has been well recognized by Sir Oliver Mowat, who, as the head of the Liberal Government in Ontario, recently carried through an Act by which his Government grants a special Provincial bonus of $1.00 per ton for all pig iron made in that Province, the product of Ontario ores.

Speaking of the treatment extended to the iron industry by both political parties in this country, neither are quite free from criticism.

It will be seen from what I have stated that the steel wire ropes act to conduct the necessary current for the operation of this towage, in addition to acting in connection with the hauling of the barges, scows, etc., etc.

Justice cannot be given to this important invention, wherein wire rope is so largely used, in so few remarks; but I hope that what I have expressed will give you a fair impression of the installation which has been adopted for the Erie Canal.

Cableway Plants—As an illustration of this I beg to give you a few particulars regarding two independent plants running at right angles to one another, and built under the direction of the Dominion Wire Rope Company, for Edwin Terrill, at Niagara Falls. At this recent illustration at Niagara Falls an excavating and conveying cableway was installed for handling sand, the digging, lifting, carrying and loading being accomplished by an overhead cableway system, operated by a single engine and boiler and a few attendants, in a simple and direct manner. Both these cableways have the Lidgerwood style of cable carriage, fall-block and engine, and employ the patent fall-rope carriers, but the whole plant was built in Canada.

A novel feature of this installation lies in the fact that we were able to make use of the Lock-Miller horizontal cableway, with an automatic scoop-bucket, with a carrying capacity of 1 cubic yard. The essential feature of this plant consists of a main cable, 2 inches diameter, suspended from two specially constructed triangular pyramid towers, and anchored beyond them to suitable and substantial anchorage sunk 8 ft. in depth. On this cable is suspended a carriage which forms a link in the endless or traversing rope, by which the carriage is hauled in either direction along the main cable, according to the direction in which the traversing drum is driven.

Through fixed sheaves in the trolley, and movable block below it, a hoisting rope is reeved so that, being led to the hoisting drum, it can raise or lower the automatic scraper scoop suspended from the trolley.

This hoisting rope is supported by carrier frames, which are distributed at intervals on a special cable known as the button-rope, above the main cable.

The machine is operated entirely by the engine-man, who runs out the trolley or carriage until it reaches a position vertically over the toe all comes up in one channel, and thus the air never reaches part of the concentrates; this, of course, prevents results from being concordant. These difficulties I hope to overcome before I bring the matter to your notice again.

The experiments have not been as yet sufficiently elaborated to draw any very definite conclusion as to the rates of solution, but they clearly show us three things of importance:

1st. That air, passing through solutions of potassic cyanide, considerably increases the rate of solubility for gold.

2nd. That air, coming into direct contact with the gold, increases its rate of solubility in potassic cyanide solutions.

3rd. That amalgam on the surface of gold protects it to an enormous extent from the solvent action of potassic cyanide.

I am now going to tell you some experiments I have made with another solvent for gold with which you will probably be more familiar, namely, mercury. That gold combines chemically with mercury we all know; the composition of the amalgam appears to vary considerably. Roscoe states that a crystalline amalgam, containing two molecules of gold to from 3 to 16 molecules of mercury may be obtained. That such amalgam must be difficult to analyze will be at once obvious, owing to the tenacity with which mercury adheres to the amalgam.

I was anxious to see what proportion of gold remained in solution in the mercury and whether the proportion was constant, so I made the following experiment:—97½ grammes of pure mercury and 2½ grammes of pure gold were placed in a bulb tube, a horn was drawn out from the glass tube just above the bulb, and the tube was kept at a temperature of from 90° to 100° C. for a week; it was then allowed to cool gradually in the oil bath, and then to stand for 24 hours. At the end of that time the point of the horn was broken off and the mercury was tapped into another bulb tube from which six horns had been drawn out at approximately equal distances from each other; in this tube the mercury was allowed to stand for 24 hours. By beginning with the top one, and breaking off the points of these horns, the mercury was withdrawn a section at a time. These quantities of mercury were dissolved in nitric acid and the gold weighed. I should say that the mercury was drawn off at a temperature of 60° F. They gave the following results:—

of collecting gold in our stamp-batteries? I think not. I think we must look at its physical properties too. As most of you know, on the surface of all liquids there exists a kind of elastic skin; if a drop of liquid be placed on a support it does not "wet," and if there are also placed on the same support, small particles of substances, some of which it will "wet" and some of which it will not wet, it will select those which it has the power of wetting and enclose them within its elastic skin, while it will leave untouched those particles which it has not the power of wetting. If the drop of liquid be now moved it will carry off those substances which it has wetted (provided they are not too heavy to break the skin) and leave behind those which it did not wet. Now this, I think, is what really happens with mercury and assists it to an enormous extent in its power of collecting gold.

In 1883-1884 an attempt was made to work the ore at Smithfield by Messrs. Brown and Edwards, the latter being a metallurgical student from Swansea, with much experience there

A small brick shaft furnace was built, having two 5-in. tuyeres, and the blast was furnished by a Sturtevant blower I regret that the furnace is in such a dilapidated condition as to preclude any measurements being taken of its interior dimensions, nor is there any dump of slag in the vicinity from which to judge of the quality of the work done. But it is known that the attempt to smelt was unsuccessful, and the remains of one or two roasting piles (for heap-roasting was all the preparation the ore received) show that the ore entered the furnace practically in the raw state.

No records are available from which to obtain the amount of ore raised during this period of activity, and the mine openings unfortunately give no clue to the percentage of galena in the rock extracted.

After the failure of this attempt the property lay quiet for several years, being examined in the interim by Capt John Nichols, well known to the gold-mining members of this Society by the fiasco at Mt. Uniacke, and at "Jumbo," near Westfield. It was also examined by another English mining captain named Evans, whose report was most favorable, and who saw no difficulty in raising 50 tons of ore a day.

In 1894, the Dominion Smelting and Refining Co. took over the property on the strength of these reports, and decided to ascertain the commercial value of the deposit.

Prior to 1894 all the development done had been confined to about 150 feet in length of the strata lying immediately to the eastward of the highway at Smithfield. Three shafts had been sunk to depths ranging from 30 to 60 feet, from two of which came the ore which the furnace was erected to smelt. From reliable information received from Mr. Edwards, and from men living at Smithfield, it appears that both of these shafts passed through the ore body (?) and entered barren ground.

The Dominion S. & R. Co. sunk two shafts, one to the eastward, the other to the westward of all previous work, during the winter of 1894-95. The east shaft (No. 1) reached a depth of about 47 feet; at 45 feet levels were run both on the strike of the measures and cross-cutting the same, but failed to find any ore, though a considerable

SUMMARY.

Machine.	Sq. ft. Cut.	Full days.	Sq. ft. per day	Hrs. work'd	Sq. ft. per hour.
Ingersoll..........	6038	11	549	97	62.24
Yoch.	5929	11	539	99	59.88
Harrison..........	4940	11	440	99	49.89
Total.........	16907	33	1528	295	172.01
Average	5635	11	509	98	57.30

COAL CUT.

Machine.	Total Tons.	Tons per day.
Ingersoll....	1627	147
Yoch..	1557	141
Harrison..	1276	115
Total.....	4460	403
Average..	....	134

(At the request of Mr. Blakemore, Statement No. 3 is withheld—EDITOR.

DISCUSSION.

MR. FERGIE—The paper is a most interesting and instructive one. I would like to ask Mr. Blakemore what he would allow for cost of plant, interest on machinery, wear and tear, etc.

MR. BLAKEMORE—I will be happy to reply to all questions, and will note each one as it is asked and answer them later on.

MR. BROWN—What is the width of the rooms you are driving?

MR. BLAKEMORE—Twenty feet. The actual cost of the powder was $1.60, five tons of coal to every pound of powder.

MR BROWN—At Sydney we produce 6 and 7 tons to a pound of powder.

MR. BLAKEMORE—I would not regard the consumption of powder on that occasion as a criterion. The cost of shot firing was excessive.

MR. DICK—Was the coal screened? How about the size?

MR. BLAKEMORE—I will give you that later.

A Mineralized Zone in Nova Scotia.

By Henry S. Poole, M.A., A.R.S.M., M.E.

In connection with the workable deposits of limonite, pyrolusite, galena, and barytes, in lower carboniferous rocks of Nova Scotia, it was only recently (*a*) that the writer realized that an important fact of economic value, hitherto but partially understood, has been made evident by the researches of officers of the Geological Survey—Messrs. Hugh Fletcher and E. R. Faribault.

Before proceeding further it may be well to premise that this paper is to be taken as purely local in character, that its generalizations are confined to Nova Scotia alone; at the same time it will be apparent that the conclusions stated are based on an experience very similar to that acquired in other parts of the world, but which it has not been possible to here apply, until a detailed topographical and geological survey map had been prepared.

Hitherto a discovery in a new locality of either one or other of the minerals in question has been followed by prospecting, more or less efficient. The skill brought to bear in the search has been practical, though often without system, until experience has supplied a local knowlege for the broad fact which now seems to be established, the limitation of such mineral deposition to a particular zone in rocks of this horizon, has not as yet become generally known. Nor would proof of the statement be so confidently expressed now but for the negative results that have attended explorations outside the zone that is limited by the immediate neighborhood of the contact of the carboniferous limestone series with rocks of older groups or formations.

The fact presented may be said to centre in the mapping of certain localities by Mr. Fletcher, and the distinct division of groups of rocks hitherto generally shown together as lower carboniferous; the distinction he has drawn would appear to be clearly justified by this fact which it itself makes evident and of practical value.

(*a*) December 1894.

of limonite, at Newton Mills it is as hematite. The gold lies on the lower cambrian in the basal bed of the carboniferous in washings of that age. The Gay's river gold mine has been regarded as workings in an ancient river-bed, but when it is considered that the auriferous conglomerate is apparently a deposit contemporary with the plaster and limestone resting also uncomformably on the cambrian, and they are unquestioned deep sea deposits, it seems more probable that the Gay's river auriferous conglomerate had a littoral origin similar to that of to-day at the ovens near Lunenburg. It may also be surmised that the section of country about Gay's river has been less elevated than about Newton Mills. In the portion of the contact between Pembroke and Smithfield the mineral deposits are in the form of sulphides of iron, lead, copper and zinc, a form which they also take on the south side of the valley five miles beyond the gold mine in Gay's river. Galena has been found on the surface and in prospect holds at other localities. (*t*)

Judge Morse speaks of lead ore having been sent about one hundred years ago from Cumberland County to Paris, and from it sufficient silver was extracted to make cups now in his possession. The source of this ore is not now known, but he thinks it may have been got near the head waters of Doherty's creek towards Wallace, where their is certainly lower carboniferous, but if it came from a deposit in contact with older rocks one would have to look towards Westchester.

In the county of Pictou the sulphides of iron, lead, and copper are found infiltrating the tissues of plants scattered in permian strata, and in spots sufficient to induce prospecting from time to time, although the deposits are hopelessly valuless.

In the coal measures between the seams, and even in veins cutting the coal, the sulphides of iron, lead and zinc occur in minute quantities.

There is yet another feature in connection with this mineral zone to be noted, and that is, the aggregation of some minerals about certain centres along the zone. In Hants county the contact carries both the oxides of manganese and iron, the former in greater abundance and in parts of exceptional purity, while in Pictou county where both are also present, iron predominates, and although manganeseis generally diffused

(*t*) Acad. Geol., p. 275; Reports Dept. of Mines; 1873, p. 35; 1874, p. 55; 1875, p. 63.

Supposing a mineral vein runs across a depression, cropping to the surface on the higher ground, each side, but lost in the low ground, being covered with drift.

Let *a b* represent the higher ground and *c d* the lower, thus :—

Thus in an altitude of 75 feet, the deviation from a straight line, would be 75 feet.

In like manner if any party prospecting or searching for the extension of a quartz lead was in possession of :—

I. A table giving the horizontal unit measurement for each degree and fraction of a degree of dip.

II. A clinometer to take the dip and,—

III. A barometer to take the altitude.

Much assistance might be rendered in finding the local deviation of a dipping lead over rough ground, from a straight surface line.

In a topographical map, the configuration of the ground is reduced to an image, which represents to the eye a large area at one glance, which in nature could not be viewed but by many separate inspections ; therefore, the judgment about the relation of the different parts of the work, will be a clearer and more intelligent one, and this refers more especially to mining work where frequently the problem occurs to strike a vein in a certain level.

it is only in spots concentrated enough for seperation. In the Stewiacke valley the iron ore there is beleived to be free of manganese.

In these notes it is not desired to convey an idea that mineral matter is absolutely confined to the contact or that the contact is uniformly mineralized. Thin veins of ore do traverse the older series of rocks near the contact, but they have not been found to lead to deposits of value in them. In a search for ore along a contact the uncertainty of finding any may be largely reduced by confining operations to such portions of the contact as are touched by limestones of the carboniferous. Along the East river of Pictou it has been observed that where there are natural pits in the soil near the contact there is almost a sure promise of valuable deposits of limonite, the natural depressions being indicative of limestone beneath. A similar experience, it is understood, has been acquired at Tenny Cape in the manganese mines; and the same may be expected in the galena district of the Stewiacke valley, although explorations have been as yet too limited to speak positively.

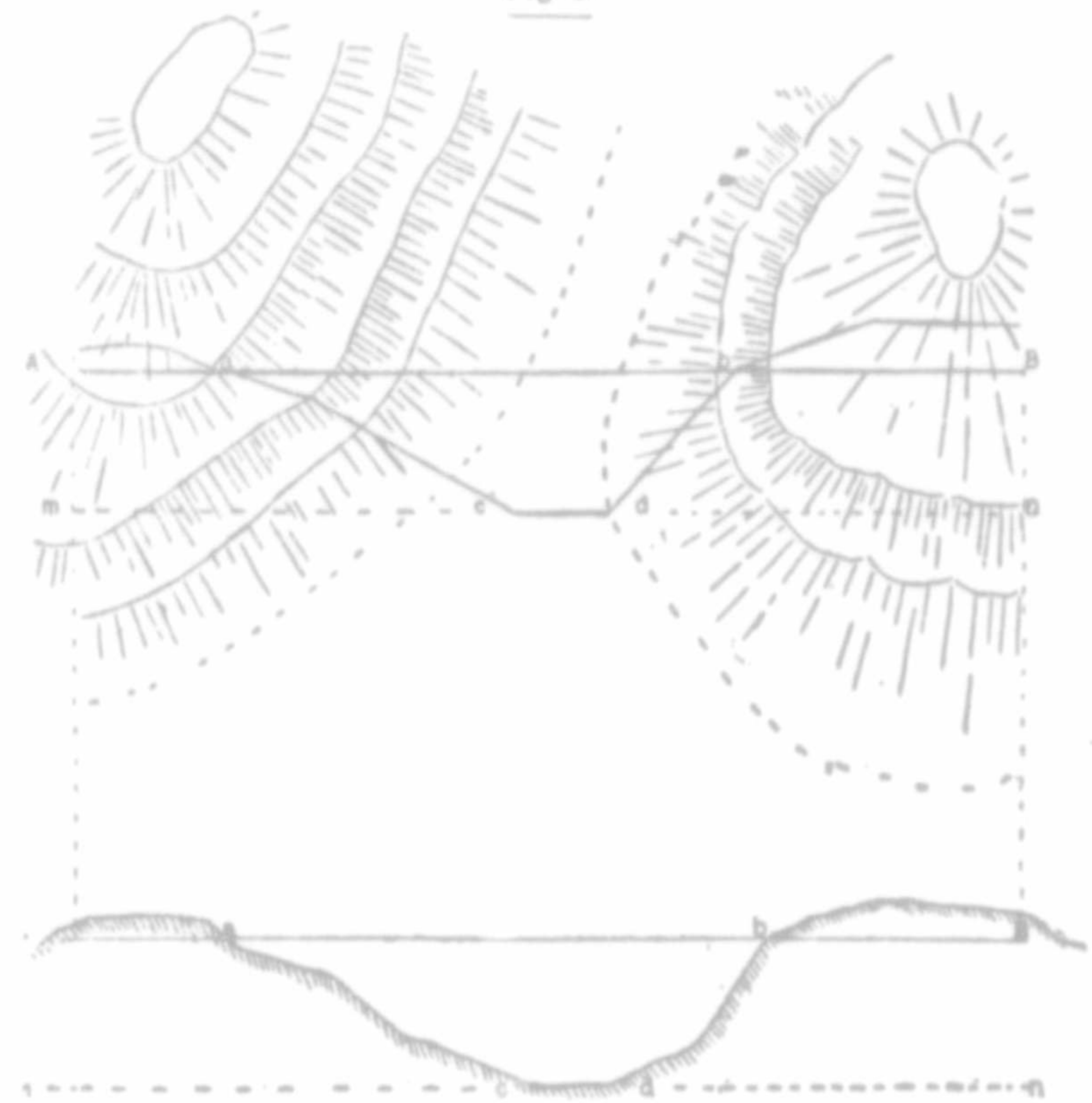
To the prospector this information should be of very great importance, for next to knowing where to go it is well to know where not to go in search of metallic minerals. But in the use of the geological maps some caution should be exercised; it should be remembered that these maps are not complete, that the facilities placed at the service of the Survey have not enabled the officers to trace with unerring exactitude the actual line of contact at all points, and this incompleteness is indicated by broken or open dotted lines on the maps. And further the prospector should not entirely ignore the finding of "float" ore away from the line until he has satisfied himself that it does not come from an outlier of the carboniferous limestone, similar to those at the Parker and Whale Creek manganese mines; or perhaps the converse condition, from a limestone resting on a boss of the older rock protruding through the newer series well within the line of contact.

To repeat the conclusion reached, it may be said that while ores of value occur both in beds and in veins through older formations, in the lower carboniferous it may be accepted as proved that deposits worth working are only to be found in the basal beds and at the contact with older rocks, with a strong probability that they are exclusively confined to the basal limestone.

If the veins or beds dip at any angle of inclination from the surface, the true bearing of the veins can only be correctly taken on the level planes, or if taken on ascending or descending ground, they must be reduced to a level plane to obtain the true bearing

Fig. 2 shows the deviation from a straight line, a dip of 45° from the vertical would assume along the surface in crossing such a ravine as represented by the profile, 45° being half a right angle, the dip would be one foot horizontal to one foot vertical.

Fig 2.



From the stake *a* one could carry the barometer in their hand and by moving over the sinuosities of the surface in a path having the same reading, could follow closely a contour line passing between the stakes *b* and *g*, *c* and *h*, *i* and *n*, to *j*, where the line should check on *j*, it being the same elevation 260.30 feet above the sea level as the stake *a*, from which the line started. Again by commencing at *b*, one could follow in like manner passing between the stakes *g* and *l*, and touching *m*, where a check could also be effected, and so on. These contours could be plotted on the map by measuring the distance on the ground from the nearest stake to the point at which the line would cross each ordinate and plotting that point on the map for the projection of the line of contour. If these sinuous lines were followed and marked by small stakes as the barometric path would proceed, these lines of level could be conveniently projected along the ground.

problem occurs to follow a strike or vein over a rough, undulating or broken surface, perhaps covered by drift or boulder clay, and dipping at a high angle. In locating roads, planning drainage works, utilization of water power and some other purposes, they are also of much value.

The operations of a topographical survey are two-fold, namely: to first project a system of points upon such a tangent plane; and, secondly, to find the distance of the same above or below the plane, or in other words, as the *Engineering Magazine* expresses it, "to measure the lengths of the projecting normals." The first process is ordinary surveying, the second, levelling.

Now, in our gold mining districts, the first process has been, or is being—from time to time, as occasion demands—performed, and it covers full three-fourths of the entire operation and expense. Assuming the lines are run and the stakes are in place, the remainder of the work, that of levelling and marking the reduced levels on the plot of survey, is the easier and cheaper part of the operation.

Provided these operations are carried out with all possible care, the work would be a very exact one. The first and not the least desirable part of the survey, would be to connect each mining district with a common level; the sea-level at half-tide, for instance. This may appear difficult and expensive; but it would not be so much as it may seem to be at first sight. Many of our gold districts are within easy distance of tidal waters, others are quite contiguous to railways or railway lines of survey where levels reduced from the datum of normal tidal waters can be obtained at any convenient point. Other places more remote should be connected by instrumental surveys.

We may, considering the limited extent of our gold districts in Nova Scotia, reject the sphericity of the globe, and establish a datum level at half-tide, which can be easily obtained at any of the sheltered harbors that indent our sea-coast. For half-tide (no matter whether the tides are normal as along the coast, or abnormal, as along the littoral waters of the Bay of Fundy) the half-tide level is almost the same tangental level everywhere. If, then, we start from half-tide, the cost of connecting the most distant district by instrumental survey would not be more than $50.00, and most of the gold fields to be so connected would not cost half that amount.

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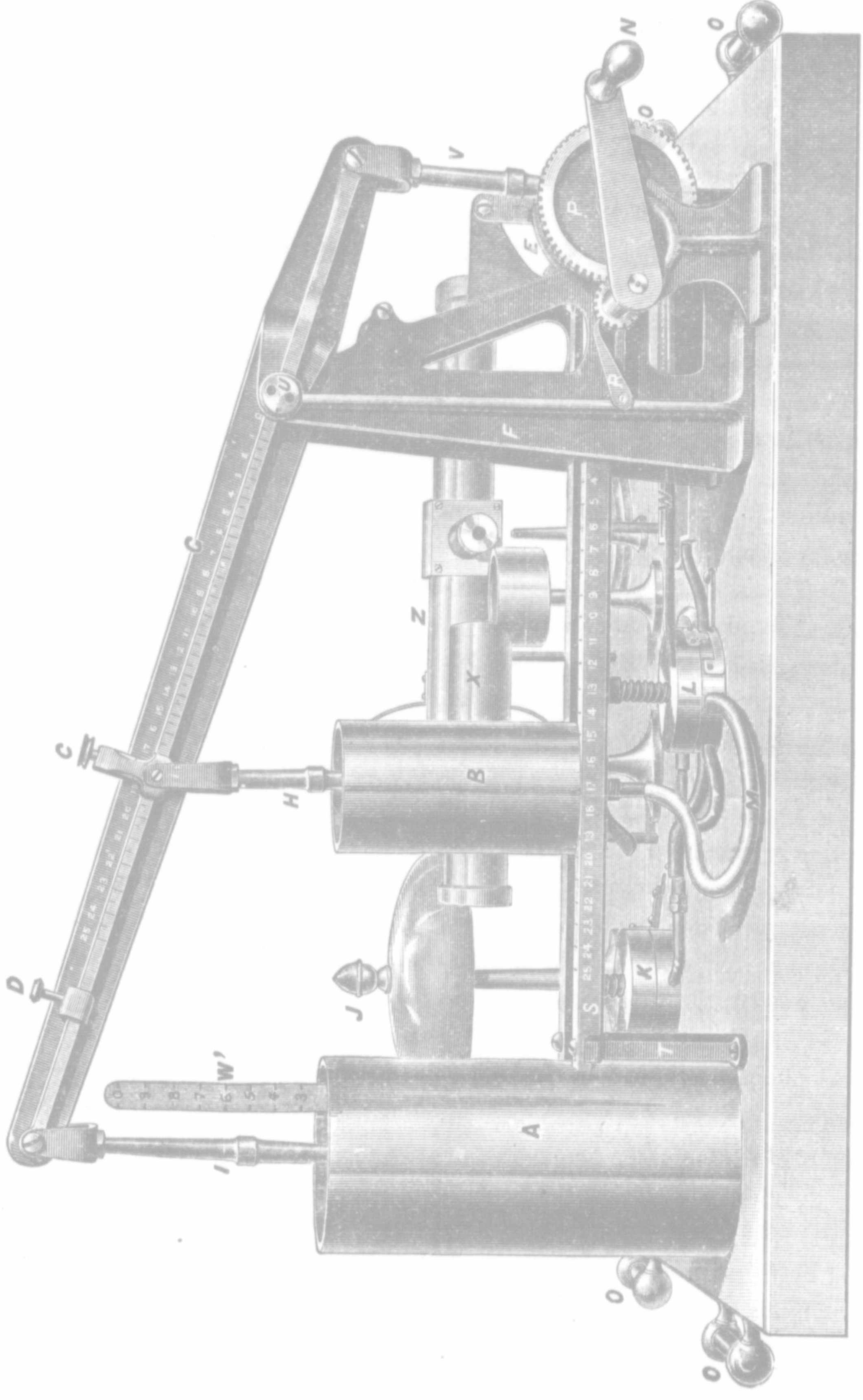

Standard Test for Ignitable Gases. Shaw's System.

now show you the reverse. The flame you will notice is on the top side above the gauze and the heat does not pass down, therefore there is no flame within the gauze tube. There is perfect safety so long as the flame is on one side of the gauze.

MR. FERGIE.—We have three hundred lamps in our mine. They are brought out at the expiration of each day's work, thoroughly cleaned, and tested before being given out again, and before passing into the working places of the mine they have to pass through the hands of two examiners, first at the surface just before entering the mine, afterwards at the bottom of the slope or before going into the workings. The lamp used is the "Marsaut," with double gauzes. The gauzes are protected by a bonnet of sheet iron; at some mines three gauzes are used, but the light is not so good as when only using two. Asbestos rings are used for the glass to bed on. The old "Davy" was not considered safe when exposed in an explosive current of 6 to 8 feet per second, and if the gauze became red hot in an explosive atmosphere it was possible for the flame to pass and ignite the gas outside if the person carrying the lamp subjected it to a jerk or violent motion. The modern and most improved lamps are considered safe in an explosive atmosphere, and moving with a velocity of 3,000 feet per minute.

not alone the manufacturer. Comparing these figures with our local ores we find in the first place we have no such regular vein formation as is found in the Alabama Red ores : we have several grades of Red Hematites, some in the Annapolis Valley, which seem to have a fine, well developed vein formation, and some in Newfoundland showing a closely developed vein formation of large extent. The Nova Scotia Red Hematites are rather limited in extent, though richer in iron than the average Alabama Red ore, as they will average 50 to 52 per cent. iron with 10 per cent. to 14 per cent. silica : they are however very much higher in phosphorus running from 1.00 to 1.50 per cent. thus giving a pig iron containing up to 3 per cent. phos. if used alone making an ideal basic pig but too high for general foundry or mill purposes. This is not the case with Alabama ores and hence is one point in their favor. The Newfoundland Red Hamatite is also hard, showing about the same percentage of metallic iron with but ½ per cent. of phosphorus and hence is richer than the Alabama ores, though entirely dis similar in physical structure and formation. They are however, very much more distant from the furnaces and more costly to mine, so at best these ores can only be put into the furnaces at from $1.85 to $2.00 per ton actual cost ; freights running from $1.10 to $1.50 per ton ; to these figures must be added profits, as the interests are not all united, as is the case almost entirely in Alabama, making the cost of Red Hematite at furnace $2.00 to $2.60 as against 75 cents in the Alabama ores. Of course the higher iron percentage overcomes some of this but there is still a large margin against the Nova Scotia furnaces, and I can repeat that this margin is largely due to the difference in the labor as before described. The Brown Hematite and Limonites of Nova Scotia are largely pockety, though following general leads of ore-carrying strata, and present certainly a very mixed and curious conglomeration of brown ore formation. The base is apparently ankerite and white ore, a carbonate of iron, lime and magnesia, which pervaded the whole formation. From this by action of water and air the other grades of ore have been formed and it appears that the extreme irregularities are caused by the fact that the walls of these deposits are rock, and hence have not permitted the drying out and draining, but on the contrary have caused the more porous masses of ore to act as the channels for all precipitations of moisture. The result is one of peculiar natural disadvantage as compared to the Alabama Brown ores. There they have a hard, lumpy gravelly ore which can be washed perfectly clean, without loss of ore, is physically dry, though chemically containing from 6 to 8 per cent. of moisture, while we have to deal with an ore running from a soft muddy paint with 30 to 35 per cent. of moisture, to a soft brown, soft red, hard brown and black limonite, and some rich specular ore. All these ores are constantly cut and mixed with the hard ankerite and white ore, though in some sections barite and concretionary manganese deposits are found which demand constant care to separate from the regular ore in order to insure any reasonable regularity. Under these conditions it is but natural that the cost is higher, the analysis more variable and the difficulties of manufacturing are greater than is the case with Alabama ores, and that we must develop every other resource and use all possible practicable interests and influences to enable us to overcome such natural difficulties, for it must not be forgotten that these raw material producing plants and departments form a very heavy factor in the labour giving elements of our industrial systems, more so relatively than the finished products, and further that they employ a class of labour which is not as yet able to either make a living elsewhere, or to change its abode, as the higher priced mechanical and skilled labour employed on finished products, where a good man can almost always save enough to move to other districts if his own are closed down and and also to find work more readily elsewhere, and is it not our labor here as yet largely composed of this class, simply because it has not as yet had the opportunity to so develop its capabilities, owing to the comparative newness of our industrial system, and will not therefore any failure to meet such more advantageously placed competition through lack of natural resources, lack of encouragement, and other causes, throw out of work a very large proportion of this labor with all its attendant miseries?

I think this covers the ore question as to its natural conditions. The limestone or flux is so similar in character and of minor importance that I will pass it with but brief remarks. The Southern limestone is partly calcite, partly dolomite, and from three to 20 miles distant the size of the tub, and at the Nottingham Colliery, in the State of Wyoming, where the average output is slightly over 3,000 tons per day, a three ton tub is used. That is, however, a very thick seam, and the conditions of haulage differ but slightly from haulage on the surface railroads.

The second essential condition of a very large output, and one scarcely less important than the first named, is a good roof and floor; however thick the seam, unless it is thick enough to admit of a coal roof being left up, it is impossible to recover coal daily from a large and rapidly increasing area of working, unless both roof and floor be strong, as the least weakness in this respect can only be overcome at a very great expense, and I have no hesitation in saying that it is much more economic with unfavorable conditions of roof and floor to limit the area of workings, maintaining a moderate output, and duplicate the mine.

But, if we have the favorable conditions of coal and roof,and there are no other special difficulties of water or "faults" to contend with, there are still other considerations which must assign a limit to the output. The first, is the difficulty of handling and despatching more than a given number of tubs per day up a single shaft, and the second is the time limit for hoisting. Thanks to the splendid machinery which is now available for the latter purpose, speed can almost annihilate distance, and there are well equipped coal mines where the load is raised 200 feet in forty seconds, but even in shallower mines where the actual time of hoisting from a depth of 200 feet does not exceed 10 seconds, if to this we add the unavoidable loss of time in caging and dumping, I believe it will be found a fairly correct estimate allowing for accidents and hindrances which occur more or less daily, that 1,000 single hoists in a shaft, is the maximum that can be safely reckoned upon, although under the most favorable conditions, it is possible to reach 1,200. If the coal be hoisted in a single tub, as is so in the case of dumping cages, and as seems to be the best practice wherever the seam is thick enough to admit of it, this would give us a basis of calculation, and would show that in the case of a very thick seam (admitting a large car which holds three tons, like that in use at the Nottingham Colliery) 3,000 tons would be the maximum output consistent with other conditions claimed, and

Is there an Economic Limit to the Output of a Coal Mine?

By Mr. Wm. Blakemore, Glace Bay, C.B.

Among the many features which are presented in a review of coal mining to-day and twenty-five years ago, none is more marked than the contrast between the average output of the two periods, unless indeed, we pursue the subject further and note the wide range between the maximum and minimum output.

In 1870, before the great boom in the coal trade of the world (but especially Great Britain) took place, there were many mines in England and Scotland working upon the same lines which they had followed with slight variations for at least one-half a century, and it seems difficult in 1896 to believe that at so comparatively recent a date appliances so ancient, and workings so limited as then prevailed, could have produced a satisfactory result to the colliery proprietor.

Take one instance: In the town of Willenhall, in the Black Country, was a property of some fifty acres containing about twelve workable seams of coal and iron stone; within a depth of 300 feet from the surface, upon this property there were no less than sixteen pit shafts, at all of which coal was raised; there were five hoisting engines as well as three pumping engines. The average output per day from each shaft was about forty tons.

Within a mile of this property was another area of sixty acres, belonging to the same firm. Upon this, were thirty shafts with an average output of twenty tons each per day. And still another smaller property of some fifteen acres with six shafts, averaging thirty-five tons each per day. The whole of this coal was hauled in small cars by horses a distance of nearly two miles, then transferred to canal boats, towed again by horses three miles, to the iron works, where it was consumed; yet, by this slow, antiquated and apparently costly process these three properties were worked successfully for more than thirty years, yielding a

Notes on Some Comparisons Between Southern and Nova Scotia Iron Methods.

By Mr. C. A. Meissner, Londonderry, N.S.

In presenting this paper before you to-day it is necessary that I should preface it with an apology, in so far as it hardly appears to me as finished and complete as such a paper should be when read before a society composed of the best industrial minds of the Maritime Provinces. My excuse must be lack of time, as the departure of our managing director for Europe has thrown a large amount of additional work upon me. I trust therefore you will overlook any shortcomings in this sketch of comparisons between Southern and Nova Scotia iron methods.

The subject is perhaps one of peculiar interest, in so far as there are many conditions in the iron industry of these two sections of this continent that are strikingly similar in many of their prominent features, and yet for the present, at least, present very dissimilar results in many instances; some of these are of a nature that can and ultimately will be obviated or changed, while others are permanent and inherent to race and natural characteristics of the two sections, and I feel our endeavor should be to gradually change our conditions to such a degree so as to more closely meet the extremely low priced southern irons with their peculiar natural advantages. This should not only refer as to prices but also as to quality, and I will discuss these two points.

The subject is, I think, of interest to nearly all our Maritime Province industries in so far as we are largely producers of raw material, while on the other hand our finished industries are steadily forging ahead and demand for their fullest development that we should present the raw materials to them at the cheapest possible price and of the best possible quality. It is perhaps needless to state that the producers and consumers of raw materials in any section of country are bound to each other by strong commercial ties, and are one a protection to the other, for the moment you remove or cripple one, the other is forced to seek

That the classes have been appreciated would seem evident from the fact that the numbers attending them have been steadily increasing as the practical character of the instruction has become known to the prospectors. For an example, during the present summer 135 attended my three classes at Rat Portage, Mine Centre (on the Seine) and Fort Francis, notwithstanding the fact that they were held during the "busy season." It is needless to say that the benefit supposed to be derived by the prospector from this class of instruction is largely indirect, for it will more than nine times out of ten be the means of proving to them that a prospect is "no good," and therefore better left alone, saving him fruitless expense and loss of time, than by revealing to him that he has made a very rich find, which in most cases speaks very emphatically for itself.

It should be added that since the first experimental class at Marmora the Government of the Province have provided the means for carrying on these classes, and their direction is at present placed in the hands of the Governors of the Kingston School of Mining, as the originators of them in Ontario.

The Royal Commission, above alluded to, deputed to me the collection of minerals at the places we visited, and the compilation of facts regarding museums of natural resources, particularly minerals of economic values. In the report of the commissioners a provincial museum is strongly recommended, and it may be noted with satisfaction that the Director of Mines, with the commission collection as a nucleus, is rapidly getting together a collection of ores and rocks in the Parliament Buildings which some day will go far towards making up a provincial museum.

In connection with the prospectors' classes in mining centres, I found that there was a great desire on the part of those attending to have a local collection of common typical rocks and ores to which they could refer as examples, and to which they could add local specimens.

In this way they hoped not only to have a collection by which they could continue their studies, and refer to for types specimens they found, and of which they were not quite certain, but they expected material benefit to the locality from a stable local exhibit of good samples of their mineral possibilities.

MR. ROBB—Would the machine require to be repaired very frequently during the progress of the test?

MR. BLAKEMORE—No repairs were done on any of the three machines during the test. They were not damaged or appreciably worn.

MR DICK (Halifax)—Was the floor even? What about an undulating floor?

MR. BROWN—Was the floor hard or soft?

MR. DICK (Halifax)—Has any test of the three machines been made worked by the same man?

MR. BLAKEMORE—Yes.

MR. DICK (Halifax)—What was the difference in the amount of coal undercutting with the machine and compared with hand labor? Does the machine waste any more coal?

MR. BLAKEMORE—I will deal with that.

MR. FERGIE—You stated that less pit room was required for the machine. Does it not require two rooms for each machine? Do you not prepare the coal one day in one room, and go at the next while it is being prepared?

MR. BLAKEMORE—In all mines the output depends upon the cutting of the coal. Where you have a machine producing five times as much in a given time as a man, it would be a question of employing more men to load, blast, and produce your coal in a small place.

The first question asked by Mr. Fergie is in reference to the cost of the motive power and depreciation of plant. The expenditure on plant is elastic, and depends upon the ideas of the engineer. I may say, however, that the result of our experience for nine months' work on this system would lead us to add about ten cents to the ton to cover cost of maintenance of plant, pipe-ways, repairs to machines and pipes, flexible hose, depreciation, and interest on cost. As to that test, I may say that we could not get as much coal in ordinary working, and the cost would therefore be higher. What I have said as to the ten cents, however, would be perfectly safe. When you have added that to the other items given, the cost is below what you can possibly do it for by hand.

As to the percentage of coal and slack, our figures show that we cut a larger percentage of round coal than by hand. We did not at first, because we did not give them the same chance as now. There is no difference in the coal brought down. Your saving will be in the under-from the furnace. The limestone here is from 15 to 20 miles distant, I believe in some cases nearer, and cost of quarrying should not show much difference, nor is its quality materially different from Southern stone. What difference there is of cost in favor of Southern stone is due to the labor conditions.

The fuel comes next, and as it represents one of the most important factors in the economy as well as the quality of the iron manufacturer, it is well to study it carefully, though I must do so very briefly.

The coals of Alabama, as a rule, are good coking coals, though rather high in ash in many cases. Five years ago they were coked unwashed, and ash in coking ran from 14 to 18 per cent. When the question of washing was broached it was claimed that owing to the slight difference in specific gravity of coal and slate, especially bone coal, it was not practicable, and coal miners rather opposed the erection of washing plants. Now the greater portion of coke used in furnaces is from washed material, except a few favored seams. The present type of coal washing plant most successfully used down there seems to be the Ramsey-Robinson Washing plant, which is used by the large companies. The result of washing there has been so apparent in the improvement of the coke, the furnace results and the quality of the iron, that I am satisfied the same conditions will ultimately prevail here. Most of our coals give an excellent coke, though most of them are rather high in ash, and hence our unwashed coke is too high in ash to compete in anyway favorable with the washed Southern coke. Already considerable effort has been made with very fair success to overcome this difficulty, although we have not yet come down to a steady 10 per cent. ash coke. All experiments made in this direction have shown a marked diminution of ash, and I have no doubt that with proper appliances and study we can yet get the desired 10 per cent. ash coke. This would be one of the greatest factors towards the lowering of our costs and enabling us to compete successfully with the Southern irons; but as is natural, with improvements of that kind, it takes time to fully develop and perfect them, and it must not be forgotten that that portion of the iron industry dealing with patent coke ovens and washing plants is comparatively so new that it would be unreasonable to expect its full development in any short period of time. The cost of Nova Scotia them. They can hence be washed to good advantage, and extensive washing plants are found at all the larger mines; they usually lie in a stiff clay, seldom in rock; analysis runs from 45 to 52 per cent. of iron, and varies considerable in phosphorus according to location, running from less than 1-10 per cent. to over 1 per cent.; Silica is from 8 per cent. to 15 per cent. One peculiarity is that they never contain lime to amount to anything, in which respect they differ radically from the Lake Superior brown ores and also from those of this, our province, they seem largely to have been formed from pyritiferous formations, while our brown ores here are formed like the red ores from lime, iron and magnesiam carbonates, by the action of air and water; the red ores lie close to the Furnace in most cases and are touched on all important points by the branches of the many railroads making them readily accessible at very low freight rates. The red ores are mined at a cost of from 38 to 50 cents per long ton, freight rates run from 10 to 25 cents a ton, and as they are handled in large 20 to 30 ton self dumping hopper cars, the cost of unloading is very slight; this therefore puts them into the stockhouse at not exceeding 75 cents a ton, and in many cases at 60 or 65 cents per ton. The brown ores cost about 65 to 80 cents per ton to mine, wash and put on cars and 25 to 45 cents freight, making cost from $1 to $1.15 delivered varying with location and distances; in considering these abnormally low costs you must remember that cost of mining is almost exclusively labor, and that this low cost is largely due to the peculiar labor and commissary conditions existing, and that the average mining community being 9-10 ignorant negro labor is not such as you would want in any of your countries, even for the sake of the cheap mining.

When I compare a mining community in Alabama with those here I cannot possibly conceive the feeling that would prompt the statements so often made that manufacturers should be able to make their products as cheaply as these southern industries do, or not become a burden to the people by demanding to be protected against these industries, when it is not the protection against their materials that is desired so much as the proctection against that class of labor, which produces those materials. I do not want to talk politics but that is my idea of protection. It is the labor that needs the protection and

The test for sulphureted hydrogen is, like that for white damp, slightly more complicated than the other tests, but it is not a difficult one to understand.

DISCUSSION.

MR. FERGIE.—In three mines in the United States they have this machine connected with the mine itself. If there is more than a normal amount of gas the bell rings in the office. Our safety lamp will detect from two to four per cent. of gas, while this instrument will detect one tenth of one per cent. From two to five per cent. of gas may be perfectly safe in a mine under ordinary conditions. In the event, however, of an explosion in another part of the mine, the first mentioned gas will become explosive on account of the compression of air. As a matter of practice, we test our airways once a week, and if we see that the per centage of gas in the returns is greater than usual we ascertain the reason why. We find that gas will explode when mixed with air at certain proportions. The gas I have here will explode at 10 8-10, the gas we have in the mine will explode at 7 per cent. What you have to determine is where the ringing line is If it is at the point where you have a proportion of ten per cent. of gas it will not ring in that proportion. The test for carbonic acid gas is different. In that case you force the gas through lime water in a test tube, and this tube is compared with tubes having a precipitate formed by a known amount of carbonic acid gas.

Place a lamp under a glass bell and fill the bell with gas, and you will see what is known as the blue cap. This experiment will also shew that when the light is put out by the presence of too much gas, the explosion takes place within the lamp itself. A back draft or suction always occurs just before an explosion.

MR. F. H. MASON suggested that the suction is caused by the two atoms of hydrogen and the one atom of oxygen going to form the one molecule of steam which immediately condenses to water.

MR. POOLE.—I will illustrate the principle of the Davy lamp. The gauze obstructs the heat to such an extent that the flame will not pass through. As I burn the gas inside of the gauze tube you will notice that the flame does not pass through. If the gauze, however, were to become red hot the flame would burn on the top side. I will nearly reached. If by moving the small cylinder one-tenth of one per cent. nearer the fulcrum, or to 4·4 per cent., it is found that the gong does not ring, when the machine is operated, it is evident that the air from the mine contains the difference between 6 per cent. and 4·4 per cent. or 1·6 per cent. of pure light carbureted hydrogen. The tests for fire damp are all simple, and depend entirely on the mixing of air to rich samples until the lowest point of ignition is found, and then adding to this the percentage of air used. This will give the percentage of pure gas in the mixture. If the sample is weak in gas, a standard gas whose point of ignition has been previously determined must be mixed with the sample tested, and the proportion of this standard gas taken must be subtracted from the previously determined point of ignition. The remainder will accurately show the percentage of gas in the sample tested.

To test safety lamps, it is only necessary to remove the cap from the choke damp tester X, and attach to it a glass bell jar, with a rubber tube. Under this bell jar place the lighted safety lamp and pump on it any percentage of illuminating or other ignitable gas (an explosive mixture from the mines is best), and watch the effect. For best results safety lamps should be tested in absolute darkness.

In testing for choke damp, a standard glass tube containing lime water representing the turbidity caused by one-half of the large cylinder full of air containing one per cent. of carbonic acid gas (which is furnished with the machine) is used. Now, if in another tube of lime water 20-100 of a cylinder of the air tested caused the same turbidity, it is evident that the sample tested contained 2·5 per cent. of carbonic acid gas, because $50 \div 20 = 2{\cdot}5$. The graduated scale W' is used to measure the proportion of the stroke at which such turbidity was attained, or in other words it measures the quantity of the sample pumped into the cylinder A.

The test for White Damp or Carbonic Oxide is more complicated than the tests for fire-damp or choke damp, but can readily be learned by a man of average intelligence. Our space is too limited to describe it here, so we will merely state that it is very similar to the test for choke damp. The principal differences being in the chemicals used for the fluid in the standard and test tubes.

Private collections are so frequently broken up and parted with that it was agreed that donations of minerals placed in the hands of trustees would be of immensely greater value to the district in the long run.

When the attention of the Government was called to these facts they very generously acceded to the request, and have arranged with the Kingston School of Mining for typical collections of ores and rocks to be placed at Rat Portage, Port Arthur, Sudbury, Sault St. Marie and Marmora.

The work of getting together the specimens and arranging for cases is now going on.

for its market or its supplies outside of its natural invironments, and the result is that either is sure to be taken advantage of in such case by such outside sources of market or supply; that is simply a natural characteristic of "human natur," as your inimitable Sam Slick puts it, and hence must be taken into consideration whether in individual or national matters of business or trade; the nearer therefore that the raw material manufacturers can come to the more favorable conditions of any extraneous trade sections, the more willing will they find the consumers to support them, the greater facilities do they offer to their section for the expansion of such finished manufactures, and the more prosperous does the section become, for I might state that I have always been a firm believer in the principle of patronizing home industries wherever you may be, on anything like equal conditions and deprecate the feeling expressed in the old proverb that "A prophet is not without honor except in his own country," and I might venture to say that there is perhaps still quite a strong feeling in the Maritime Provinces to look outside for their requirements rather than in their own midst, thus adding to the difficulties of their manufacturers. This is perhaps natural in one way as the manufacturing industries are comparatively young, and the whole tendency of former generations has been to go outside for all such supplies, but certainly manufacturers in the Maritime Provinces are now well able to meet almost any reasonable requirements, and it would facilitate their efforts towards the material progress of the provinces if their citizens could shake off that feeling of dependence on outside sources, wherever the home manufacturers are prepared to supply them. I do not think that they as yet give full credit or fully realize the importance to them of the great Industrial system of which you here are the representatives, and for which you are putting forth your utmost endeavors. There is, however, I think, a gratifying progress and change of feeling being noticable on this matter in the last few years, which will ultimately lead to a full realization by a large majority of the fact which is all important in this effort to improve the material progress of the provinces, that of every dollar spent at home a large portion is bound to come back directly or indirectly, while every dollar spent abroad is an absolute drain on the country! While this may be disputed by some, yet I think I can safely large profit to the fortunate owner and contributing no inconsiderable proportion of the $15,000,000 fortune which he left at his death.

I am tempted in this connection to mention another striking illustration of small output and slow work which is a fair example of what prevailed in the adjoining district of Shropshire, where the Duke of Sutherland holds large estates. Within the period mentioned, I have known mines worked on the "charter" or "butty" system, where the hoisting was done by means of an old vertical engine with reversing gear operated by foot, and travelling so slowly that the old man operating it, after starting the load from the pit bottom would saunter down the steps to the engine house, clean his fire, shovel on the slack, light his pipe, stroll back again, sit down on the stool, and still be waiting for the bell to ring which would indicate the approach of the load to bank, and that in a shaft any more than two hundred feet deep. The output in this case would be about ten tons per day, and scores of such pits were working on this estate up to fifteen years ago.

Now contrast this state of things with mines to be found in every district in England to-day, yielding from 1,000 to 1,500 tons, and a few in Lancashire and South Wales reaching 2,000 tons a day, to say nothing of many in Ohio and Pennsylvania and Wyoming exceeding 3,000 tons.

The era of 1,000 ton mines may be said to have dawned with the boom above referred to in 1870, and in England at any rate, the result is largely due to the enormous influx of capital under the "Joint Stock Company's Act," but in this as in everything else, the economy of Nature played a very important part, for it must not be forgotten that in 1870 a Royal Commission had been appointed to investigate the unexhausted supplies of coal in Great Britain, and that while the report of this Commission removed all doubt as to the adequacy of coal supply for at least 100 years to come, it also pointed to the necessity for delving deeper in order to unearth the rich stores of natural fuel still to be recovered.

With this heavy capitalization of coal mines, it was imperative that if shareholders were to receive even a moderate interest upon their outlay, larger outputs must become the order of the day, and as most of the coal seams developed by these new enterprises lay at a greater depth than the older workings, the incidence of more costly appliances, as well as deep sinkings and wider areas of working, accentuated this same necessity, in other words the large output was a perfectly natural and legitimate evolution of mining science, and our subject is not in any sense an attack on the principle involved, but to ascertain whether it has been developed to an undue extent.

It must be conceded that when a mine has been properly laid out, that is, upon the principles of recognised and well-established mining practice, the most economic result is to be attained by putting out the maximum output consistent with the safe, systematic and efficient working of the mine, but to this output there is a limit imposed not only by physical conditions, but oftentimes at a much earlier stage by what we prefer to call economic conditions.

Manifestly it is impossible in this, as in many other things, to erect a standard which shall be applicable to all mines, or even to mines in general, the many conditions prevailing below ground, with all of which the practical manager is conversant, contributing their quota to a full consideration of the subject. But there are certain suggestions which seem to have a bearing upon the decision of this matter in respect to every mine, and which may here be briefly indicated.

The first, and most important of these is the thickness of the seam, because however perfect and up-to-date the mechanical appliances in use, it is impossible to raise as much coal in a given time from a three-foot seam as from a six or nine foot, at least if such a thing could be done at all it would only be for a comparatively short period and at an enormous outlay which would not ultimately be profitable. So far as I know, there is not a colliery raising as much as 2,000 tons a day up a single shaft from a thinner seam than five feet. The thick seam renders a large output not only desirable, but necessary, if a maximum is to be attained and while it is possible by special layout and haulage system, and by constructing cages to carry as many as six or even twelve tubs of coal to reach a high figure from a considerable depth, this is done at a great disadvantage compared with the raising of the same output from a thicker seam by the aid of a larger tub. Wherever an attempt is made to reach the very large outputs which now seem to be the aim of mining men, there is a tendency constantly to increase

Prospectors' Classes and Mineral Collections in Mining Centres.

By Wm. Hamilton Merritt, F.G.S., Associate Royal School of Mines.

Ontario being as yet the only Province, or State, on this Continent which has adopted the New Zealand plan of Prospectors' Classes in mining centres, and the first to approve of the plan of placing mineral collections of a mixed economic and scientific character in localities where mining or prospecting is carried on, I have deemed that a few facts in relation thereto might be acceptable to the Institute.

The origin of the classes, of the Bureau of Mines, and of many reforms and alterations to our mining laws, may be traced to the Royal Commission which was appointed in 1889 by the Government of Ontario to enquire into the Mineral Resources of the Province.

As a member of that Commission it was my duty and pleasure to bring to the attention of my colleagues certain facts regarding classes held in Mining Centres in New Zealand for the encouragement of prospecting.

As it was evident that Ontario was yet essentially in the prospecting stage, and that its vast extent of territory and diversity of mineral occurence should prove a prolific field for prospectors, the Commission took evidence as to the desires of those interested at the different points where Sessions were held. The Secretary of the Commission, Mr. A. Blue, also collected extracts from the New Zealand parliamentary documents and in their final report the Commission strongly recommended prospectors' classes in mining centres somewhat on the New Zealand plan.

No action was taken in the matter until in 1894 the Governors of the Kingston School of Mining instructed me to hold a Prospectors' Class at Marmora for two weeks, the charge for attending which was four dollars. The course of work which I adopted varied somewhat from that in vogue in New Zealand, so far as can be judged from the official reports of that country.

In New Zealand the plan of their course resembles rather that of the eight weeks Prospectors' Course held at the Kingston School of Mining in the winter—viz a short School of Mining.

can earn more money by it. Men who were getting with the hand picks an average of $2.00 to $2.50 per day are getting with the machine from $3.00 to $3.50 and $4.00, and as high as 5.00 per day. In the face of that you cannot wonder that there is no further opposition to the machine.

As to its utility in regard to ventilation. You cannot ventilate the mine with it, but the escape of free air from it is a help to ventilation. in driving a heading the escape of air helps to keep the face sweet and free from gas. We are still using the longwall machine. We have not done any better than when the former test was made. We once cut 500 lineal feet on the face and 3 feet undercut in a day's run of eight hours with it as trial test. It now averages per day about 200 lineal feet on the face with a five feet undercut.

At the conclusion of that test we talked about what would be a fair price. We agreed to assume the basis of half the work done during the test, and upon that basis a price was fixed. We find that any of the men can do about half the amount of work that was done in that test

MR. DICK—What is the steepest up-hill grade you have worked against?

MR. BLAKEMORE—One in twelve. It is a question whether it could be worked at 30 degrees. It is certain that you could use it on steeper grades than 1 in 12 by elevating your tail-board.

The writer has had the Shaw machine in use at the Drummond Colliery for the past three years and has found it to be everything that the inventor claims for it. There is great satisfaction in being able to tell exactly just what per centage of fire damp is being carried in the air currents of the return airways.

The machine is better explained by referring to the cut, and the following description of it is taken from the *Colliery Engineer*, Scranton, of April, 1893:

It will be seen that F represents two standards supported on an ordinary metal bed-plate, and G represents a beam lever mounted on bearings at the top of the standards; the short end of the lever is connected by the connecting rod V with the crank disc E; the long end of the lever is connected by the rod I with the plunger-head of the pump cylinder A, and the intermediate section of the long end of the lever is connected in an adjustable manner with the plunger in pump cylinder B, through the connecting rod H. The lever is vibrated in a vertical direction, a pre-determined distance, by the crank disc E, actuated, through gearing P, by the hand crank N. The full stroke of the cylinder A equals 800 cubical centimetres, and that of cylinder B equals 266⅔ cubical centimetres.

The plunger of cylinder A is given a full stroke at each revolution of the crank disc E, whilst the position of cylinder B is made adjustable upon the supporting bars S, and secured in any position by an ordinary screw nut beneath the bars S. The cross head of the connecting rod H is arranged to slide upon the two projecting ribs of the vibrating beams G, and is secured in place by the clamping screw C; the beam and bars are marked with figures showing the exact percentage of the relation of the two cylinders to each other in cubical contents. The pumping cylinders are free from all ordinary check valves; the valve duties for both cylinders are performed by one single disc valve L. This valve consists of two discs with ground faces, the upper disc vibrating upon the face of the lower one, through an accurately determined distance. This valve is operated automatically by the connecting rod W. At the upstroke of the pumps two ports in this valve are open and an equal amount of air and gas would be forced through, if the arrangement of the cylinders was such as to take equal amounts.

occurs; and the last consideration that there are few mining engineers of experience who would not prefer if they had their choice, to raise 10,000 tons per day from six mines than from three.

In conclusion, I wish to emphasise what I have already stated, that there are conditions which render it imperative to secure a larger output if financial success is to be attained and of this we have an excellent illustration in the case of the Dover sinkings just commencing in the County of Kent, England, where a seam of coal 4 feet 6 inches has recently been pierced at a depth of nearly 3,000 feet; here the conditions appear to be favorable for a maximum output, and the depth is so great that a small output would never pay, but I would point out that the proprietors are starting with a full knowledge of the conditions to be met, and are adapting their appliances from the commencement to do what is required.

DISCUSSION.

MR. CHAS. FERGIE.—I would suggest that papers be discussed at the meeting following the one at which they are read. You cannot get at the merits of a paper read to-day, but if you had an opportunity of reading it at your leisure you could be prepared to discuss it.

MR. H. S. POOLE.—A foot note should be attached to the papers to the effect that they would be open for discussion at the following meeting, and that the secretary would receive comments on them in writing.

MR. FERGIE.—The paper was very interesting. I hope Mr. Meissner succeeds in getting ten per cent. of ash from his coke, but I doubt it. I agree with him that the very best place to put his furnace would be near a coal mine. I guarantee that we will give him a free site, free taxes, water, etc., etc.

MR. POOLE.—I am sure the hesitation on the part of most members to comment on the paper has not been at all from want of appreciation, but the reverse. They feel that it is beyond the experience of most of us. We feel that we should want to study it before speaking of it in the manner we would wish to.

distance to go before they reach their markets, but so do we here; the geographical conditions of Canada being exceptionally unfortunate in this respect.

The main reasons for this difference in cost lie first in the natural and labor advantages they possess over us, which are difficult to remedy; and second, in conditions of plant and improved appliances which we have not yet had time to either introduce or get the full benefit of, but which are bound to be remedied by us if we receive as they do the proper national encouragement, and I repeat again that it is only in the last four or five years that they have been able to adopt that perfection of plant and manufacture which they lacked for fifteen or eighteen years previous owing to conditions before mentioned.

To begin with their natural advantages, the ores take first place. They have practically two classes of ore, the Red Hematites, soft and hard, and the Limonites or Brown ores. They have some deposits of Black Band and Magnetic ore, but neither are of commercial importance; the Red Hematite belongs to the Clinton formation of the Silurian and runs from Middle Alabama through the States up to Maine, and curiously enough even through Nova Scotia, as I had a sample from Cape Breton which in appearance was distinctly the Red Clinton ore of Alabama; though I do not yet know its extent. This Alabama Red ore lies in a regular vein formation, traced for miles and in some cases within a mile of the furnaces; it varies in thickness from three to thirty feet and outcrops on the hilltops; it is cut by many gorges, making it easy of access at a number of places; the ore is divided into soft and hard, the latter appearing in the vein after the soft has been worked down some two or three hundred feet; in fact the hard red ore is the original formation, containing the lime, while the soft ore has had the lime leached out of it by action of water and air. This soft red ore will run all the way from 35 to 50 per cent. metallic iron, and from 2-10 to 6-10 of Phosphorus; Silica running from 13 per cent. to 18 per cent. The hard red contains from 12 to 17 per cent. of lime, 35 to 40 per cent. iron, and 11 to 15 per cent. Silica, and is therefore often more than self fluxing; the brown ores are usually limonites and lie in pockets of greater or less extent, and very uncertain character. They occur as lump or gravel and seldom is any soft paint ore found with coke is rather higher than in Alabama, owing to the proximity of the mines there in most cases to the coking plants and furnaces, which not only reduces freight charges, but saves freighting the ash and the volatile matter, for which as yet we must pay full freight, and when you calculate that the loss in coking is 40 to 42 per cent. and the loss of ash in washing is 8 to 10 per cent. of the coal, you will see that here is a very heavy factor of cost which could only be overcome by washing and coking coal at the mines. Another natural condition which nobody can remedy and which is against you here is the difference in climate, in so far as it would be impossible to wash coal in winter at the mine and ship it to the furnace owing to its freezing to a solid mass. There are therefore but two solutions to this problem, first wash and coke the coal at the mines and save freight on ash and volatile matter; second wash and coke at the furnaces and pay all extra freight. If the iron and coal interests were connected, the former way would at once be adopted, as it is the latter, the more costly plan, is the more feasible and is already in operation at one plant. It hardly seems to me though that we should abandon our iron plants simply because we cannot make coke as cheaply as they can elsewhere.

The next point is the labour question, which is a serious factor in favour of the southern furnaces, and yet of such a nature that I am certain that no Canadian would be willing to see it inaugurated in his own country. I have lived and worked five years with the southern colored labor and while it was a very satisfactory labor in one way, in another it holds the country down to a very much lower grade of civilization and progress as a whole than any similar amount of white labor. The negro does not strike, he works hard when properly pressed, he is good natured and willing as a rule, and can stand climatic conditions but he is naturally ignorant and lazy; he will only work when watched closely and can seldom be relied upon to do any work without slighting it. He lacks all feeling of responsibility, of morality, means well, but like a child cannot see the difference between right and wrong as we view it. He is usually shiftless, seldom saves his money, yet when closely watched and in localties where there is not much other employment to be obtained by him he will work steadily and quite faithfully; he gets about the same wages as the white laborer in the north, and was so well known at the time of Confederation, that neither we here nor our customers west should ever complain of this. If Canadians are to act as a body, these geographical conditions are simply inevitable, and must be dealt with, and no amount of grumbling will ever change them. They should be accepted, and no one section can afford to throw over any other section on that account without disorganizing or disrupting the whole country. There are always certain phases of national entity, and this strikes me as one of them, which cannot well be thrown aside from commercial reasons, without threatening this national entity by disintegration. There is one point, however, where the railroads here are very much behind those of the South, that is in car equipments. Coal, ore and limestone in Alabama is principally hauled in large hopper cars, holding 15 tons and running up to 30 tons capacity, self dumping, so that one or two men at any plant can dump the entire stock received at the furnace daily. This is a very strong point in their favor and the lack of this equipment a serious tax on Nova Scotia industries. The lack of this class of cars causes a detention and delay, especially in winter, forces the railroads to put a much larger equipment into the service, and adds to the cost of the work, to them as well as to the furnaces. This is one of the points that can be remedied, and I have no doubt that the time is not far off when it will be.

As to plant, the Southern furnaces, as a rule, are very much better equipped than those here, though it is only in the last few years that this material improvement of plant has taken place, and the progress made since then has been very marked. The same is beginning to apply to the Nova Scotia industries, though the extremely hard times for the last few years have held them back to some extent, still improved coal washing plants, mining appliances and other appurtenances to plant have been and are being introduced everywhere, and I look for the next few years to show a very marked activity in this respect, as we will all realize the importance and absolute necessity of such improvements to enable us to properly meet our competitors. Naturally tariff legislation will play a large part in this activity. It must never be forgotten that improvements of this nature for the production of raw materials, whether coal, ore or iron, are almost invari-

But as the cylinder B is smaller than cylinder A, and the stroke of the plunger connected with rod H is shorter than that of the plunger in cylinder A, only a certain proportion in volume of each is conducted into the cylinders. It is well to state here that the gas or mixture to be tested is conveyed by a rubber tube to one of the ports of the disc valve L. On the up stroke of the pumps cylinder A is filled with air, and cylinder B with the gas or mixture to be tested. On the down stroke the ports in disc valve L that were open on the up stroke are closed, and opposite ports are opened. Through these the air and gas, or mixture, is forced to a mixer, where they are thoroughly mixed with each other. The resulting product of mixed gases are led by a tube to a central port in the hand valve K, from which it is conveyed to tester Z. This is the case in testing ignitible gases. This tester is of the highest importance, as it is the instrument that solves the problem of giving quick and positive tests of all percentages of ignitible gases in the air, and for determining values of pure and mixed ignitible gases to the smallest desirable fraction. For testing choke damp the hand valve K is set so that a different port is opened, and the mixture instead of being conveyed to the tester Z is conducted to the tester X. If the handle of the hand valve is turned so that the arrow points to F D the mixture will be conveyed to the fire damp tester Z, and if turned so that it points to C D the mixture is conveyed to choke damp tester X.

Tester Z consists of a square metal valve box supported upon metal pillars. This box is provided with screw threads for the reception of brass cylinders. The cylinder to the right of the square box is provided with a perforated cap end, while the one to the left is provided with a piston valve held under slight compression by bow springs and wire thread with an adjustable lever and weight to regulate the tension.

The mixed ignitible gases for test are led into the tester under slight pressure, and blown against the piston valve from which point they flow backward, expelling any previous air or gas out of the aperture in the perforated cylinder head, and out an igniting nozzle against the flames of a small lamp. The mixed gases blowing through the flames are caused to unite at the lowest ignitible point, and about four per

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from this figure we must graduate downwards according as the conditions vary.

Coming to a thinner seam of coal altogether, such as is worked in the Rhondda Valley, South Wales, we find the Ocean Colliery, which is one of the best equipped in that district, yielding 2,000 tons per day from a five foot seam; here, the tubs are much smaller, only holding about a ton; the mine is admirably laid out and under the management of one of the most experienced mining engineers in South Wales, and the output attained may be fairly accepted as the highest consistent with good management and profitable working. From the foregoing it may be deduced that physical conditions must limit the output from a single mine, up a single shaft which is reached in the case of a thick seam, that is, a seam from 8 feet and upwards at about 3,000 tons per shift, and in a seam below five feet at about 2,000 tons; and that any attempt to force a mine beyond some such working as this, while it may be possible to yield a few more tons, is likely to add to the difficulty and expense to an extent which would far outweigh any advantage derived.

That the minimum limit is determined by natural conditions which have been described and which cannot be overcome except at a loss, and that this limit is also fixed at a much earlier stage than that determined by merely physical conditions such as the necessity for maintaining the safety of the mine in the interests of the workmen by limiting the area ventilated, timbered and otherwise kept safe, it being much easier to do this in a mine of moderate than of excessive output. I know that this statement will be met with the objection that to insure safety it is only necessary to increase your inspecting staff as you enlarge the area of working; this is true to a certain extent, but not absolutely, there are certain officials who must supervise the whole of the mine if its efficiency and safety is to be maintained, and who say that the enormous extent of workings in recent years prevents this being properly attended to. It is hardly necessary to insist upon this law, which is with every rightminded colliery proprietor the chief consideration, to point out that however perfect the system of a mine, the larger the output, the greater loss and inconvenience arising whenever one of the many hindrances to which mining operations are always subject,

The Shaw Gas Tester.

By Mr. Chas. Fergie, M. E., Westville, N. S.

The instrument is the invention of Mr. Thomas Shaw, M. E. of Philadelphia.

It is the most delicate instrument for accurately testing and determining low percentages of gases in the air of a mine yet brought before the mining world, and is accurate to the one thousandth part.

There should be no misapprehension as to the use to which this instrument is intended to be put. It is not intended to take the place of the safety lamp for examining the working faces of a mine. Its purpose is for detecting small percentages of gas in the return airways, and such percentages as the safety lamp is not capable of showing.

The ordinary safety lamp will not detect gas unless the proportion of gas present in the air is from 2 to 4 per cent. The Shaw machine will detect the presence of one-tenth of one per cent.

Some may argue that it is not necessary for a mine manager to ascertain such minute proportions of gas, and such as the ordinary safety lamp is incapable of doing. It is, however, now an acknowledged fact that coal dust plays a very important part in mine explosions, and it has been proved that under certain conditions one per cent. of fire damp in a dusty atmosphere becomes explosive. It should also be remembered that mixtures of air and small percentages of fire damp—considered quite safe under normal conditions—of the mine become highly dangerous in the event of an explosion being propogated. It is therefore obvious that some fire damp detector is necessary, other than the safety lamp, to show the true condition of the air of a mine as regards the percentage of gas it is carrying.

Periodical tests should be made of the air of the main returns and the exact percentage of fire damp present ascertained, and any increase due to atmospheric depression, reduced volume of air current, or an outburst of gas, is detected at once, and steps can immediately be taken to remedy and counteract the same.

cut. A man by hand-pick will take 18 or 20 inches on the face, and with the machine you can do with 12 or 14 inches. After taking 14 inches off the face you follow down to a narrow groove. At the back of the cutting you only have 3 to 4 inches. In the case of hand labor you must leave a larger space. You get five per cent. more coal with the machine than you do by hand.

As to the inequalities of the floor. A man cutting by hand can humor his work to the inequalities of the floor. You do not do that with the machine. You are obliged to leave coal on the floor equal to the height of the swell. That has to be taken up by hand. That, however, only means a few inches.

I have been asked as to one man running the three machines. I cannot settle their merit beyond what I have told you. I think I may say, however, that there is very little to choose between the three. We have had as much coal cut by one as by either of the other two, when the same man worked the machine. The Yoch machine which is the heavier one and has the larger cylinder, is no doubt better adapted to very hard seams than either of the others.

There are just three other points of interest that you might like to hear about. You might ask how the men received these machines. Of course at first they did not receive them with open arms. I recollect the Right Hon. Jos. Chamberlain once made a remark that he had never known a machine introduced in any trade, and which was opposed by the workmen, which in the end was not beneficial. In the first instance we had to bring outsiders to work them. Now we can get better average results with our own men than we did with the experts who came down to work them. No man will go back to hand labor who can get a machine. The machine looks too big for a man to handle, but I believe it is not so hard on the man as cutting by hand-pick, which is laborious work, as each bit has to be cut out. With the machine he can in a sense be resting part of the time. The machine is fixed on a board sloping towards the face, 700 lbs. on an inclined plane. Then you have your motive power, and the effect is to draw the machine back and the weight of the machine re-asserts itself. He has only to guide the machine and just to aim it at the point which will the more readily break down his coal. When he has learned to steer it properly it is not so laborious as hand labor. Another thing to make it popular is the fact that a man

Our two weeks prospectors' course at mining centres is designed to be essentially a field course, entirely devoted to what a prospector sees, handles or manipulates in his prospecting or field testing.

One of the chief objects of the course is to encourage and assist the prospector in the testing of any ores he may be interested in, and so thoroughly appreciated is this branch of practical instruction that as a rule some members of the class are at this work all day during the time which the class lasts.

Lectures, illustrated by diagrams and specimens, blow-pipe work, panning work and assaying of gold and silver constitute the general outline of the course. Most of the testing work has been done on gold ores, and to meet the needs of the prospector in the field I have got together a cheap and portable outfit by which he can determine the value of the ores of the precious metals in the field as low as $1.50 a ton free milling in gold, and less in silver, and as high as the ore likes to run.

As this outfit is now made by Lyman Sons. & Co., of Montreal, in a form to go in a pack-sack, the prospector can have no difficulty in finding out in his tent how many dollars a ton his ore runs, instead of the vague generality that "it pans."

A couple of results made by prospectors in this manner might not be without interest.

PAN AMALGAMATION.						FIRE-ASSAY
		CONCENTRATES.				
	Free Gold per ton Ore.	No. tons Ore to ton of Concentrates.	Value ton of Concentrate.	Value of Concentrates per ton of Ore.	Total value per ton of Ore.	
1	$39 60	128	$60	·50	$40 10	$41 33
2	$163 40	42	$38	·90	$164 30	$180 00

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ably of a very costly nature; they take time, care and study, for failure means the sinking of a large amount of capital, which then can seldom be realized again or converted to other uses, and capitalists will therefore be very slow in undertaking such matters unless assured that they will work properly and economically, and also, that trade conditions will be of such a nature as to warrant such expenditure and assure a reasonable return for it. If we have the iron industry here on such a fôoting as is the case in the South, except the labor conditions, we could more readily overcome the disadvantages of long distance from markets, and could in fact create a home market which would be bonnd to be of the greatest material advantage to the Maritime Provinces.

Before closing I want to call your attention to a most excellent pamphlet on the subject of Southern Iron Manufactories, by Dr. W. B. Phillips, chemist of the Tennessee Coal, Iron and Railway company, and one of the best authorities on Southern scientific and industrial matters.

I think I have now taxed your patience to its utmost extent, and will therefore close with an expression of sincere thanks for your courteous attention, and hope that the paper here presented, in spite of its shortcomings, may have been of interest in some few points to all of you.

DISCUSSION.

MR. R. H. BROWN.—I have taken a great deal of interest in the paper of Mr. Meissner. He dwelt on the subject of protection in connection with labor. I don't see how it could be applied to Nova Scotia in that respect because there is no attempt to bring in Southern labor.

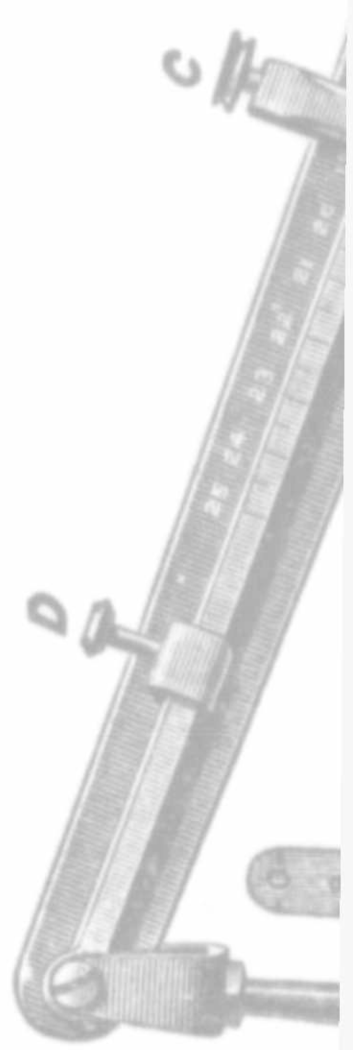
MAJOR LECKIE.—This labor is turned into material.

MR. R. H. BROWN.—It will always have to take the shape of material. I don't see any help for it. Cheap labor is on the increase there.

MR. MEISSNER.—My reference applies solely to the material composed of this cheap labor. That is why I made the remark that our labor should be protected against the product of that cheap labor. The fact of the existence of those conditions would make it necessary to adopt some protection against the class of material made from that class of labor.

cent. below the explosive line, at which point there is sufficient expansive effect of the combined gases in the test cylinder to propel the piston valve against the gong J, causing an audible and unmistakable sound, which occurs always at a certain definite fraction of the percentage of the gas tested, and which point is made a standard for comparison for all other percentages of the same gas.

If it is desired to test the gas taken from a mine for fire damp, a supply of the mixture existing in the mine is secured by pumping it into a rubber bag by means of an ordinary small diaphragm pump and brass tube fitting the mouth of the bag. As soon as the bag is filled it is corked and taken to the testing machine on the surface, and a cork with a tube and ordinary stop cock replaces the first cork. This is then connected by rubber tube to the disc valve L. The gas cylinder B is set at the point marked 6 per cent. on the beams for the first test of gas of unknown quality. The crank handle N is operated by hand, giving two or three strokes of the pumping cylinders, the combined action of which forces 6 cubic inches of gas from the rubber bag with 94 cub. in. of atmospheric air through the mixer, to the tester. If the lowest point of ignition is sufficient to cause the gong to ring, by the expulsion of the piston valve, it would determine the presence of pure light carbureted hydrogen gas of rich quality. When tests of air containing low percentages of fire damp are required, any ignitible gas is first taken in a rubber bag, and its lowest point of ignition, when mixed with air is determined. The clamp D on the beam G is moved to the point at which the small cylinder B was located when the lowest point of ignition was determined, or 6 per cent. and clamped. The cylinder B is then shifted to a point marked one per cent. less than the point marked by the clamp or 5 per cent. At this point the instrument can be operated without any possible sound from the gong, because the quantity of gas is decreased. If, when the air from the mine is forced through the machine and mixed with the standard gas taken, the gong rings, it is known that there is more than one per cent. of explosive gas in the mine air, so a smaller proportion of the standard gas must be taken, by moving the cylinder B back to 4½ per cent. and again operating it. If the gong rings from a faint blow of the piston valve, it is known that the test is nearly completed, and the line of demarkation



if this were all there would not be a marked difference in his labour as a cost factor against the average white laborer, but it is through his ignorance and indifference that he becomes a cheaper laborer, because through him the Company Store System flourishes, as it is absolutely impossible to flourish with any white labor. The negro in most cases is paid through the Company's store. Some few will have a large portion of their pay coming to them at the end of the month, especially in town districts, but in more remote districts there is no question but that any considerable amount of cash on pay day is a rarity. Owing to his ignorance the temptation arises to charge him heavy prices, and the result is that while our iron costs are more than those of the Southern iron, yet this is largely due to this peculiar labor condition, as you can readily see when you consider that the mining of coal, ore and limestone is almost entirely labor, and that it is just in these processes largely carried on in more remote places, that the conditions above mentioned of inordinate store profits cause the extreme cheapness with which those articles from which iron is made, can be produced. Canadian labor is so vastly the gainer by none of these conditions existing among it, that it cannot afford to lose sight of them for a moment in any discussion of our industrial systems.

The worst feature of the Southern labor conditions, however, is the contract prison labor, which is a virtual system of legalized slavery. All State prisoners are auctioned off to the highest bidder, usually a mining company, and then penned up in a camp near the mines and made to work, the company feeding and housing them, besides paying the stipulated price to the State per man. This system naturally allows of very cheap mining, for, while the men are usually treated quite fairly- yet, every effort is made to get the most work out of them for the least expenditure.

In regard to railroad facilities and distances from market, both sections are at a disadvantage as compared with the Northern and Central iron plants, but taking this long distance into consideration, the differences are not great, though Alabama has the advantage of 7 or 8 trunk systems, while you practically have but two. This not only gives occasionally more competition, but also a wider scope of market, This, however, is so purely a geographical condition of Canada, and say that to any student of national economy this is an absolute fact.

As against all this it may be urged that Canadian manufacturers were not able to furnish either raw material or finished product as cheaply or as well as other sections can; as before said, this may have been true formerly, but certainly has not been true of later years, and in manufacturing industries, when once the impetus has been given, their forward progress increases relatively very much more rapidly after they have once obtained a foothold, and it is only ignorance of industrial conditions that would permit of taking the stand that because any new industry has languished for a number of years it is bound to be unsuccessful, or that conditions are naturally against it; take your industry here and compare it with the Southern, and look back to the number of years that the Southern Iron Industry languished, was pronounced a failure, was practically abandoned except by a few persistent far-sighted men, who, realizing the truth of above statements, clung to it and finally brought it out to its present large dimensions and its enormous advantages to its own section of country, and I do not hesitate to say that some of your industries in special lines are now far ahead of some of theirs. You have here the same experience to go through, and from what I have seen and studied of the progress of the last few years, it appears to me that the industries here are decidedly on the upward trend and have obtained that foothold from which, if not checked, their forward progress is likely to be as rapid, with the advantages of greater diversification than the Southern industrial system.

You will pardon this digression, yet it was made in view of the enormous strides made by the Southern industries, especially raw material, which have not only built up industrially a large portion of the United States but have also furnished to the general consumers of the country an article, that through its low cost and good quality has been a most potent factor in stimulating its iron industries.

Roughly speaking the average cost of Southern iron is about $4 to $5 cheaper than Nova Scotia iron, of which probably $3 or more is due to the peculiar labor and commissary conditions, caused by the preponderance of ignorant negro labor, neither of which I am sure you would ever want introduced here, even for the sake of this $2 or $3 lower cost, and of which I shall try to speak later; they have a large