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TWENTY-SECOND YEAR OF PUBLICATION

The Canadian Mining Review

Established 1882

Vol. XXIII—No. IV. OTTAWA, APRIL 30th, 1904. Vol. XXIII—No. IV.

POWER STEEL ROPE

...THE MOST POWERFUL ROPE MADE...

"It Wears Well because it's Made Well"

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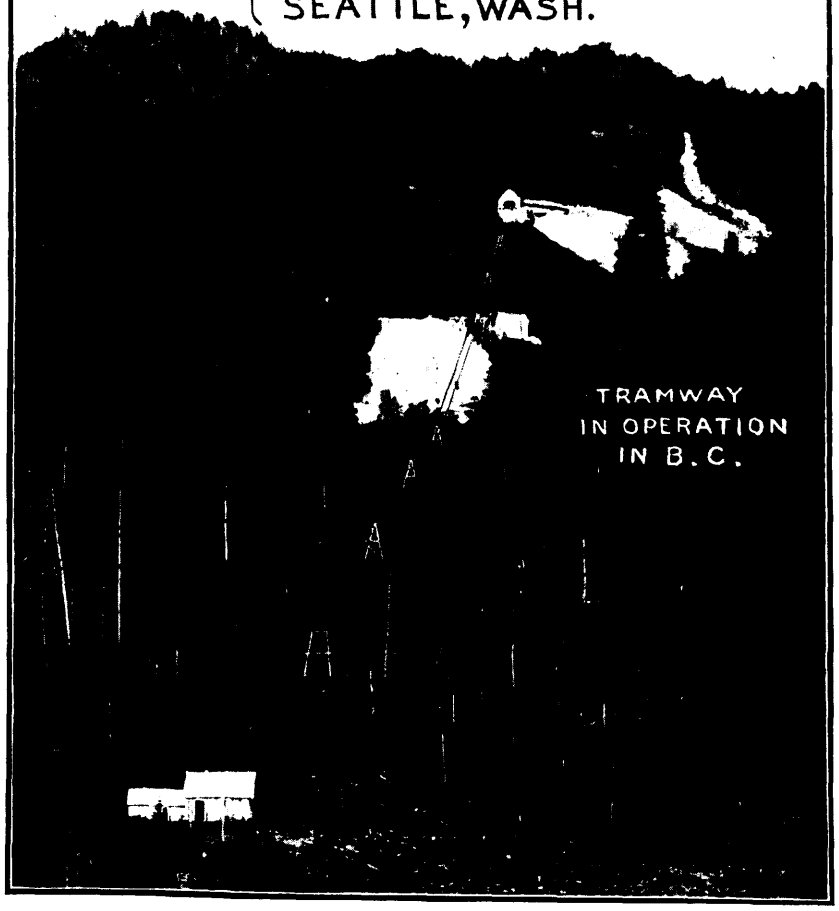

A California logger says, "Your POWER ROPE is far ahead of any we have ever used, is now in use 10 months and will last several more. Has handled more logs per month over a worse road than any of our previous ropes. Have never obtained over two or three months' service from other makes."

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DIRECTORY OF MINING ENGINEERS, CHEMISTS, ASSAYERS, ETC.

22nd YEAR OF PUBLICATION

The CANADIAN MINING REVIEW

Established 1882

THE OLDEST AND ONLY OFFICIAL MINING AND ENGINEERING JOURNAL PUBLISHED IN THE DOMINION OF CANADA.

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CONTENTS.

British Columbia and the Lead Bounty.

The bounty on lead which was granted by the Dominion Government has now been payable for some three months, and the first payment was made this month to several producers, as is mentioned in this issue in our "Mining Notes," from British Columbia.

The resumption of mining operations by the silver-lead companies has been eagerly anticipated by shareholders, and the month of April has seen an unusual amount of activity in the Slocan and in East Kootenay. The St. Eugene mine started up about the 20th of April at full capacity, having agreements which ensure a market for over 30,000 tons of its concentrates.

From the reports of the meetings held between the lead mine operators and the smelter representatives, as given in press reports during the last six weeks, it appears that several disagreements arose, amongst others the question of what proportion of the bounty was to be received by the mine and what by the smelter. The end of the month of March witnessed several meetings of the Silver-Lead Mine Owners Association, and of the Boards of Trade of most of the mining towns in the Kootenay District. The Mine Owners Association proposed addressing a Memorial to the Dominion Government praying that the bounty be made payable on a fixed quantity of lead ore to be exported out of the country, and promising that the lead smelters should be given a sufficient quantity to keep their furnaces in full operation.

To such a proposition there was not, naturally, a unanimous consent on the part of the Mine Owners, nor did the proposal fully meet the views of the representatives of the smelters. In consequence a joint conference was arranged to be held between the mine owners and the smelters for the 29th of March. In order to fully appreciate and correctly comprehend the results finally reached by this joint meeting it is advisable to give a few of the facts and proposals which obtained before this important meeting was held.

The granting of the bounty last year was the cause of the re-opening and increased development of many lead mines which had previously closed from lack of market. The smelters had done what was possible by them by reducing charges, and the C.P.R. had also reduced freight rates, so that at the first of March, 1904, the basis was (in brief) a freight and treatment charge of $11 per ton on ores of not less than 20% lead contents, and $15 per ton on ore of 40% lead, or better, with a penalty of 50 cents per unit for zinc in excess of 10%, and an additional charge of 1 cent per pound on lead contents of ore, which was supposed to defray costs of marketing the lead in England, or on the Continent.

Recently, the smelters at Trail and Nelson asked the Mine Owners Association to guarantee an annual production of 40,000 tons of lead ore, or accept an increase of $2 per ton in charges. To get such a production as 40,000 tons per annum meant the compliance of the big St. Eugene Mine, and if that mine remained closed down the other silver-lead ore producers had no recourse but to accept an increase of $2 per ton in freight and treatment charges. The pressure used brought Mr. T. G. Blackstock to British Columbia, accompanied by Mr. Ehrenzoller, the New York representative of European ore buyers. Mr. Ehrenzoller said to the Mine Owners Association that he would take up to 50,000 tons a year, for a period of two years, of silver-lead ore which would average not less than 55% of lead and 40 oz. of silver per ton of ore, and offered a freight and treatment rate of $8 per ton, the ore to go by rail to Vancouver, and thence by water around Cape Horn to Europe.

This offer from a European Agent, brought the local smelters to the point of offering to take the entire output of the mines of both East and West Kootenay Districts, irrespective of quality or grade, for a period of 12 months, but with present charges.

The smelter representatives discussed details with the mine owners which resulted in a concensus of opinion to memorialize the Government to permit (a) the Canadian lead smelters to export such ore as was in surplus of the amount needed for their furnaces, and to receive the bounty, payable under the Bounty Act, on such surplus

exported; (b) the payment, to the producers or miners of such exported ore, of the full bounty of $15.00 per ton if there remained from the $500,000 appropriated, a sufficient sum to pay the full bounty; if not, then to receive such reduced bounty per ton as would absorb the balance remaining from the $500,000, after payment of bounty had been made on the ores smelted by the local smelters.

This Memorial, after modification and acceptance by the Mine Owners and smelters at a meeting held on March 29th, was endorsed by the Board of Trade meeting, held at Nelson on the 30th of March, and in the language of the street, "it was up to the Government."

The western papers have not dealt with the question of what percentage of bounty is going to the smelter and what to the mine owner, but it is known that in some cases the smelters have obtained over 75 per cent. of the bounty payable.

That the mine owners regard the terms as satisfactory may be inferred from the resumption of work at the St. Eugene Mine, where, as before stated, work is now in full blast. This mine expects to produce 36,000 tons of high grade concentrates during the next twelve months, of which 18,000 tons will be exported and approximately 18,000 sent to the local smelters.

That the proposal is equally satisfactory to the smelters is evidenced from the remarks of Messrs. Aldridge and Campbell at the Board of Trade meeting, where both gentlemen approved the agreement.

Any solution of the troublesome lead problem that is satisfactory to the mine owners, should be satisfactory to the country at large, and the REVIEW rejoices that the first lode-mining industry of British Columbia, (that of silver-lead) has again the promise of a vigorous life—we hope it may be a long one.

The Electric Smelting of Iron Ores.

The technical press of Europe and America has, during the last six months, been giving considerable attention to the matter of smelting iron ores, or iron scrap, into pig iron and steel by the use of electricity. It will be remembered that the Canadian Government, at the close of last year, appointed a Commission, under the leadership of the Dominion Superintendent of Mines, to proceed to Europe and inquire into this subject; the Commisson has returned, and an authorative pronouncement on this topic may shortly be expected. In this issue the REVIEW offers to its readers the conclusions of the best authorities who have previously investigated the matter.

The object of the different electric processes which have been invented and tested during the last six years has been to secure the direct reduction of iron ores to metallic iron by means of the electric current, and without the use of fuel to melt the iron and slag products. Most of the methods exploited have aimed to effect this reduction in one operation and one furnace, but some inventors have used two furnaces and thereby have claimed to produce a high grade steel. Both the electric arc and the electric resistance furnaces have been used, the majority, however, using the arc by reason of its being the most efficient method of applying the electric current. But it has developed special difficulties since the arc method permits only comparatively small portions of the mixture to be subjected to the action of the arc at any moment of time, and necessarily increases the cost of the product because of the necessary reduction of the ore to small particles, to permit of its being mixed with the reducing carbon and fluxes. From this difficulty has arisen the resistance furnace so-called, which has been designed to receive the ore, flux and carbon in the lump form, after the manner of a blast furnace.

The claims made by the inventors of electric smelting methods have been attractive to the iron master and to the capitalist, but have not been of a character to appeal to the owners of coal mines or coke ovens. The amount of electric current needed has been so large that the generation of such current, by the burning of coal, would be much too expensive to permit of the application of the process. The possession of large water powers, which are permanent, is unfortunately restricted to a comparatively small number of localities. The first matter for consideration and investigation evidently is the amount of electric power needed, and its cost.

At the Stassano (Italy) works, which are now idle, the consumption of power has been given at from 3800 to 4000 horse-power-hours for each ton of metal produced.

At Gysinge, (Sweden) where a crucible process was used, the consumption of power was put at 1,320 horse-power-hours per ton of metal.

At Kerrouse, (France) the power consumed is stated to be 3,800 horse-power-hours, and Mons. Harmet gives his figure at 3,600 horse-power-hours.

The Ruthenberg furnace, experimentally tried at Lockport, N.Y., by the Cowles Electric Company, does not melt the ores to a fluid mass but has been used for two different and specific purposes,—the one to *reduce* iron oxides to sponge iron, preparatory to melting that sponge in an open-hearth furnace,—the other, to *agglomerate* the fine particles of iron oxide, which have previously been separated from earthy matters, and enriched by magnetic or other methods of concentration.

There is, therefore, from four works, an average of 3,800 horse-power-hours as the power required to produce one ton of metal; this number being according to the statements of the inventors, which are open to question as being, if anything, minimized.

To produce 1 horse-power-hour there are required 635.3 calories, or 2,580 heat units; at an efficiency of 80 p.c. this would be about 508 calories. The average calorific value of American coal is given (Suplee's Mechanical Engineers' Reference Book) at 7,598 calories. Since the highest recorded thermal efficiency is (we believe) but 22⅝ p.c., and since, in actual practice, it is rare to attain 15 p.c., if an efficiency of 20 p.c. is assumed, the result will be more favorable than perhaps it should be to electricity.

On such an assumption, the number of calories given out, would be 1,519 per kilo of coal, and 3 horse-power-hours would about equal the effect of 1 kilo (2.2 lbs.) of coal: this gives a consumption of 2,785 lbs. of coal for the production of one ton of metal.

It is, therefore, evident that unless electricity is called for by other considerations than that of smelting alone, it cannot compete in regions where metallurgical fuel is cheap.

In one of the first electric furnaces to run successfully, (Stassano, 1898) a potential of 80 volts with a current of 1,000 amperes was used. The total charge weighed 154.5 lbs. and was made up of 80 p.c. of ore, 9 p.c. of limestone and 11 p.c. charcoal; the ore contained 60 p.c. metallic iron, and yielded nearly 55 p.c. of iron, which (by composition) was a wrought iron. The time required from beginning of charge until the pouring of the metal was 2 hours. The total amount of energy delivered was 132.24 horse-power-hours, and the thermal efficiency was 61.33 p.c.

The cost of producing a ton of metallic iron, by this method, is given by Mon. Stassano, at $21.60, according to the *Iron and Coal Trades Review*, to which we are indebted for a very long and able presentation of this subject. But, as that admirable paper says, inventors' claims and figures are open, in some cases, to serious doubt if not disproof.

Analyses of the iron produced at the Stassano works by this

method, showed carbon, ranging from .04 p.c. to 9.77 p.c.; and manganese, from .05 p.c. to 9.65 p.c. The greatest length of electric arc used attained 40 inches.

All the processes of Stassano, Keller, Heroult and Harmet are substantially in agreement as to the consumption of power and heat used in the reduction. They produce a metal approximately of the character of an open hearth steel, but requiring modifications and extra expense to make the quality of crucible steel.

The Ruthenberg process at Lockport, N. Y., already spoken of, depends upon the formation of an arc, which, in the tests so far made, has been assisted by the addition of cast iron borings. The reduction of the oxide to metallic iron sponge, appears to have been more successful than the agglomerating process, as it forms a product which can be directly charged into an open hearth furnace.

The Heroult process is now being used on a mixture of scrap iron and pig to produce a tool steel, for which there is a ready sale. An electric arc is used on a charge of 3 tons, and to the first of the year 1904, some 1,500 tons had been produced.

The Kjellin process produces crucible steel, but uses soft wrought iron with some pure charcoal pig, and does not attempt the reduction of the metal from its ores. The cost is stated to be $41.00 per ton.

A new process of Mr. Gustave Gin, uses a resistance furnace, which dispenses with the use of carbon electrodes, the ore and coke being disposed in a long channel of small cross-sectional area. This process has not yet had sufficient trial to demonstrate its capabilities, but it is noteworthy that its special claims are on the line of what has already been achieved, namely, the production of special steel alloys, such as ferro-manganese, ferro-chromium, ferro-tungsten and nickel-steel.

The conclusions which may be drawn from the articles in the English and American press, point out that the conditions under which electric smelting may be done *profitably* are very rare. The *Engineering News* shows that 131 electric horse-power-days (of 24 hours) are required for the production of one ton of iron from a 65 p.c. ore. The Kerrouse works, France, require 161 electric horse-power-days for each metric ton (2204 lbs.) of steel produced. In the *Iron Age* Mr. Rossi has stated that, the average result of an actual test extending over ten weeks, was 200 electric horse power-days per ton of metal.

The *Iron and Coal Trades Review* dwells upon the fact that to few localities is given the possession of a sufficiently large water power to smelt 350 tons of iron per day, and compares the first cost figures of a blast furnace plant with those for an electric plant, putting to the latter a cost approximately five times greater than the former. In connection with this article, there has appeared a letter to the Editor of the *Iron and Coal Trades Review*, in which a Canadian gentleman has courteously differed with some conclusions reached. In this letter the statement is made that water powers of 50,000 horse-power are not rare in Canada, and that some can be developed "at a capital cost of $30 per electric horse-power." The point is perhaps worth mentioning, that the REVIEW knows of no development of electricity by water power, where the capital cost has been so low as $35 per electric horse-power.

The power at Shawinigan Falls, Quebec, has probably been developed more cheaply than any existent power in Canada, yet the electrical equipment alone cost $25 per electric horse-power, without considering any capital cost for dams, penstocks, etc., etc. The Lachine Rapids power cost in excess of $85 of capital per electric horse-power developed. The Niagara companies are all in excess of the figures mentioned. The development of a water power upon the large rivers of Canada is variously estimated by the engineers of existent electrical companies at from $50 to $100 per electric horse-power according to circumstances and conditions; the cost of electrical equipment (Dynamos, switchboards, etc.) is put at from $20 to $25 per electrical horse-power so that a minimum of $70 of capital per electric horse-power developed represents the lowest figure obtained as yet in this country, for large powers.

Canada is blessed with huge natural resources, amongst which are water powers, and the REVIEW sincerely hopes the low figures which have been given may be reached; yet if they are, beyond the question of the cost of the neccessary power, arise two other questions which must be solved before Canada can hope for much from electric smelting, and these are the costs of assembling ores and fluxes, and the cost of getting the metallic products to a *profitable* market.

The report of Dr. Haanel, and his colleagues, on these subjects will be authentic, and should be authorative. We may expect some trustworthy figures as to the consumption of electric energy from the Electrician of the Commission, and some reliable data as to the quality of the ores which have been found specially suitable for the electric process. Until the report of the Commission is issued it would be unwise to accept the various statements contained in the articles referred to as in any sense final.

Electricity in Mines.

The report of the British Committee appointed by the Home Secretary to inquire into the use of electricity in mines was issued early in the year, and will be a valuable document to colliery owners and managers.

The Commission has found that electric currents for use in mines are broadly classified into "continuous" and "alternating," and observes that the tendency in America is to use continuous current especially for haulage by locomotives. For generation and transmission the alternating current is more desirable, but for motors which are frequently started and stopped, it finds that up to the present time a continuous current has been the most satisfactory.

It is the opinion of the Commission that electric apparatus which is properly set up and used presents no such dangerous features as would justify the prohibition of its use; it fully considers the points of broken electric lamps with resulting danger of sparks, of winding from shafts, of electric coal cutters, etc., etc., before forming the conclusions which the report expresses.

The question of what voltage should be employed has been considered by the Commission which deals with the evidence submitted, and has also carefully gone into the matter of what restrictions should be permitted as to the voltage of the current at the point where the electricity is to be applied. The report is followed by a lengthy set of rules which are proposed by the Commission for regulating the use of electricity. These rules are too long for reproduction, but their general effect is rather that of instructing or informing the workmen than of imposing restrictions against the use of the electric current. As a matter of fact perusal of the report conveys the idea that the Commissioners are of the opinion that future legislation on the use of electricity should be along the lines of rendering such use safe, and not with a tendency to restrict the application of the electric fluid.

The general treatment of this subject as made in the report suggests the general principles: that the plant should be of good quality and so placed as to ensure its safety from fire or sudden shocks; that the plant should be under the charge of competent persons whose work should be periodically supervised; that all the apparatus should be inspected at stated times and tested as to its efficiency and safety; that wherever and whenever electrical machinery is used in gaseous mines, all such machinery should be so enclosed as to prevent any gas

being reached by a spark, should a machine become dirty or deteriorated so as to generate sparks.

The Rules proposed by the Commission are, as a whole, elementary, and exceedingly simple of observance to anyone at all familiar with electricity. Rule No. 5 is somewhat extended and governs the conditions under which low, medium, or high, pressure voltage may be employed. The Commission has taken low pressure voltage as not in excess of 250 volts; medium, permits of any voltage between 250 and 650; high voltage means any current between 650 and 3000 volts. In the section dealing with switches, fuses and cut-outs, all open type switches, fuses and cut-outs are prohibited, and in the section dealing with motors is the rule that the motor must be stopped if the presence of fire damp is indicated.

CORRESPONDENCE.

Oil In Canada.

To The Editor.

Sir:—

The reports of Mr. F. H. Oliphant on the production of petroleum and natural gas in the United States in 1902, have just been issued by the United States Geological Survey. These reports constitute every year parts of the annual reports of Mr. David T. Day on the mineral resources of the United States, and are, as usual, highly interesting, even more so this year than usual, as a more detailed account of each field is given, not only of the fields in the United States, but also of the foreign fields.

The following important conclusions have impressed themselves upon me in reading these reports, and they may be of interest to your readers:—

1. The enormous value of these products in the United States amounts now, each year, to more than $100,000,000, in their crude state.

2. The enormous amount of energy, work and money devoted to the finding of the pools, or deposits, of petroleum in the United States, there being an average of over 1,300 wells drilled in every month.

3. The number of new districts which become large producers, the percentage of oil produced by the old fields in comparison with the total product in the United States, was 62% in 1902, 80% in 1901, and 91% in 1900, showing the large productions from new fields.

As Canadians, we can draw very valuable lessons from the above conclusions which are suggested by Mr. Oliphant's reports; viz.—from the first we can understand what little conception we have of the truly enormous value of these wonderful products.

From the second, if we compare the fact that 1,300 oil or gas wells are drilled every *month* in the United States, while in Canada we do not drill *twenty* in the same time, we can easily see why our neighbors get valuable oil and gas fields while we do not. The simple reason of it is that we do not drill in search of these products, notwithstanding our heavy duties on oil protecting the Canadian producers. These producers clamor and agitate for an extraordinary amount of protection (which is more than 100% of the price of crude oil in the United States,) and yet they do not help the oil consumers, nor even themselves, by doing a reasonable amount of drilling and exploring for new fields. That these new fields exist in Canada, the third conclusion from the valuable reports of Mr. Oliphant clearly shows. Indeed, many remarkably prolific new fields are being opened up in the United States in many of the States not before productive, (Kentucky, Tennessee, Louisiana, Texas, Kansas, Colorado, Wyoming, California, etc.,) why cannot the same thing be done in Canada? There is absolutely no question but that it can be done if we only drill and search for these new fields, as they now do in the United States.

As I have advocated, in several communications to the Canadian Mining Institute and to the American Institute of Mining Engineers, and as it is rapidly being admitted now, the origin of oil and of natural gas is a volcanic one, and therefore:—oil and gas were supplied along some of the lines of structural weakness, or along some of the fractured zones of the crust of the earth, and new fields are to be found only along these zones or belt. Many of the fractured zones, or belts, from which our neighbors derive $100,000,000 per year of oil and gas products, extend over into Canada, and if some do not, on the other hand, entirely new belts are indicated in Canada; therefore, the future of these industries is most promising in our country, but it is evident that we must drill wells before we can obtain results. Talking and heavy duties alone will not do it, but well directed drilling operations certainly will.

Yours very truly,

Eugene Coste.

Toronto, Ont., April 19th, 1904.

The Ore Deposits of Rossland, British Columbia.

By Edmund B. Kirby, E.M.* (Illustrated by four maps.)

The Rossland Mining District began active production in 1894. Its total yield up to January 1st, 1904, is 1,620,540 tons of smelting ore, containing about $26,000,000 gross value, or $16.00 per ton in gold, silver and copper.

This tonnage was derived from the following mines:

	Approximate Tonnage.
Le Roi	974,785
War Eagle	240,455
Centre Star	229,648
Le Roi No. 2 (Josie and No. 1 Mines)	115,007
Iron Mask	17,655
Rossland Great Western Nickel Plate	12,331
Columbia-Kootenay	7,790
Velvet	5,416
Jumbo	4,395
Giant	4,344
I. X. L.	2,900
Miscellaneous	2,447
Evening Star	1,500
Spitzee	900
Monte Cristo	400
White Bear	302
Homestake	140
Virginia	100
Portland	25
	1,620,540
Estd. Value	$25,816,342
Average	$16.00

The ore is transported to the Columbia river over two competing lines of railway, and supplies extensive smelting works at the town of Trail and at the town of Northport. These towns, together with a population of about 6,000 in Rossland, are thus supported by the mines.

GEOLOGICAL POSITION.

The geological position of these ore deposits is shown by Map 1, which is a slightly modified copy of a map by the Geological

* Paper read before the 6th. annual meeting of the Canadian Mining Institute, March 1904.

Owing to delay of electrotypes, the illustrations for this paper could not be printed in this issue; they will appear in the May issue.

Survey of Canada, from studies by Mr. R. G. McConnell. The elongated oval area of gabbro is surrounded by a border of varying width of augite and uralite porphyrites and fine grained green diabases. The transition from the gabbro to the porphyrites is not well defined, and they are both from the same magma. Beyond the above border come alternating series of porphyrites, tuffs and slates, and beyond these are agglomerates.

The basic coarse crystalline and plutonic gabbro thus surrounded by borders which become more acidic and finely crystalline, and finally pass into volcanic breccia and tuffs, indicates an ancient volcano centre. The gabbro area is the main plug or neck of lava crystallized at great depths and exposed by deep erosion. Its great age is indicated by this erosion and by the numerous alterations in the rock structure and in the rock minerals.

The active mining has been carried on, not within the gabbro area, but outside of it and in the porphyrites surrounding its western end. The principal mines are all included in the small group of claims shown near the edge of the gabbro and located on the flank of Red Mountain, above the town of Rossland. Map No. II is a horizontal section through this group of claims at the approximate elevation of 3,530 feet above sea level. It shows the structure details exposed by the workings of the Le Roi, Centre Star, War Eagle, Josie, Number One and Iron Mask mines. These mines aggregate some 20 miles of total workings, and the principal depths attained are those of the War Eagle, 1,615 feet measured on the vein; the Le Roi, 1,361 feet, and the Centre Star, 1,289 feet.

On the west of these claims there is a belt of fine grained eruptives, probably porphyrites, which are in a schistose condition; having been so plated by pressure as to frequently resemble shale.

COUNTRY ROCK OF MINES.

Within the area of the claims the prevailing rock is evidently all from the same magma, but shows innumerable variations in rate of cooling and degree of metamorphism. It is mainly composed of plagioclase feldspars and pyroxene, generally in about equal proportions, but towards the gabbro area, bodies of pure pyroxenite are occasionally encountered. There is usually a small proportion of orthoclase feldspar and sometimes hornblende, and some observers have noted the fact that these appear more frequently towards the west. The rock appears to be holocrystalline and more or less porphyritic. The crystals may be either microscopic or as large as, say, five mm. while one or two mm. is a common limit. The feldspars are more or less altered to a turbid or porcelain-like appearance, while the pyroxenes are partially transformed to fibrous minerals of the uralite group. In strongly altered places, and especially within the veins, the rock is frequently colored brown from microscopic crystals of secondary biotite.

Although varying considerably in different places, specimens of this rock have generally been determined by microscopical observers as augite porphyrite, and it certainly belongs to the gabbro group, differing from the central area mainly in relative time and rate of cooling. Broadly speaking, the size of crystals tends to increase towards that area, and coarse crystalline masses are more frequently encountered, while in the other direction the structure becomes more fine grained.

DIKES.

This country rock is cut by innumerable dikes which require detailed comparison and determination by the microscope. Generally speaking, they appear to be either mica traps, (perhaps kersantites) or altered basalts (perhaps melaphyre). The latter are often greatly decomposed.

The general direction of the parallel fractures has been north 10° w. with dips, which are either vertical or very steep, to the east. Their detailed fluctuations in strike and dip and the way in which they branch, unite and re-branch are clearly shown by the map. As explained hereafter, they probably belong to at least two periods, one before and the other after the ore deposition. Occasional belts of special crystallization in the counntry rock indicate dikes of an earlier date, which have since become cemented with the country rock and jointed to correspond with it. These have not been mapped.

THE VEINS.

These are shear zone fissures consisting of a series of parallel platings of the rock produced by shearing under high compression. In the Centre Star-Le Roi vein, in which the shear zone is most typically developed, this series of platings is 20 to 40 feet wide and dips about 70° to the northwest. The Josie vein is parallel; but the Centre Star north vein, the War Eagle and Iron Mask veins are branches from the Centre Star-Le Roi vein. Their positions and dips are shown upon the maps.

The ore consists of country rock more or less replaced or impregnated by pyrrhotite, accompanied in places by small proportions of chalcopyrite, pyrite, arsenopyrite and quartz. The pyrrhotite when it occurs by itself, even in solid masses carries, but little gold, say, from $0.50 to $3.00 per ton. The chalcopyrite is the principal carrier of gold, and ore of commercial value occurs only in those localities where chalcopyrite, pyrite and arsenopyrite have been deposited with the pyrrhotite. The manner in which these minerals occur within the interstices of the pyrrhotite, and the fact that continuous masses of pyrrhotite ore are impregnated in some places and barren in others, proves the later deposition of these valuable minerals. They have been introduced after most of the pyrrhotite was in place, although occasional occurrences of chalcopyrite and pyrrhotite in quartz point to the possibility of some contemporaneous deposition. The change from one deposition to another was probably gradual. A small proportion of the gold in the ore is native in the form of small grains and scales. The fact that oxidation extends only a few feet below the surface, while the proportion of metallics seems to average much the same even in ore shipments from the lower levels, suggests original deposition in this form. No data have been collected, however, to indicate whether it was contemporaneous with the pyrrhotite formation.

The average proportions of gold, silver, copper and total sulphides in a grade of, say, $15.00 full assay value are as follows:—

	Average Centre Star Ore.	Average War Eagle Ore, Representing also ore of Number One, Josie-Le Roi.
Gold, (oz.)	0.59	0.505
Silver, (oz.)	0.43	1.0
Copper, (%)	1.12	1.78
Sulphide Minerals, (1%,)	25.0	22.5

In various places the pyrrhotite seems to be accompanied by a little nickel and cobalt. Specimen analyses ranging from 0.13 to 0.65% nickel, and from a trace to 0.59% cobalt.

FAULTS.

These have an average direction which corresponds to the dike system, with dips ranging from vertical to 50° easterly. Out of the great number of fractures studied and surveyed only the principal faults have been plotted, i.e., those fractures which appear to have affected the veins by well defined displacements or by acting as barriers to mineral solutions. The map gives only a

partial idea of the way the main faults branch in strike and in dip, and of the numerous minor interlacing fractures which connect them. In certain localities it will be seen that the ground is hopelessly shattered.

The faults are frequently not plainly marked, having no clay filling, and at most only a small thickness of comminuted material. They frequently consist of a zone or series of close fractures, some of which are better marked than the others, and these fracture planes often interweave in such a manner that local measurements of their strike and dip are deceptive, and these can be determined only by comparison with other workings. As a general rule, the faults appear to have been too tightly compressed to give access to mineral solutions, and those existing during the deposition period have therefore tended to act as barriers to the flow of these solutions.

Since individual faults often cross dikes at sharp angles in strike and in dip, a fault frequently breaks along a dike for considerable distances. Hence in many cases of vein displacement it is impossible to say how much of the total amount has been due to the dike fracture, and how much to subsequent fault fractures accompanying it. In most cases where dikes are not accompanied by plainly marked fracture planes the displacement is so small as to indicate that the fault system, and not the dike, has probably been responsible for most of the shifting.

The sharp angles at which the faults cut the War Eagle vein have tended to produce overlaps of the vein, which is most clearly disclosed in the case of fault (K) on upper levels.

The Josie and Centre Star-Le Roi vein, being crossed more squarely by the fault system, afford the best indications of its effects. The Josie dike, or more probably an undetermined fault accompanying this dike, have caused a displacement, which is indicated in the Josie and Number One to be a north throw going east. Proceeding east from fault to fault they are found to have the same throw up the faults (I and J) at the junction of the Le Roi-Centre Star territory, after which the steps occur in the other direction, with a throw to the south. On reaching fault (Q) a north throw is again encountered, and the steps to fault (T) are then south, north, north. The large scale reversal often stopping in both directions from faults (I and J) indicates a lifting of the blocks from this centre, the possibility of which is borne out by various connections of the fractures between faults (H) and (K), indicated in lower workings. As explained hereafter, much of the faulting occurred after the ore deposition and also at a later date than the dike formation.

DISTRIBUTION OF ORE AND ORE SHOOTS.

The pyrrhotite mineralization has been very abundantly distributed through the larger veins, but the secondary disposition of gold and copper bearing minerals has been more localized, occurring in the more favorable places. The bodies of valuable ore thus found are sometimes lenses, tapering out at the edges, and sometimes blocks terminating against faults or dikes. These ore bodies are found distributed within more limited portions of the vein area, which in the practical sense thus constitute the ore shoots, and indicate those portions of the area to which the gold and copper bearing solutions had the best access. The shoots are upon a large scale and of such irregular form that their shape and limits have been developed very slowly, and the largest and best defined up to the present date are those of the War Eagle, Centre Star and Le Roi mines.

The War Eagle shoot has a dimension of 300 to 450 feet along the vein, and an almost perpendicular trend upon its plane. It is so located that its median line roughly coincides with the line of the main shaft.

The Centre Star main shoot is located in the space between the shaft and the Le Roi end line, and appears to have a dimension of 300 to 500 feet along the vein, with a steep trend to the east. The Centre Star east ore shoot is several hundred feet east of the shaft, but has not yet been sufficiently developed to determine its length along the vein or its trend, although the latter now appears to be either perpendicular or very steep towards the east.

The Le Roi ore shoot on the 350 foot level stands near the east end of the claim, as shown in the map, and descends perpendicularly, then assuming a westward trend. A little below the plane of the map it stretches out so as to include the entire distance between the Josie dike and fault (1), as illustrated by Map III of the Le Roi 700 foot level. The structure of the shoots and of the pay ore bodies within these shoots everywhere points to the conclusion that their location and shape are due entirely to the accidental conditions directing the upward flow of the mineral bearing solutions.

The marked difference between the proportions of gold, silver and copper in the Centre Star ore shoots and those of the other mines suggests that the solutions in the Centre Star came from a different region than those which furnished the other deposits. The fact that the Centre Star was somewhat nearer to the volcanic centre than the others, and that its ore shoots trend in that direction, may account for this.

These shear zone fissures, more or less shattered by repeated movements, have afforded permeable channels for the ascending mineral solutions, which have penetrated and decomposed the country rock, replacing its rock minerals wholly or partially by metallic minerals. In places the entire width of the shear zone has thus been transformed into ore, while in other places the mineralization has been narrow. The solutions have frequently jumped across from one set of plating fissures to another, shifting the pay streak from the hanging to the foot side, or to intermediate positions, as the case may be. In the Centre Star-Le Roi vein the foot wall fissure is the one which is the most regular and distinct, and is marked by a vein of small interlacing calcite seams, which has been found a very reliable indicator of the position of the vein. As a rule the heaviest ore deposition has taken place near this foot wall, and mineralization extends to irregular distances on the hanging side, gradually fading into the country rock. In the War Eagle vein the hanging wall is generally the most distinct and best mineralized, with irregular extension into the foot wall side.

While many of the dikes and faults merely occasion small displacements, with no effect upon the mineralization, a number of them evidently occurred before this mineralization was begun, or at least before its completion, and acting as partial barriers to the flow have so deflected the solutions as to greatly increase the deposition on one side, although they have not themselves been mineralized. Map IV of a portion of the War Eagle 6th level illustrates the way in which solutions rising through the fractured ground, caused by a fork in the vein, have been stopped by a large dike, and were so deflected and accumulated in rising along its under side as to produce exceptionally large and rich ore bodies. In the Josie vein the Tramway dike has in a similar way produced the Annie ore shoot below the plane of the map, and the Josie dike has had the same effect upon the Le Roi and Black Bear veins (see Map III). In both these veins the solution towards the west end seem to have been more or less confined to the space between the Josie dike and the partial barrier afforded

by fault (D). Between (D & E) the ore bodies are smaller and less frequent. The principal channel for solutions has been between faults (E) and (I), where large masses of ore have formed, reaching widths of 100 feet up against fault (E). The same phenomena are repeated throughout the Centre Star ground, as exhibited by Map II, which everywhere shows the tendency of such mechanical barriers to deflect or accumulate the solutions. In the Centre Star it will be noticed that the principal channel has been that portion of the vein between fault (K) and fault (Q). Fault (K), however, notwithstanding its large displacement, has for some reason been an imperfect barrier. In the lower levels heavy deposition has occurred on both sides of it, while on the second level, shown on the map, it has been mainly on the east side, and, at this horizon, is also accompanied by a deposition of ore along the plane of the fault. This is rather exceptional, and in fact is the most clearly marked case of deposition within fault planes. In the few other instances there is some doubt as to whether the material is not dragged ore or an original vein. As a rule, the faults do not appear to have been very accessible to the solutions.

The numerous instances of displacements by faults and dikes where the severed portions of the vein on each side are alike, prove that some of the dikes and some of the faulting occurred after the ore formation. If the dikes were studied in detail and classified they would probably be found to belong to two or more different periods, some of which were later than the deposits. As to faults, the facts observed accord fully with what is known of dynamic action during the long period while volcanic activity is expiring. Shocks and movements occur repeatedly at increasing intervals. Early fractures would afford planes of weakness which would not only be kept open by the repeated movements but would be multiplied and extended by branches and interlacing fissures. Such action probably continued long after the ore deposition and also after the dike formation, since these are found to be cut by faults.

It is very noticeable that the later solutions introducing the gold and copper bearing minerals with quartz have as a rule followed the pyrrhotite deposition, and do not seem to have sought or found new permeable channels in the rock where these minerals might deposit by themselves. On the contrary, they seem to have been unmistakeably restricted to the ground already impregnated with pyrrhotite, and the greatest enrichment has as a rule occurred where the previous pyrrhotite deposition was most extensive.

There seems no reason to believe that the pyrrhotite had chemically any more influence on the subsequent deposition than ordinary country rock would have. It may have been that the friable pyrrhotite ore presented such local weaknesses as to become especially shattered by subsequent movements, and thus afforded the most permeable channels. What probably occured, however, was that there was one continuous flow which gradually changed in chemical contents and conditions of deposition. The altered solutions at the time of the secondary deposition merely followed the channels of flow which were already established, possibly modified more or less by a refracture or brecciation of the pyrrhotite ore.

CONCLUSIONS.

The conclusions derived from a study of these deposits are as follows :—

(1) The pyrrhotite was deposited from aqueous mineral solutions ascending through the more fractured and permeable portions of the shear zone fissures.

(2) The gold bearing chalcopyrite, pyrite and arsenopyrite with quartz were deposited later from the same flow rising within the same channels but restricted to those portions of the channels which still remained unfilled, or which were re-opened by further fracturing of the friable pyrrhotite ore.

(3) The main faults and some of the dikes existed before the formation of pyrrhotite began, or at least before its principal deposition.

(4) Their intersections with the shear zones made barriers which more or less directed the flow, accumulated the solutions, and determined the position of the main ore bodies.

(5) After the ore formation more dikes appeared. Faulting was repeated intermittently, continuing probably up to recent times, and the early fractures were kept alive.

The writer is well aware that the origin of pyrrhotite is still in dispute by eminent authorities, but believes that a study of the Rossland deposits must remove any remaining uncertainties as to this question. All observations, from the occurrences of the pyrrhotite as mineral replacements, veinlets and films in the rock to the effect of dikes and fractures in massing its formation, point to deposition from mineral solutions. In these deposits at least, it is impossible to even consider "direct igneous origin" or "magmatic segration," and no evidence has been found to suggest any difference between their origin and that of ore deposits of pyrites or other minerals whose genesis is now established.

The evidence does show, however, that the conditions necessary for pyrrhotite deposition prevailed at an earlier time than those required for chalcopyrite, pyrite, arsenopyrite and quartz. It is well understood that during the period while heated waters are ascending in the vicinity of cooling eruptive masses the chemical contents of the solution slowly change, and so do the conditions of deposition. For the same flow to first yield pyrrhotite, and then so alter as to produce the other minerals, is no more exceptional than the well-known excessive deposition in veins of the more common minerals. It may be that the only difference between their origin and that of pyrrhotite is that the latter requires exceptional depth, heat and pressure. The heat would be greatest during the earlier stages of circulation, and the great erosion noted by the Geological Survey indicates the prevalence of unusual depth and pressure at the time.

EFFECT OF STRUCTURE UPON MINING METHODS.

Map II illustrates the peculiar difficulties presented to exploration work within an ancient volcano. Every dike and every zone of fissures constituting a fault creates a gap or blank in the formation and to these are added the gaps due to vein displacement. Systematic cross cutting aided by diamond drilling is necessary on account of these displacements, vein-branching, the variations of vein thickness and the shifting of ore from one set of planes to another. If carelessly placed a cross cut or drill hole encounters so many of these blanks as to afford no information, or what is worse, indecisive results. It is very difficult to make such work efficient, and it calls for every resource of care and skill.

In the War Eagle and Centre Star mines structure details are carefully kept up, and it is endeavored, so far as possible to make cross cutting effective, to avoid work in belts ofdike systems or belts of shattered ground, and to direct the principal explorations to the main channels of flow.

ACKNOWLEDGMENTS.

The structure details of the maps are by Mr. Carl R. Davis, E.M., Superintendent of the War Eagle and Centre Star Mines, and Mr. Hugh Rose, A.B., Mining Engineer. The writer also

desires to acknowledge the friendly assistance and courtesy extended to him by Mr. S. F. Parrish, Manager of the Le Roi Mining Co., Limited, and Mr. Wm. Thompson, Manager of the Rossland Kootenay Mining Co., Limited, and Mr. Paul S. Couldrey, Manager the Le Roi No. 2 Mining Co., Limited, who have freely placed at his disposal all the data and information in their possession concerning the structure of these deposits.

Acid Making From Pyrrhotite.

By ERNST A. SJOSTEDT, Sault Ste Marie, Ont.

Attempts at using pyrrhotite (monosulphide of iron, $Fe_6 S_7$) instead of brimstone or pyrite (bisulphide of iron, $Fe S_2$) for acid making have often been made, but the same having repeatedly ended in failure and disappointments, they finally come to be considered as useless and foolhardy undertakings; and some engineers and professional men have even gone so sar as to publicly pronounce it an impossibility, as will be seen from the following quotation:—

"One of the most serious errors ever perpetrated in the manufacture of acid from pyrites is the atttempted employment of pyrrhotite for pyrite. Aside from the greatly lessened proportion of sulphur, 36% as against 53%, the pyrrhotite will not even yield freely what sulphur it contains, but crusts with oxide of iron, turns black, and is soon extinguished when treated in an ordinary pyrite kiln. It seems scarcely possible that extensive works for the manufacture of acid should have been erected, their supply being entirely derived from a deposit of the valueless monosulphide, but such has been the case in more than one instance, and will continue to be so in enterprises conducted without skilled direction."

When, therefore, a few years ago the problem was presented to us of treating the Sudbury pyrrhotite so as to recover not only the nickel, cobalt and copper present, but to utilize its sulphur and iron contents as well, no sympathetic co-operation was to be expected, and open criticism was heard from many quarters. It is with a feeling of no small amount of satisfaction, therefore, that we are now able to announce that the question of economically using the sulphur from said ore has been solved; and take pleasure in herewith presenting such information and data as will prove to the engineering fraternity the value of the work done, and the importance of the results obtained.

THE PROBLEM.

The Sudbury pyrrhotite, as shipped for smelting purposes averages about 15—20% suiphur, 1—3% nickel and .5—2% copper, the balance being made up of a corresponding percentage of iron and gangue. Realizing the impracticability of using such low grade ore for the purposes set forth, the first step taken was in the direction of concentrating it. The pyrrhotite being easily distinguished by its pale color from the deep yellow chalcopyrite, the separation of the same from the copper ore and the gangue was readily accomplished in the rock house, at the crusher and on the sorting table; and in this separation we obtained two workable grades of ore, one hign in copper and gangue and low in sulphur, designed for the ordinary matte smelting process, and the other, low in copper and gangue but high in sulphur and nickel, intended for the acid plant. This latter grade usually averages about 28% sulphur, 3% nickel, .5% copper and 50% iron,

The plan proposed for utilizing the sulphur in this ore was to roast the pyrrhotite in a closed furnace, with the recovery of the resulting sulphur dioxide gas, which, after having been cleaned and cooled, was to be used for the following purposes:

1. In the manufacture of a "bisulphite liquor," of a character suitable for, and to be used in, the sulphite pulp industry.

2. In the manufacture of liquid sulphurous anhydride, intended as a reserve supply for the sulphite mill in case of any stoppage or interruption at the roasting plant, or when the pulp mill would call for more or a stronger gas than that furnished by the roasters in operation; also intended as a separate commercial product to be disposed of for the purpose of refrigeration, ice making, sugar refining, bleaching, disinfecting, etc.

3. In the manufacture of sulphuric acid—50°B, 66°B and 98% strong—for the great market open to such an industry, covering an extensive field from fertilizers to gold mining, and including manufacturers of fertilizers and soda water, oil refiners, dyers, furriers, cotton bleachers, brewers and galvanizers; and also for the rubber and hat trade, the woolen and wire mill; the nitroglycerine and dynamite manufacturers.

THE ROASTING PLANT.

The question of greatest importance at this stage, consequently, was to find a method or roasting system by means of which a clean and sufficiently strong gas could be obtained at smallest cost. Roasting experiments were, therefore, carried out in a systematic manner in shaft and reverbatory furnaces; and the first conclusion reached was that the ore, in order to be successfully treated, must be crushed to a powder. It now happened that at this time the Herreschoff roaster for treating pyrite fines was brought to public attention, and receiving some encouragement from the designer as to the feasibility of this furnace accomplishing the desired aim (a dead roasting of the ore without any auxiliary heat), one of these roasters was purchased and erected at this place for trial purposes. In spite of every effort, and after a long series of tests, however, we found that this roaster, as constructed, would not answer our purpose—the roasting heat not being maintained by the combustion of the sulphur in the ore, and the gas produced being too diluted. The many excellent points embodied in this type of roaster being fully appreciated, attempts were at first made simply to improve on the weak points as applied to our special problem, but gradually a somewhat different type was evolved, containing some important changes, thanks to which the problem was eventually solved. These modifications consist of (1) a minimizing of the heat of radiation, (2) the application to best advantage of the roasting heat generated, (3) the exclusion as far as possible of an excess of air over and above that required for the oxidation of the sulphur in the ore, and (4) the application of an auxiliary source of heat, in case of need. And the special features embodied in the new roaster are the following:—

1. The combination of four single furnaces in one battery, disposed equidistant from a common centre.

2. A minimum distance between the floor and roof arches of the roasting chambers, made possible by the construction of the arm, and the manner in which it is secured to the centre shaft (it being secured in position by a horizontal motion and a quarter turn).

3. A round rabble arm, with a perfectly secure locking device having both ends closed so as to prevent any inflow of air from the centre shaft to roasting chamber; the air of combustion being admitted through special pipes, provided with valves for a perfect control of the same.

4. Separate muffle chambers for the application of an auxiliary heat, and having no connection with the roasting chambers, the one under the bottom hearth being a combustion chamber, and those under the second and top hearths being heating chambers,

* Paper presented at the sixth annual meeting of the Canadian Mining Institute, March, 1904.

through which the combustibles of the extraneous fuel pass from the combustion chamber, and thus utilized to advantage in heating the corresponding roasting floors.

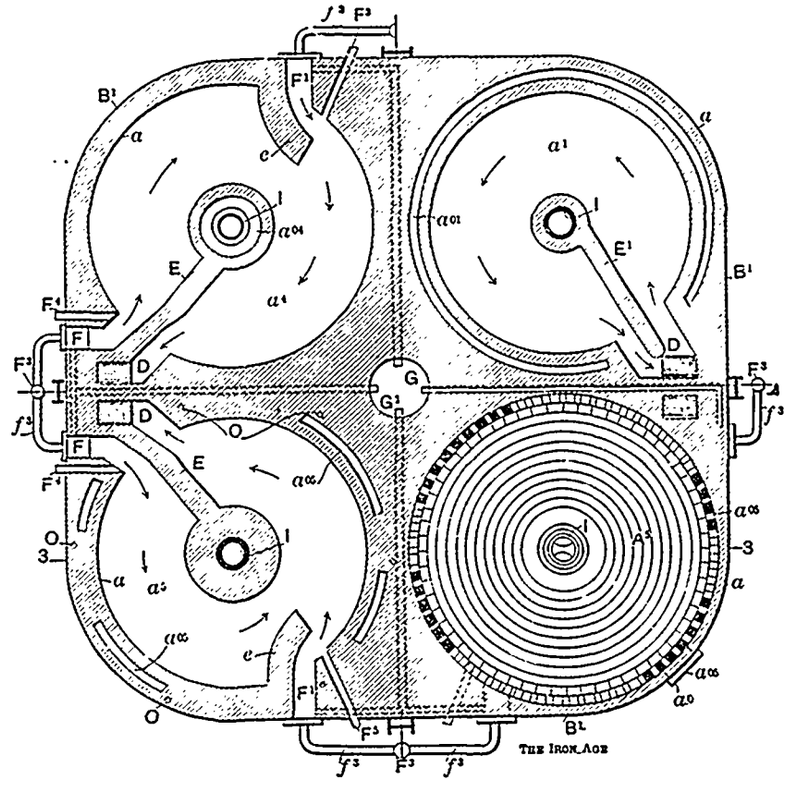
5. A screw device for feeding the ore from the hopper to the roaster, the same being propelled by means of an endless chain from the main driving shaft.

This roaster is shown in Figs. 1 and 2. Fig. 1 presents a battery of four furnaces in horizontal cross section on broken lines, 1——1, 1'——1' and 2———2 on fig. 2, showing the combustion chambers a^6, the lower and upper heating chambers a^4 and a^1, and the lower or discharging hearth A 5; fig. 2, shows a sectional elevation of the battery on lines 3————3, on fig 1, through the central columns of the furnaces, one side shown with the rabbles and one without. A1—A5 are five straight arched hearths, and a^1, a^4 and a^6 the combustion and heating chambers. The flow of the fuel gas and combustibles is indicated by arrows. The gas or oil, entering from main F3, through branch F3 and a suitable burner into the combustion chamber at F and F1, strikes the hot baffle walls and is readily ignited, passes through the chamber and reaches the flue D, which leads to the heating chamber a4 over the lower roasting hearth. This chamber also being provided with a baffle wall E, which extends to and surrounds centre shaft 1, separating the gas inlet from its outlet, the combustibles are compelled to make a full turn here before passing out and up through the upper section of chimney flue D to heating chamber a1. Here it makes a similar circuit before finally passing out through the last section of D and flue D1, to stack K, which is in common to the whole battery of four roasters. F4 and F5 are peep holes, for inspecting the heat and the combustion in the heating chambers. G is an air receiver ("hot blast") in the centre of the battery into which the air of combustion is introduced under pressure and heated from the brick walls with which it is surrounded, and thence carried through blast pipes B2 to burner at F. The ore finely crushed is introduced through an opening in the top of roof A of the upper roasting chamber to the hearth A1, by feed tube n, provided with an automatic screw charging device nl. Owing to the bottom heat furnished by the heating chamber aL, the ore is soon dried and is now moved towards the circumference by the teeth of arms L, fastened to the revolving centre shaft I, and finally drops down on hearth A2 through rim discharges a o 1. The arms of this hearth, having their teeth placed in opposite directions to those in hearth a1, now cause the ore to move towards the centre, and discharges it through centre openings ao2 on hearth a3, and the ore is thereupon moved towards the circumference, drops through ao3, on the shelf a4, is then moved towards the centre and discharged on shelf a5, and finally through ao5, and spout ao6 in the ore conveyor. O are pipes admitting and controlling the air supply for the roasting of the ore, and M is a cast iron pipe leading from the top of arch A of each roaster and through which the sulphurous gases pass out from the roaster to the main gas flue.

Four of these batteries of kilns—16 units—have been built, with a total capacity of treating forty tons of ore per day; also a crushing plant has been installed, consisting of one 24" x 15" jaw crusher, two 36" rolls and two revolving screens of No. 16 mesh, with a capacity of pulverizing about 80 tons of ore per shift of 10 hours; also two Dellwik-Fleischer No. 4 water gas generators, each having a capacity of producing 20,000 cubic feet of water gas per hour, or with a total capacity of about 800,000 cubic feet per day; also an electric installation of three 95 h.p. General Electric motors for supplying the required power.

THE ROASTING GAS.

At first water gas was used as an axiliary fuel, but by gradually improving the details of the roasters and gaining in experience we finally succeeded in doing without it, and since then have roasted our pyrrhotite without any extraneous fuel (even at times when the sulphur in the ore averaged but 20 to 25%, producing a gas of sufficient strength 6-10% SO_2), for making bisulphite liquor and liquid SO_2; also a fairly well roasted ore, running as low as 20% to 75% S when admitting a liberal amount of air and obtaining a weak gas, but generally from 1% to 3% S when producing a good gas.



A glance at the chemical reactions taking place in burning sulphur and in roasting iron sulphides will assist in forming an intelligent idea of the maximum strength of gas obtainable, as well as of the efficiency and significance of a 10% SO_2 gas from pyrrhotite.

When burning sulphur: $S + 2O = SO_2$, i.e., all the O combines with the S to form SO_2. When burning pyrite: $2\ FeS_2 \times 11\ O = Fe_2O_3 + 4\ SO_2$; i.e., 8 parts of O out of 11 unite with S to form SO_2. When burning pyrrhotite: $Fe_6S_7 + 23\ O = 3\ Fe_2O_3 + 7\ SO_2$; i.e., 14 parts of O out of 23 unite with S to form SO_2. When burning pyrrhotite: $2\ FeS + 7\ O = Fe_2O_3 + 2\ SO_2$; i.e., 4 parts of O out of 7 unite with S to form SO_2. The roasting being accomplished by means of air instead of undiluted oxygen, (containing 21% O, by volume), we readily find that the highest theoretical percentages of SO_2 obtainable are the following:—when burning sulphur, S: $21 \times 2 \div 2 = 21\%\ SO_2$ max. When burning pyrite, FeS_2: $21 \times 8 \div 11 = 15.27\ SO_2$ max; when burning pyrrhotite, Fe_6S_7: $21 \times 14 \div 23 = 12.78\ SO_2$ max: when burning pyrrhotite, FeS: $21 \times 4 \div 7 = 12.00\ SO_2$ max.

The annexed tables from our daily records of two weeks run in February last, during which time we used pyrrhotite only (and that of an inferior grade) will furnish exact data of results obtained under such circumstances.

Composition of ore used, average sample taken from each 40 ton lot.

	a	b	c	d	e	Average
Insol	24.74	29 20	24.95	21.03	16.10	22.50
Sulphur	26.30	23.81	24.67	27.60	29.90	24.46

Roasting Results, (average of tests made each hour).

February	11-12	13-14	15-16	17-18	19-20	21-22	23-24
Strength of Gas, % SO_2	8.60	8.30	7.90	7.90	7.40	7.60	7.70
Roasted Fines, % S	1.66	1.86	2.04	2.54	1.78	0.95	1.86

During these two weeks we treated 210 tons of pyrrhotite, containing 111,112 lbs. of sulphur, and recovered 191,917 lbs. SO_2, thus obtaining an efficiency of 86%. The average working cost, exclusive of heating and lighting the building, amounted to $1.86 per ton of ore treated, distributed as follows:—

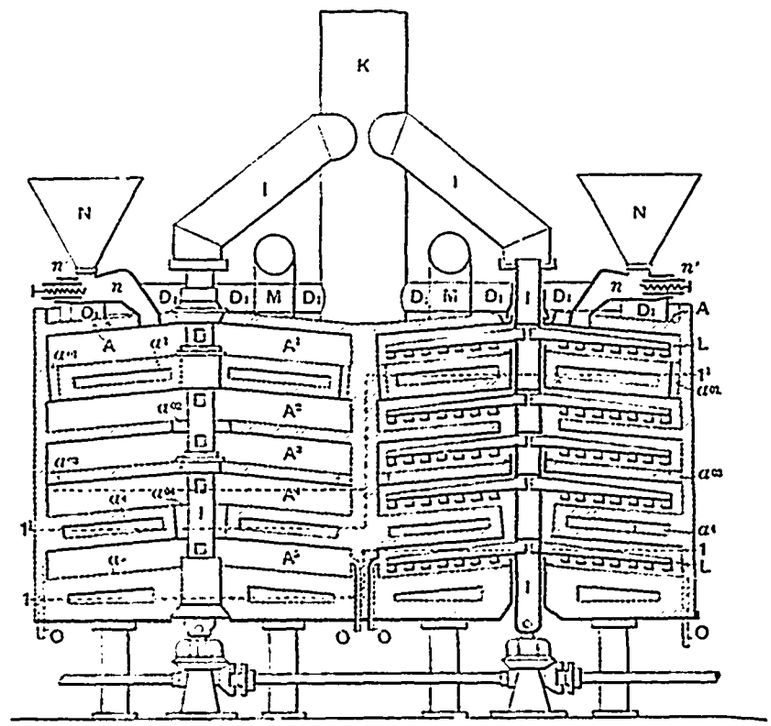
Labor	$1.12	Crushing	.50
Power	.24	Roasting	.75
Repairs and sund..	.50	Sup. rep. and sund..	.61
	$1.86		$1.86

If to this amount we add depreciation of plant (say 14 cents per ton), the cost of the raw ore (say $5.00 per ton) and the cost of briquetting the fines (say 75 cents per ton), and then subtract the value of the briquetted ferro-nickel ore, (which we will assume to be equal to that of the unroasted ore, or $5.00 per ton), we obtain a total of $2.75 as the cost of 914 lbs. SO_2, equal to a rate of $6.00 per ton of SO_2 gas recovered, corresponding to $12.00 per net ton, or $13.44 per gross ton, sulphur.

It may be well to state here that at first no other raw material than pyrrhotite was used for the acid making, but some valuable deposits of pyrite having been discovered in close proximity to the company's iron mine, it was decided to use some of it at times when treating a low grade pyrrhotite, or when an extra supply of gas would be required. During the last half year's run a few hundred tons of brimstone were also used, on account of shortage of both pyrrhotite and pyrite from the mines—(caused by the company's financial condition at that time). Altogether 10,000 tons of pyrrhotite and 3,000 tons of pyrite have been roasted in these kilns, and 375 tons of brimstone used as raw material at our acid plant up to the present time.

THE BISULPHITE LIQUORS.

Tilghman, in his patent involving the use of sulphur dioxide in reducing wood to pulp, states that his invention consists of a process of treating vegetable substances, containing fibres, with a solution of sulphur dioxide in water, either with or without the addition of sulphites, heating the same under pressure in a closed vessel to a temperature sufficient to cause it to dissolve the intercellular incrusting or cementing constituents, leaving the undissolved product in a fibrous state, suitable for the manufacture



of paper pulp etc. Owing to the smaller absorption of the sulphur dioxide by water, than by a watery solution of metallic oxides, such as soda, lime or magnesia, the practice in pulp making is therefore to make use of such solutions in different ways—the system in use here being what is called the "tower system." This consists of a battery of high towers filled with a coarsely broken dolomitic limestone, through which runs a spray of cold water, while the roasting gas is forced up through the tower, meeting the weak lime solution thus formed, and is absorbed by the same, forming monosulphite of lime ($CaSO_3$) and magnesia; and upon the neutralization of the lime by the gas, the water absorbs free SO_2, forming an acid solution (H_2SO_3) which again dissolves some of the lime and magnesia salt, resulting in the formation of a solution of monosulphite of lime and magnesia in free sulphurous acid (H_2SO_3)—the so called "bisulphite liquors." The desired strength of this solution is about 4% total SO_2 and 1% lime (5.5°B); and our experience here has taught us that for economically obtaining such a liquor a minimum of 5% SO_2 in the roasting gas is required.

The gradual progress and improvement made in our work in this department will best be seen from our first year's record hereby presented.

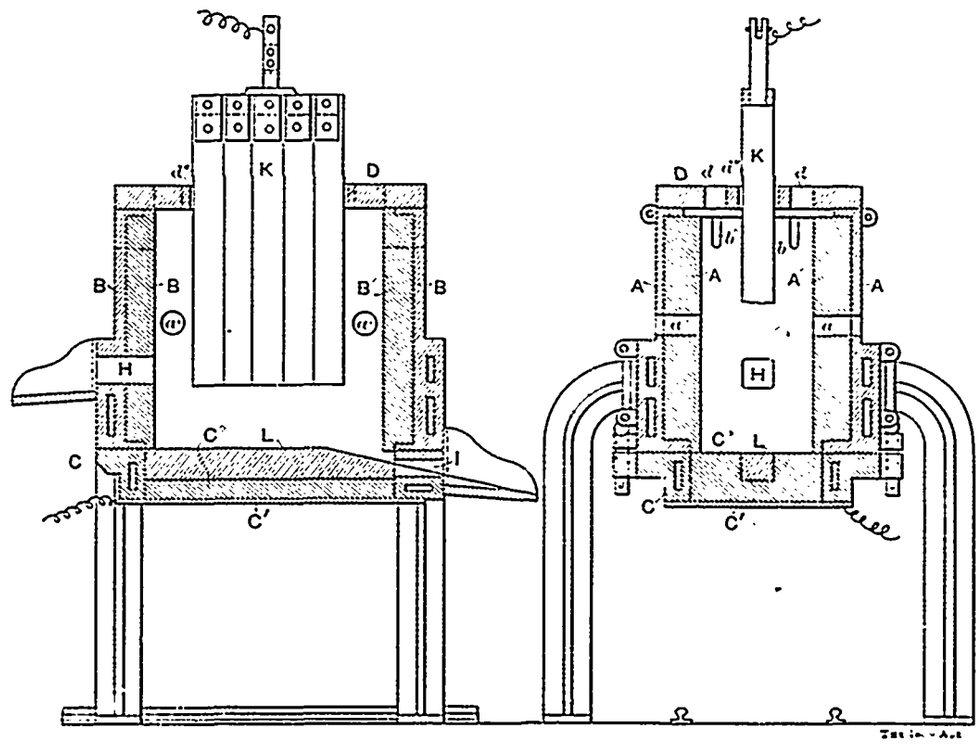
	Tons SO_2 made.	Tons SO_2 recovered.	Av. Strength of gas, % SO_2	Efficiency of recovery.
January	228	163	5.9	71.4
February	208	107	4.7	51.4
March	221	165	5.3	74 9
April	249	173	4.7	69.3
May	197	125	4.1	63.2
June	250	163	5.0	65.6
July	265	125	4.6	60.3
August	265	117	5.1	44.3
September	285	205	6.6	71.8
October	241	205	6.7	85.3
November	252	221	8.1	87.0
December	260	255	12.6	97.0

This table also shows that from January to July inclusive the gas supply was constant but weak, and the absorption not sufficient (66%); also that during July and August, when the weather was warm, the efficiency was still more unsatisfactory, being only 52%; but that, after the installation of a larger cooler in August, a great improvement in the absorption was had, September showing 71.8% and October 85.3% efficiency; and finally that in December, when using part pyrite, a much stronger gas was obtained, and also (owing to the low average temperature (38°F) of the absorption and cooling water during this month), a nearly theoretical recovery of the gas—97% efficiency. Later on, after having made further improvements at the roasting and the absorption plant, we succeeded in producing an 8% SO_2 gas from pyrrhotite with less than 25% sulphur (as previously shown), and found subsequently no difficulty in making a gas of 8%-10% SO_2 contents from a rich (30%S) pyrrhotite, and in obtaining a recovery efficiency of 70%-80%.

THE LIQUID SO_2 PLANT.

The principle underlying the liquifaction of diluted sulphur dioxide gas is quite simple, consisting merely in the absorption of the SO_2 by water (thereby separating it from the nitrogen and oxygen and other gases with which it is diluted), heating the acid solution obtained, so as to evaporate off the SO_2, dehydrating this acid gas, and compressing and cooling the dried gas. In practice, however, many difficulties present themselves for an economical solution of the problem, caused principally by the low degree of solubility of the gas in water of high temperature, and the poor absorption of a very dilute gas. The annexed table shows some of the values regarding the SO_2—gaseous and liquid—at different temperatures:—

Temperature. °C	Temperature. °F	Vol SO_2 soluble in 1 vol. H_2O	% SO_2 in a saturated solution	Sp. gr. of the watery solution	Pressure (in atms.) of the liquid SO_2
10	14				1.00
0	32	79 8	18.58		1.53
5	41	67.5	16.19	1.061	1.80
10	50	56.6	13.93	1.059	1.26
15	59	47.3	11.92	1.054	2.70
20	68	39.4	10.13	1.042	3.24
30	86	23.4		1.024	4.12
60	140				10



The above figures are correct only when dealing with 100/ gas as the solubility of the diluted gas is much smaller. For instance: A 10/ -12/ volume SO_2 in the roasting gas will, at ordinary temperature give a max. absorption of only 2/ SO_2, instead of the 10/ -15/, shown at temperatures between 10-20 °C.

The requisites for an economical liquefaction, therefore, are as follows:

1. A strong gas, and gas flues free from leakage.
2. An effective cooling and cleaning system.
3. Cold water for absorption and cooling.
4. Large absorption towers.
5. An economical heating exchange (counter current) system.
6. Cheap fuel and economical heating and concentrating systems.
7. Ample compressor capacity.

All the above points have been carefully studied and applied in our liquefaction plant, the general arrangement of which is shown by the annexed sketch Fig. 3.

The roasting gas from furnace A rises to gas main a, and is from there drawn off by means of a lead lined fan D, through a cooler B, and spray tower C, and then forced through absorption tower E, where it meets a shower of water, by which it is absorbed, leaving the nitrogen, oxygen, and other gases to escape at e. The acid solution leaves the tower at e, and runs by gravity through pre-heater F, overflowing through pipe f, into heating pan G, where it obtains its final temperature for driving off the SO_2 contents, and from which the hot spent liquor runs through pipe f back to the pre-heater. In this apparatus, built on the counter current and heat exchange principle, the outflowing spent liquors give up their heat to the inflowing cool acid solution. When brought near boiling point, the solution gives up its SO_2, which then, together with some steam, rises up through the gas out-take g, to condenser H, where most of the vapor is precipitated, and then to the dehydrating tower I, where its last trace of moisture is absorbed by the strong sulphuric acid entering the tower through pipe K. This acid, on being diluted by the absorbed water, runs by gravity through pipe i' to acid pan J, where it is evaporated and concentrated to full strength, and run off through j into acid eggs K, from which it is again forced through k back to the dehydrating tower. The now pure and dry SO_2 gas passes through suction pipe i to compressor L, where it is subjected to the required pressure; is then cooled and liquified during its passage through discharge pipe l and cooler M to storage tanks N. From these tanks the SO_2 can either be drawn off in liquid form at n', or in gaseous state at n", as desired.

With roasting gas of 7%-9/ strength, and with the cooling and absorption water with a temperature of 40 -45 F we obtain an absorption of 70 -80 efficiency, and maintain the strength of the acid solution at 1.2-1.5 SO_2, the temperature of the gas entering the tower being 70 -80, and the solution leaving the tower at about 45°F, entering the preheater at about 165, is here further heated by exhaust steam to about 188°, and thus the balance of only 24 F needs to be furnished by direct fuel.

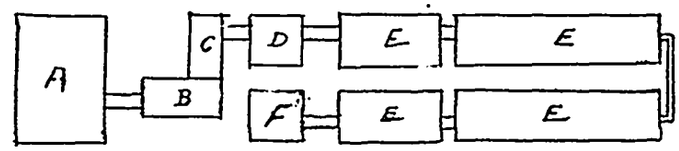
The capacity of the plant is from 8 to 12 tons of liquid acid per day, and the cost of liquefaction includes the following items:

Fuel	$1.00 per ton	
Power (Electric)	1.00 "	
Water, light and incidentals	1.00 "	
Labor and superintendence	1.75 "	
Depreciation and repairs	1.25 "	
		$ 6.00
2 tons SO_2 gas at, say $8.00		16.00
Total cost of one ton of liquid SO_2		$22.00

THE SULPHURIC ACID PLANT.

Sulphur dioxide gas, in presence of free oxygen and steam will form sulphuric acid ($SO_2 + O + H_2O = H_2SO_4$). For this industry a weak gas is not only permissible, but even necessary, a surplus of oxygen being required. In fact the the sulphuric acid makers do not want any stronger gas than 8/ SO_2, while one of the most prominent consulting engineers has advised us that even "from 5%-6/ SO_2 gas sulphuric acid can be produced, at a very low cost, that will compete with any manufactured from pyrite."

In the manufacture of sulphuric acid two systems are now in use, namely, the Chamber system and the Contact system; but the one especially recommended to us is the old Chamber system. As planned, this plant will have a capacity of 30 tons 50° B,-21 tons 66° B, acid, and will be arranged in the following general manner:—



The gas from roasting furnace A enters first into nitre oven B, where it is mixed with nitrous vapors, then to dust chamber C, hot tower D and lead chambers E, where, under the influence of steam and at the expense of oxygen of the nitrous acid, it is converted into nitric oxide and further oxidized (by the air present in the chamber) into nitrous acid, which again decomposed by SO_2 etc.—the process being continuous. From here the sulphuric acid formed passes through cold tower F, filled with coke, where it is freed from its mixture of nitric and hyponitric acids:

$(SO_2 + N_2O_3 + H_2O = H_2SO_4 + 2\,NO)$

The daily cost of manufacturing a 50° B, acid from pyrrhotite or pyrite in the above named plant would include the following items:—

	Pyrrhotite 30% S	Pyrite 45% S
Pyrrhotite, 25 tons at $25.00	$125.00	$
Pyrite, 15½ tons at $5.00		77.50
Nitrate of Soda, 420 lbs. at $2.25	10.50	10.50
Steam	10.00	10.00
Labor	8.00	8.00
Repairs, 25c per ton S	1.75	1.75
Depreciation, 10/ on $50,000.00	15.75	15.75
Total cost	171.00	124.00
Deduct values of the roasted fines	100.00	15.50
Net cost per day	71.00	108 50
Net cost per ton 50°B Acid.	2.37	3.62

CONCLUSION.

From the data above given we find that the pyrrhotite not only can be roasted without the aid of special fuel, but also made to yield a sufficiently strong SO_2 gas for the sulphite pulp industry, for liquefaction and for the manufacture of sulphuric acid, thereby giving to this much neglected mineral a value and an opportunity which it never had before.

But before concluding, I wish to explain my position in this respect, and to state that my contention is not that pyrrhotite necessarily is the most economical raw material for the acid industries under all circumstances, but simply that, when a pyrrhotite, containing some other valuable elements, such as nickel, cobalt and copper, and where the prevailing practice is to roast

the same before smelting, and when a deposit of magnetic pyrites can be obtained at the cost of mining and used for local consumption, the monosulphide of iron stands a fair chance of being a cheaper source of sulphur for the above mentioned industries than brimstone, or pyrite bought at market price at a distance—and consequently making many magnetic pyrite deposits, heretofore considered worthless, become of economical value.

Methods of obtaining Water Supply, for Sugar Plantations in the Hawaiian Islands.

By J. N. S. Williams, Puuene, Maui.

What is now known as the Territory of Hawaii, United States of America, consists of a group of Islands lying in the Pacific ocean 2,100 miles S. W. from San Francisco in Longtitude 155° to 161° W. and between the 18th. and 22nd. parallels of N. Latitude, just within the Tropic of Cancer and in the path of the Northerly trade winds.

The principal Islands of the group are Kauai, Oahu, Molokai, Maui and Hawaii, also some small and unimportant islands near by.

Geologically this group of Islands is peculiar and is supposed to be in connection with a long chain of islands stretching from North West to South East for some thousands of miles in the mid Pacific Ocean, the mountain tops of a submerged continent.

Each island in the group with the exception of Kauai consists of two mountain ranges of volcanic origin connected by an interval of comparatively flat and low land, these mountain ranges cross the path of the prevailing winds and form barriers to the clouds brought down which condense and precipitates a heavy rainfall on the mountain slopes on the windward sides of the various islands.

This heavy precipitation, amounting to upwards of 400 inches per annum in places, has caused great erosion of the steep mountain slopes, which, on the exposed sides are seamed with tremendous chasms some of them many hundreds of feet deep.

This process of erotion is still going on, and has had the practical effect of sweeping a great proportion of the surface soil of the windward coast down to the flats into the sea.

For this reason the best and most continuous stretches of lands are on the flats connecting the mountain ranges, and on the leeward sides of the islands. Since the rainfall on this side, while extremely heavy at times, is intermittent and due to a wind which seldom occurs, the land is not much cut up by gulches or canons nor yet has it been denuded of surface soil to such an extent as prevails on the windward side, and is much more fertile and productive.

These lands are composed partly of volcanic mud ejected from volcanoes (now extinct) and partly of decomposed lava resulting from ancient volcanic action and are covered by very scanty vegetation until water is brought out to them.

When the growing of sugar cane was first started on these islands some forty or fifty years ago, the plantings were made on the windward side of the islands to take advantage of the rainfall, and it was not until some years after the inception of the industry that it became evident that the rainfall was not regular enough, excepting in some few places, to produce the best results in cane culture; and hence the first attempts at irrigation, accomplished by damming up streams and leading the water out by means of ditches to the head of the cultivated lands.

One successful ditch after another was put through and the sugar industry prospered greatly, giving incentive to works of colossal magnitude, consisting of miles of ditches and thousands of feet of inverted siphon pipes for carrying water across gulches which could not be bridged nor yet got around by flumes.

These siphon pipes are of sizes varying from 18 inches diameter to 48 inches in diameter and are made of rivetted wrought iron or steel plates of strength sufficient to carry static pressure due to heads of 500 feet and upwards.

These pipes are made in sections and riveted in place; the fall given to the siphon pipe is usually one foot in one hundred feet of pipe measured on the curve, that is the bottom of the entry ditch will be one foot in one hundred feet of pipe higher than the bottom of the delivery ditch.

The size of the pipe is calculated so that the velocity of the water through it shall not exceed from 3-7 feet per second.

This fall in the pipe is more than is necessary to pass the water at the given speed but is allowed to compensate for the collection of mud, stones etc. in the bottom of the pipe and also for any growth that may form on the interior.

These pipes are always fitted with manholes and waste valves at the lowest points for the purposes of inspection and cleaning and are kept painted with an asphalt composition on the outside.

It sometimes becomes necessary to make close calculations on the delivery of water in iron inverted syphon pipes, and the following useful formula based on that of Trautwine has been successfully used in such instances.

Formula for finding the *total* head in feet that must be given to a rivetted steel or iron pipe of a given diameter, coated inside with asphaltum, to enable it to discharge a given required quantity: (Adapted from formula Art. 3, Page 248, 1885 edition, Trautwines' Civil Engineers Pocket Book)

Let H = total head or difference in level between the bottom of entry and delivery ditches serving an inverted siphon pipe.
D = required discharge in cubic feet per second.
L = length of pipe in feet measured on the curve.
d = diameter of pipe in feet.
c = Constant for asphalted rivetted pipe 3496.

$$H = \frac{D^2 \times [L + (d \times 54)]}{c \times d\,(d^2 \times .7854)^2}$$

The constant c, = 3495, is deduced from the results of observations made by Mr. H. C. Perry C. E. in charge of the ditches and pipe lines on the sugar estate belonging to the Hawaiian Sugar Co. of Makaweli, Island of Kauai.

These pipe lines are 40 inches diameter inside the small end of the courses of pipe and deliver 55 cubic feet of water per second measured over a weir situated in the delivery ditch.

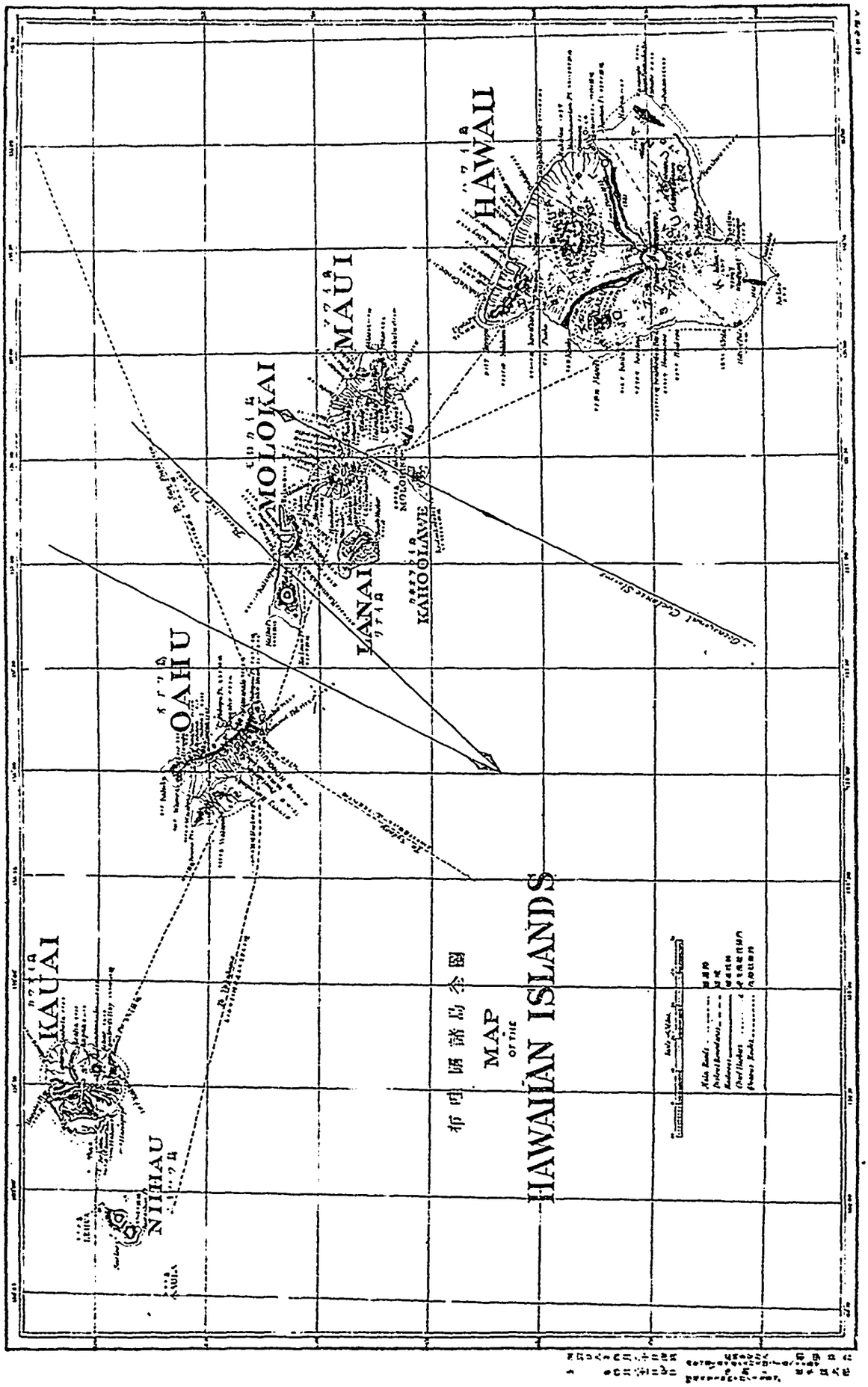
In all siphon pipes used in this country the radius of curve is so great that the pipe can be taken as straight without appreciable error.

The formula gives results which compare closely with observed discharges in several pipe lines varying from 20" to 48" diameter and from 500 to 2,500 feet in length.

No observed data are available for pipes longer than about 1000 diameters.

Of late, tunnelling as a means of conveying water in a country very much cut up by gulches has been successfully adopted, particularly in districts where the canons are very deep and close together. The tunnels are driven on a grade and follow the general course of the canons keeping some little distance back from the face of the bluffs; break throughs are driven from the tunnels to the face of the bluff as a means of ventilation, for the discharge of rock and for the purpose of catching small streams which fall

* Paper presented at the Sixth Annual Meeting of the Canadian Mining Institute, March, 1904.


HAWAII
MAUI
MOLOKAI
LANAI
KAHOOLAWE
OAHU
KAUAI
NIIHAU
MAP
OF THE
HAWAIIAN ISLANDS

HAWAIIAN SUGAR PLANTATION.

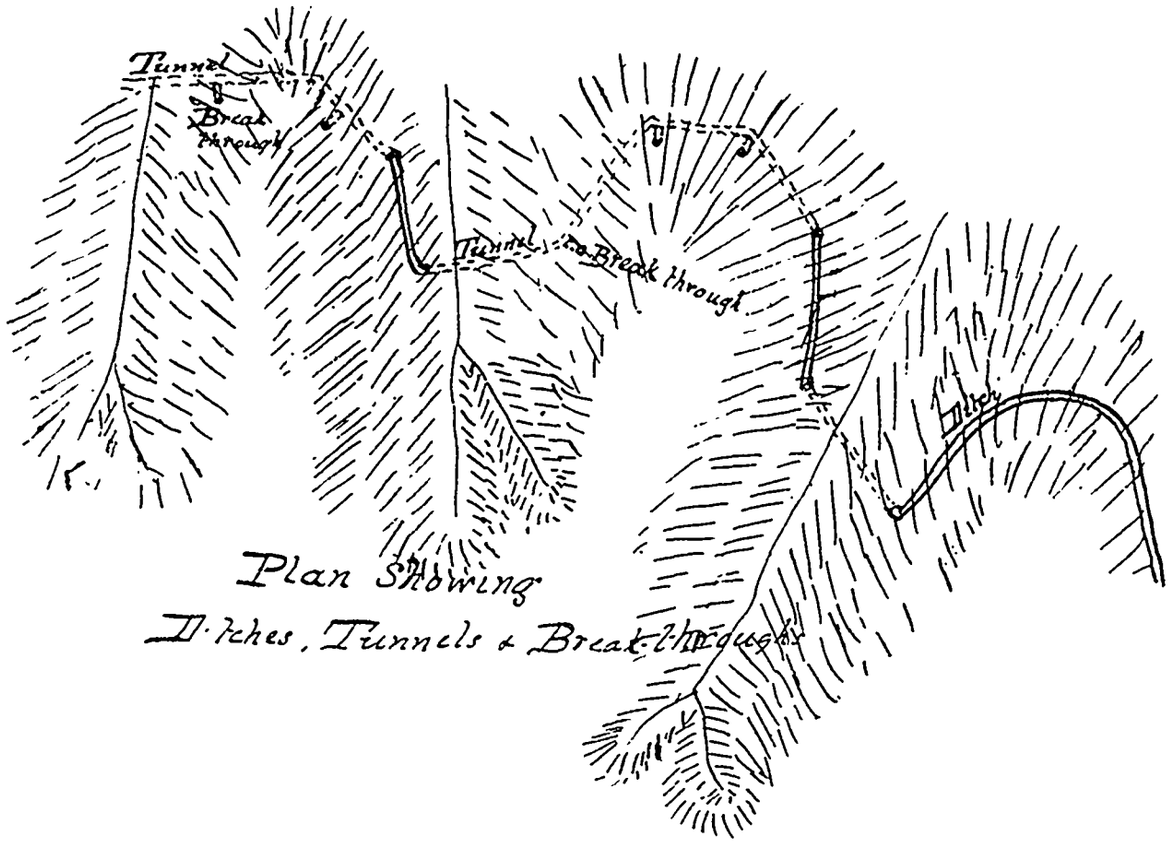


FIG. 1.

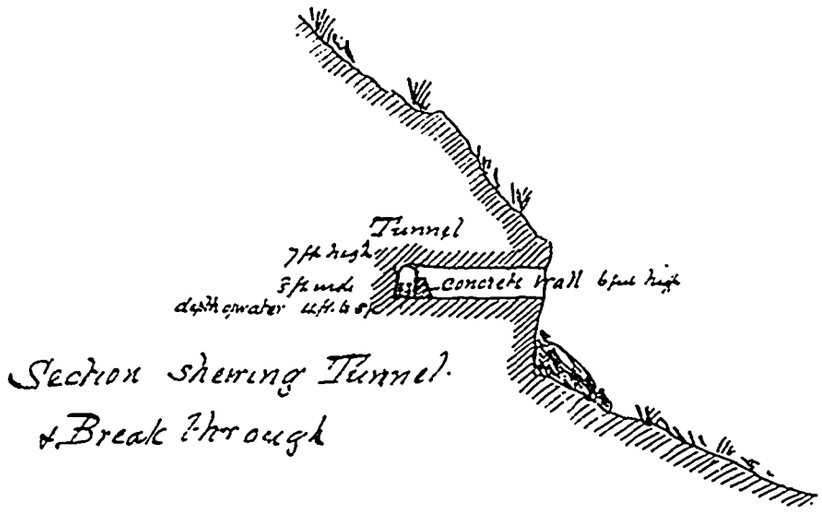


FIG. 2.

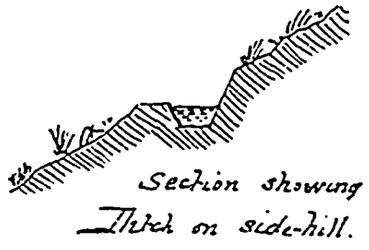


FIG. 3.

down the face of the cliffs especially near the heads of the gulches, —see sketch of cross section of tunnel herewith.

A special instance of this work is shown in the Olokele Ditch just completed for the Hawaiian Sugar Company above mentioned ; and in the Nahiku Ditch for the Hawaiian Commercial and Sugar Company of Maui, Hawaiian Islands, now under construction, both of which ditches with all work connected therewith are under the supervision of M. M. O'Shaughnessy, Esq., C.E.*

Where the tunnels pass through seamy rock the bottom and sides are lined with cement mortar 1 part cement to 4 parts of sand, in ordinary rock the mud brought down by the water in freshets will in a short time tighten the tunnel bottom so that no leakage will occur.

The ditches are given a grade of 1 foot in 1,000, sometimes a little more depending upon the scouring action of the water on the ditch bottoms.

As regards the construction of the ditches and flumes where used, the ordinary practice is followed, special care being taken at the entries to siphon pipes to fit substantial and large waste gates, so that in event of heavy local rainstorms the excess of water shall escape away from the head works of the pipe line.

In general work on a sugar plantation that uses irrigation, the quantity of water required to properly irrigate 100 acres of land under cane cultivation is one million gallons per 24 hours, and as large plantations have from 7,000 to 12,000 acres of land in cane, from 70 to 120 millions of gallons of water per 24 hours is required.

Some plantations are situated in districts where no surface water is available, others again cannot obtain a sufficient supply from their ditches and catchment areas, so to supply their needs, sinking for water has been resorted to.

On the Island of Oahu an underground reservoir of water which could be tapped by artesian wells was discovered some years ago ; this water rises at this place some 30 feet above the level of the sea and is found at depths varying from 400 to 1,200 feet.

Pumping machinery of great capacity was put down and the underground supply drawn upon for use on the plantations situated within the artesian area.

At the present time the daily water pumped from artesian wells on the Island of Oahu reaches about 300 millions of gallons, some of it lifted upwards of 500 feet in height.

This condition of an artesian supply does not appear to exist on any of the other islands in the group, and when pumping is resorted to, open wells or sumps are excavated, the underground supply resulting from rainfall on the mountain sides percolating through an upper broken stratum and retained by the lower stratum of impervious rock.

These sumps are excavated to about 20 feet below sea level, tunnels are then driven on the lower stratum directly inland, opening up the water bearing rocks and the supply thus obtained is pumped from the sumps through very long pipe lines to the levels required on the cultivated areas.

To avoid the heavy expense of long pipe lines, there are three instances of shaft sinking at the upper levels of the cultivated lands down to sea level and regular underground pump of mining pattern installed, but these have proved so expensive in first cost and upkeep that there is no encouragement to repeat the experiment.

One of the largest stations of this kind is at Kihei on the Island of Maui where the shaft is 300 feet deep and two pumping engines of a combined capacity of 17 million gallons of water per day lifted 400 feet high are situated in a very large chamber excavated in the rock ; an abundant water supply is found at sea level ; but the expenses of operation are very heavy in comparison to those of surface pumping stations delivering water through long pipe lines.

The machinery installed in the various pumping stations is of the most modern and complete make obtainable at the present day, and as in no other part of the world are such mechanical irrigating plants in existence, a more than passing notice may be of interest.

The plantations that pump all or part of their irrigation supply are situated as follows :

Island of Kauai,	3,	approx. delivery	24	hours, in gallons	75	millions.
Island of Oahu,	6,	"	"	"	360	"
Island of Maui,	5,	"	"	"	150	"
Island of Hawaii,	2,	"	"	"	10	"
Total delivery per 24 hours, gallons about					595	gallons

The average height to which this water is pumped is about 200 feet and the total power developed to deliver this enormous quantity of water is over 20,000 horsepower.

The stations are divided into units of various capacities situated at spots most convenient for obtaining the water. The largest units deliver from 10 to 12 millions of gallons per 24 hours and a station may have as many as four units ; the majority have only one.

The pumps themselves can be divided into three classes : Impeller pumps such as centrifugal or other types of rotary pumps ; Multivalve pumps such as the Worthington and others in which piston or plunger pumps draw and discharge water through large numbers of small valves set in suitable suction and discharge chambers ; which valves open and close by the water pressure : and pumps having mechanically operated suction and discharge valves of which only one type, the "Riedler" Patent constructed by the Allis Chalmers Company of Chicago, has been operated in this country.

The pumping stations are fitted with all kinds of boilers of which two makes stand first in point of numbers installed—Babcock and Wilcox Water tube boiler and the Sederholm Fire tube boiler, and there are all kinds of fuel and labor saving arrangements. Green economizers in the flues, arrangements for coal handling, automatic damper regulators etc. etc. And as a result exceedingly high efficiencies are obtained in ordinary work.

The engines driving the pumping machinery are almost all of the Corliss type two cylinder compound, three cylinder triple expansion, and four cylinder triple expansion of the very best make and finish, and fitted with all modern appliances in the shape of condensers, feed water heaters, and in one instance the latest ideas in superheated steam have been applied.

The mechanical efficiencies obtained on the various systems of pumps are as follows :

Centrifugal pumps delivering to 50 feet head, from 45%–55%

Impeller or Rotary Pumps from 60%–75%

Multivalve pumps, from 75%–85% and mechanically operated valve pumps from 85%–90%.

In one mechanical efficiency test made by the author on a Reidler triple expansion pumping engine, delivering water at 375 feet above the level of the water in the sump, at the rate of 10

* The author is informed by the Hon. H. P. Baldwin that this method of conveying water was first adopted in this country when the Hamakua Ditch Co's line on the Island of Maui was constructed some 25 years ago, since then this very bold scheme has been improved upon to such an extent that in the above mentioned ditches no siphon pipes or flumes, (which are liable to distruction by cloud bursts or violent rainstorms) have been used, and a arge proportion of the entire ditch line is tunnel.

million gallons per 24 hours, and the water delivered by pump measured over a wier especially made for the purpose, the remarkable figure of 91.85% was obtained; that is, of the horse power developed on the main engines 91.85% was expended in doing useful work on the water delivered.

This test was undertaken for the purpose of determining the slip or back lash of the water in a pump having mechanically operated suction and discharge valves, which in this instance was found to be ¼ of 1%.

The necessity of high economy in pumping machinery in this country is seen when the cost of coal at from $7.00 to $9.00 per ton delivered into the furnace is considered.

A large number of pumping stations are now operated with California crude oil as fuel, which is furnished to the various stations at $1.50 per barrel of 42 gallons; at this price oil is about equal in value to coal at $6.00 per ton, but as oil leaves no residues nor yet soots up the tubes or economizers as coal does, the economy in labor by using oil instead of coal is very marked. In a large pumping plant formerly employing eight firemen and coal passers per day, and two water tenders, the eight men have been cut out entirely, the work of keeping steam with fuel oil being done, and done easily, by the two water tenders in addition to their other duties.

It, however, is clear that such an economy is obtainable only in large plants, as in small plants operated by one man on a watch, no economy in labor is possible.

The burners used for crude oil are of various kinds and makes, but the results obtained by each are about the same, 6 pounds of ordinary crude oil of 18 Beaumé (mimus scale) being equal to 10 pounds of ordinary coal.

When the use of oil was first contemplated it was expected that the boilers would suffer from the intense heat generated in the furnaces, but this expectation was not justified, as all experience here goes to show that the life of a boiler will be just as long with oil as with coal for fuel, provided that the proper furnace arrangements are adopted.

By the courtesy of the Allis Chalmers Co. the writer is enabled to present plans showing a typical four cylinder triple expansion Reidler pumping engine and a Sederholm boiler fitted with automatic stokers etc., also a photograph showing a three cylinder triple expansion pumping plant of ten million gallons capacity as erected and in working order on the Oahu Sugar Co's and Hawaiian Commercial Co's plantations.

By the courtesy of the Hon. H. P. Baldwin, General Manager of the Hawaiian Commercial and Sugar Co., the writer is enabled to give the following figures for the cost of pumping water to different elevations by the following machinery:

Pump plungers	11 7/8"	diameter	x 42"	stroke.
Steam Cylinders, H. P.	19"	"	x 42"	"
I. P.	33"	"	x 42"	"
L. P.	50"	"	x 42"	"

The whole forming a Reidler Triple Expansion Pumping Plant.

Sederholm Boilers, Green Economizers, California Crude oil for fuel, Steam pressure 180 lbs. above atmospheric pressure.

Revelutions of Engine per minute 54.

Delivery in 24 hours at this speed 9 million gallons.

Elevation of delivery.	Cost of million gallons.
100 feet	$ 7.85
200 "	11.57
225 "	12.50
250 "	13.44
300 "	15.30
350 "	17.17

which figures include superintendence, labor, fuel, supplies and repairs during one year which contained 240 pumping days. The figures would be considerably modified if continuous pumping were employed, but as occasional rain storms occur, the pumps are only operated when required.

The economy of such a pumping plant is high; one horse-power being produced for the consumption of 1.12 lbs. of oil per hour, which at the rating of 6 lbs. of oil being equal to 10 lbs. of coal in ordinary work is equivalent to 1.87 lbs. of ordinary coal per horse power per hour.

As a rule pumping is considered to cost 50 more than ditching, but since the ditch depends on rainfall for its supply there is an element of uncertainty about it. Pumping on the other hand is very sure, since the underground supply of water is practically inexhaustible, and even during severe draughts when the ditches are nearly empty, the pumps are always able to furnish water.

The most conservative practice in irrigation works for sugar plantations where possible is to have both systems so that whichever way the barometer goes water is available for the crops in the ground.

LONDON LETTER.

LONDON, April, 1904.

Mining Markets here continue distinctly hard in tone with a tendency to increased business. But for the coyness of the public we should, no doubt, have brisk markets, seeing that the financial position is sound and prices generally cannot be far off bedrock. The elimination of the Whitaker Wright regime will also have its effect in due course and tend to render mining investments more in fashion.

British Columbians.—There has been a better market than for some time past. The Premier Mines (Le Roi No. 1 and Le Roi No. 2) are showing up very well and if the recent favorable developments hold good there are decidedly better prices ahead. Le Roi No. 1 on Febrnary results is earning a 50 p.c. dividend on its to-day's price of 28 p.c.

All Canadians will be glad to see the Le Roi properties having a fair chance, as they are now free of financial embarrassment and well equipped with working capital.

Australians are a very steady market with a rising tendency. The policy of centralization of control is having a remarkable effect in preventing share rigging. Nearly all the important mines are now in the hands of Bewick, Moreing & Co., with the result that working expenses are considerably reduced and every individual mine has the benefit of its neighbors' experience.

The Associated Northern Block squabble is now over and the real business of mining is in hand again These shares round about the par price of £1 are not too high, as the mine possesses potentialities.

Great Fingalls and Golden Horseshoes are also solid investment. In fact a very promising "trust" could be made in this market.

South Africans.—The Kaffir circus is now in a very interesting situation. With the labor question practically solved, the bull account reduced to very modest dimensions, easy money, and prices at the lowest for the past four years, the market is in a position to respond promptly to a good lead. The last few days have shown increasing business of an investment character, and the undertone is very firm indeed. Stocks are in good hands and there are no keen sellers at present prices. On the whole this market has not looked so promising for a long time.

It is hoped that the better time coming will not be of quite such a mad character as in 1895, but that there will be steadily rising markets with good business all the way up. The Land Companies and Deep Levels are excellent purchases without almost an exception. As soon as the magnates are quite ready the market will go right ahead.

West Africans.—This much maligned market is not dead by any means and the shares of the Premier Mine (the Wassau) having fallen from £8 down to 30/- or so, have now turned the corner and are showing a much steadier front at about £2. Amalgamateds are also buyers.

Miscellaneous.—The big Wai-hi is going strong and the shares are being bought by insiders. Of course at £5 for the £1 share the future is rather discounted, but the shares are talked to £7 or £8. It is certainly an immense proposition and in capable hands, with enough ore in sight to last a decade

Rio Tintos are buoyant on the past year's results and present strength of copper.

Taken all round the mining markets are well worth close attention

PERSONALS.

Dr. Eugene Haanel, Superintendent of Mines, Mr. T. Cote, Mr. N. Strom and Mr. C E Brown, electrician, of the Canadian Commission appointed to investigate the matter of the electric smelting of iron and steel, returned to Ottawa on the 16th of April.

Professor E. Rutherford, F.R.S., of McGill University, gave a lecture on Radium before the McGill Graduates of the Ottawa Valley, in Ottawa on the 19th instant.

Mr I. Obalski, Inspector of Mines, for the Province of Quebec, was in Ottawa during the month.

Mr. Eugene Coste, E.M., Toronto, was in Ottawa on the 15th instant, and removed the furniture and papers of the late Secretary of the Mining Institute, to Toronto

Mr. W. S. Lecky has just completed a tour of three months throughout Canada, from coast to coast as representative of Messrs. Lyman Sons & Co., of Montreal. This house which is well known for its supply of chemists and assayers material intend to give to Canadian chemists and assayers a first class service and a very large stock from which to select; a new catalogue will be issued for circulation this summer.

Mr Ervin Dryer has resigned his position in connection with the Westinghouse Electric & Manufacturing Co., and has accepted an appointment with the Allis-Chalmers Co. Mr. Dryer's connection with the Westinghouse Company extended over a period of sixteen years, and his wide acquaintance throughout the western part of the United States will be of great service to the Allis-Chalmers Company in the extensive new developments which they have undertaken.

Nova Scotia Gold.

A recent number of the *Canadian Gazette*, (London, Eng.) publishes what purports to be a cable despatch from Ottawa to an English paper, which says:—

"Official reports received here from Halifax state that very rich discoveries of gold have been made in Northern (?) Nova Scotia. Prospectors have been searching for the metal for a long time, but have only just found it in paying quantities The new fields, according to the descriptions received here, are regarded at present as being comparable in richness to the Yukon and Australian mines."

The *Gazette* goes on to say that the discoveries of rich ore at depths of 950 feet in the Caribou District are due to the action of the Nova Scotia Government in granting aid to the sinking of shafts to a depth of 2,000 feet. Since the Act to encourage and aid deep gold mining in Nova Scotia only became law in March of this year it is difficult to believe that the deep shaft of the Baltimore and Nova Scotia Company is owed to the recent action of the Nova Scotia Legislature." Our good friend, Mr. L. W Getchell, Manager of the B. & N. S. Co., began and has prosecuted his mining work without regard to Government aid which, as a matter of fact, has not yet been availed of by any one.

The *Industrial Advocate* of Halifax, in commenting on this absurd presumption, says:—

"It is a pity that such inaccurate statements should obtain currrency in a journal identified with large Canadian interests in London. The impression conveyed by the message of the Ottawa correspondent is equally erroneous, as it gives the uninformed reader the idea that the discovery of gold in this province is a matter of recent occurrence, whereas the fact is gold has been successfully mined in Nova Scotia for forty years. The gold measures of the province extend from Yarmouth in the west to Guysborough in the east, a distance of nearly 400 miles, with a width from 25 to 75 miles. The geologists have held the opinion for years that the formation was analagous to that of the Bendigo-Australian mines, and the attainment of vertical depths of 900 feet by several companies proves the correctness of the above theory, the ore being found in a regular series of superimposed saddles, showing as good values in depth as at the surface. This important development has influenced the local government to engage to defray half the cost of sinking one or more perpendicular shafts 2,000 feet to demonstrate the permanency of the gold measures of this province."

The perseverance and intellectual acumen of Mr. E. R. Faribault, C.E., of the Dominion Geological Survey, has enabled him to correctly work out the formation of the saddle veins in Nova Scotia, and to his work more than to any other cause is due the renewed interest in the possibilities of deep mining in the Nova Scotia gold fields That such deep mining will be remunerative, and that Nova Scotia gold mines will add to their reputation within the next decade, cannot be doubted by any one who is familiar with the industry in that Province.

Eastern Canadians have not been much interested in that strong organization known as the Western Federation of Mining, but our countrymen in British Columbia (especially Rossland) have known that same organization somewhat intimately. Western subscribers therefore may find it interesting to know that the martial law which ruled at Telluride, Colorado, and which was occasioned by the lawlessness (even to murder) of certain strikers and agitators, was ended about the middle of March, and that the guarding of the town and mining properties has again been left to the citizens. Agitators were deported from the towns affected and warned not to return, and as a rule they have heeded the warning. While there may be, and probably is, no connection between the offenders and the Western Federation of miners, yet the influence and effect of the disturbance has been detrimental to the Federation, inasmuch as the Union miners in Cripple Creek are disaffected and have left the ranks of the Federation which is thus crippled in what, hitherto, has been its greatest stronghold in the Western States.

The Ogilvie Gold Dredging Company.

The annual meeting of this company was held in Ottawa on the 29th. of March. The President, Mr. Wm. Ogilvie, presented the report of the Directors for the last year, which (briefly) stated that during the season of 1903 the management had devoted their efforts to the prospecting of about seven miles out of the 110 owned by the Company. Some rich deposits had been located, but their extent had not been accurately determined. The board was, however, satisfied that during the coming season sufficient ground would be tested and located to permit of keeping a large dredge at work on profitable ground; the President added that he was assured, personally, of a satisfactory future for the Company, and moved the adoption of the Report.

In the discussion ensuing several shareholders expressed their dissatisfaction with the Report and the Management; there were no details presented in the Report, nor any statement of receipts and expenditures. Mr. McIsaac, M.P. for Antigonish, N. S., voiced the sentiments of some Eastern shareholders and expressed dissatisfaction with the results obtained. He claimed that a return of only $1300 in gold for a whole season's work with a dredging capacity of 1000 yards per day, showed incompetency somewhere; more gold should have been saved; the delay in waiting for repair parts to the machinery could have been avoided if the management had been good.

Mr. Arthur Ross, of Montreal, was dissatisfied with the information afforded to shareholders, he would like to have seen a detailed account of receipts and expenditures submitted, and moved that a printed statement of the accounts be prepared and sent to shareholders; this was agreed to.

The President, Mr. Ogilvie, in reply said that the object of last season's work was exploratory and not intended to be remunerative, the Board had wished to do this work before purchasing a large dredge to work the ground commercially. He stated that the machinery delays had been unavoidable because of failure to deliver on the part of the firm furnishing the machinery. Any such delay could be avoided for the future. The report was then adopted.

Mr. N. J. Kerr made a motion that the dredge be worekd the coming season as a gold saver, and not as a prospecting machine; this motion was seconded by Mr. Thos. Birkett, M.P., and carried.

The election for directors resulted in the following as the Board for the coming year:—Mr. Wm. Ogilvie, Wm. Gamble, R. R. Samuel, Thos. Birkett, W. Morley Ogilvie, N. J. Kerr, and H. P. Godard.

The Montreal and Boston Copper Company.

A meeting of this corporation was held in Montreal on Wednesday, the 20th of April, at which the shareholders voted in favor of a resolution merging the Montreal and Boston Copper Co., The Dominion Copper Co., Ltd., The Morrison Mines, Ltd., The Athelstan and Jack Pot Gold Mining Co., Ltd. and three-fourths of the Emma Mine into a new corporation, to be called The Montreal and Boston Consolidated Mining and Smelting Co.

The new corporation is to have a capitalization of $7,500,000, of which $1,000,000 is to remain in the Treasury, $1,500,000 to be issused to the Montreal and Boston Copper Co (at the rate of one share of new stock for two shares of old), and $5,000,000 to a Syndicate which agrees to turn in therefor the whole of the capital stock of the other three companies mentioned, together with three-fourths of the Emma Mine. The Knickerbocker Trust Co. of New York City has agreed to act as Trustee to receive and exchange the old shares for the new ones.

The programme of the new corporation is to erect a fourth blast furnace, and a converter with a daily capacity of 1500 tons, at Boundary Falls. It is also announced that the new coporation intends to secure a coal property and erect its own coking ovens, so that the operation of the furnaces will be independent of the labor troubles which the Crows Nest Pass Co. have had to contend with. The possibility of the Montreal and Boston Consolidated Company having labor troubles of its own does not seem to have been considered.

MINING NOTES

NOVA SCOTIA.

The Londonderry Iron & Mining Company has now one of its two stacks in operation, turning out foundry pig; the second stack will not be remodelled at present. The bulk of the output is used by the Eastern branch of the Montreal Pipe Foundry Company, whose new plant at Londonderry has just been completed.

The old workings of the Londonderry mine have been cleaned up so far as possible, and a considerable quantity of good ore recovered; the necessary ores for mixing are obtained from other iron mines in the Province. Mr. W. F. C. Parsons, the resident mining engineer of the Company, has also started new drives in promising ground, and appearances indicate that this property, which has been worked by different corporations for over fifty years, has yet a long and profitable life before it.

The Acadia Coal Company, Stellarton, N.S., are to instal an electric lighting plant for their offices, tipples, collieries, etc. The Westinghouse Company's machinery is specified and the contract for the machinery and installation has been let to John Starr, Son & Co., of Halifax.

Annapolis County has been pleasantly excited by the rumor that a combination of American and Canadian capital is to establish extensive iron works near Parrsboro, N. S. It is reported that this combination has secured control of the iron deposits near Torbrook, and contemplates the erection of blast furnaces, bloomaries and rail mills. Names of interested people, however, are not given and the report lacks confirmation.

Heyl and Patterson, the Pittsburg construction firm which contracted for the new coal washing plant of the Dominion Iron and Steel Company at Sydney, C. B., were put to considerable annoyance by a general strike of their workmen early in this month. When the firm took laborers to Sydney they were promised the same wages as obtained with the employees of the Iron and Steel Company for similar work, viz. from $1.50 to $1 60 per day for the concrete men and $2.50 per day for carpenters. On beginning work it was found that the Steel Co. was not paying as high wages as the contractors had supposed, hence the strike. The Italians were the first to quit work to the number of over 100, and they threatened violence to the other laborers should they resume work. The carpenters, numbering about 75, then went out on a claim for 25c. an hour, but returned the same day for 22½c. per hour. The laborers' strike has since been adjusted.

QUEBEC.

Bell's Asbestos Co. had a better year in 1903 than in 1902, and declared a 4 per cent. dividend. The balance carried forward is over £10,000, of which £7,000 is put to Reserve Account, and £2,555 is divided amongst the Directors; of of this £2,555, £2,000 is appropriated to the Managing Director by way of salary. The shareholders are dissatisfied with the division of profits.

NORTH-WEST TERRITORIES.

Mr. Hugh Sutherland, of Winnipeg has obtained the control of what are reported to be very extensive beds of gypsum, situated in Northern Manitoba.

BRITISH COLUMBIA.

The *Athn Claim* reports a strike of ore in a quartz vein 8 feet wide which assays 13 ozs. 14 dwts. of gold to the ton. The strike is on Boulder Mountain.

The Golden Copper Mining Company has been incorporated under British Columbia laws, with a capital of $200,000, to carry on the business of mining and smelting ores of that metal.

Southern East Kootenay, from present information, is to have a gold boom this year. Reports claim that two old river beds of Triassic gravel have been discovered, which carry high values in gold.

It is reported from Vancouver that a gentleman largely interested in Coast properties has devised a new process for the recovery of values from sulphide ores, and has erected an experimental plant with a capacity of 25 tons per diem.

The Pacific Coast Steamship Company has chartered two vessels, the J. B. Thomas and the St. James, to carry coal from Ladysmith, on Vancouver Island, to Nome, Alaska; the intention is to carry from 15,000 to 20,000 tons during the season.

It is reported from Banff that the Canadian Pacific Railway Company has promise of a valuable bed of anthracite in or near the Park limits which, in size and quality, surpasses the exhausted seam at Anthracite. The preliminary opening of the deposit is being made by a cross-cut tunnel.

Arrangements are making to purchase the property of the former Dundee Gold Mining Company, Limited, in Ymir District, from the Bank which now holds possession. The proposals contemplate the formation of a new company with a nominal capital of $500,000. The amount of value exposed in the workings is put at $120,000 gross.

News of a new rich placer field was received in Vancouver early in the month of April. The find is reported to be at the head of the Nahaani river, a branch of the Liard river, in latitude (approximately) 61° north, and longitude 126° west. The distance from Fort Wrangel is approximately 450 miles.

Western papers report that the British Columbia Copper Company, Limited, is to resume the exploitation of the deeper levels on that property during the coming summer. For nearly three years the Company has confined its attention to the extraction of ore from its surface quarries, from which some 300,000 tons have been shipped.

The Granby Smelting Company is interested in the International Coal Company of Crow's Nest Pass, Alberta, and as the latter company are now building coke ovens it is presumed that the smelter people will supply their works with the coke made by the International Company.

At the present time it is reported that the Butte Smelters are taking 300 tons a day of coke from the Crow's Nest Coal Co., and that the latter company are seeking a market for an additional 600 tons per day, which they claim are available. It is well known that the output of the C.N.P.C. company's coke ovens is now far beyond any possible demand of the Kootenay smelters.

Shipments of ore from the Rossland Camp to the smelters dropped in the middle of April to 3,000 tons from the usual amount of 9,000 tons weekly. The stoppage of the Le Roi owing to the shut-down at the Northport smelter to which it ships, and the interference with the traffic by the sudden melting of the heavy snows on the mountains account for the big drop in shipments.

During the month of February, 1904, ten carloads of ore were shipped from the Arlington Mine, Erie, containing 229 tons, the net smelter returns from which amounted to $10.453.69. The expenses in British Columbia for the month amounted to $3,639.23, leaving a profit on the month's working of $6,814.46.

The Consolidated Cariboo Hydraulic Mining Company has been much hampered and delayed for several seasons by lack of water, although its fine system of reservoirs and ditches is very extensive. The Company therefore will undertake this season to dam another lake and make its waters tributary to the old system by the construction of another ditch some 15 miles in length. The construction cost of obtaining this additional supply is estimated at $250,000.

The sales of zinc ore made by the Payne Mining Company have demonstrated the importance of the zinc ores of the Slocan District. The experience of the St. Eugene, Ivanhoe and other mines in shipments made to Antwerp, and to Iola, Kansas, form a solid basis for a permanent industry which will not only add to the yearly wealth coming from British Columbia mines, but will also aid in solving economic problems for the silver-lead companies.

On the 13th of April the agent for the Dominion Government, (Mr. G. O. Buchanan,) paid over to the mine owners the first bonuses payable under the Lead Bounty Act. The mines receiving cheques were: the Sovereign, Highland, Whitewater, Enterprise, Sullivan, Rambler-Cariboo, Black Prince, Wilcox, Silver Cup, Bluebird, Red Fox, Neepawa, Mercury, Idaho-Alamo, Ymir, Payne, North Star, Province, Bosun, Pontiac and Marion.

There are the usual rumors this year of proposed new smelting works in different parts of the Province. During the last five years there has been a distinct advance in the number of smelters in active operation, as witness the stack at Crofton, and the one at Ladysmith on Vancouver Island, which are in constant operation and which derive their ores entirely from Coast mines; some copper ore has also been shipped down from White Horse, but the future of the smelting ores from the Yukon depends almost entirely upon the transportation problem.

Early in this month the Payne mine at Sandon, B C, reported a strike from No. 8 tunnel. A drive on the vein broke into about two feet of galena, showing a large sprinkling of ruby silver and grey copper. Picked samples assayed 840 ozs. of silver to the ton. This is good news to shareholders, some of whom believed that the days of rich ore were over. It is most important as showing that the Slocan ore bodies do not lose their high values with depth, (the former average value of the Payne ore ran about 100 ozs. of silver,) and should induce owners and corporations to prosecute deep level work.

Reports from the Iowa-Lillooet Dredging Company are very glowing. The new dredge installed by the Hamilton Manufacturing Company took out an average of 40 oz. of gold per shift of ten hours, for a period of twelve days. This dredge is operating on a lease of the Fraser River, at Lillooet; the gravel has been prospected in places to a depth of 40 feet, and it is predicted that the results from the dredge will average $1,000 per day. As a result a boom in gold dredges for this section is predicted. The old dredge at Lytton has been repaired and is now at work, and reports are circulated that it is earning good pay.

The Western Fuel Company are constructing large coal bunkers, modern wharves, etc., at Northfield Point, Vancouver Island. A new shaft has been started to cut and open the 7 foot seam recently found in the Northfield slope; this shaft will be used exclusively for hoisting coal, the miners using the slope as heretofore for ingress and egress. The plant which has been brought out is one of the finest in the West. The company is also settling a townsite of its own, just north of the colliery, which will have the name of "Brechen." Cottages are to be brought in from Northfield and provision made for a settlement of 500 people.

Irresponsible talk credits the C.P.R. with the intention of building a branch line from Spence's Bridge, B.C. to Nicola Lake, for the double purpose of serving the rich Nicola Valley and of opening up the coal fields lying near the Lake. It is now some three years since the REVIEW had special knowledge of these coal fields, which are certainly large and contain several seams of high grade coal. The point, however, is made that British Columbia at present has a far larger supply of excellent coal than there is sufficient market for, and that the C.P.R., being a business corporation, is not likely to expend money on new branches until there is assurance of a steady paying traffic on such branches.

The Nickel Plate Mine in the Similkameen district is also reported as a probable builder of a smelter. It is reported that Mr M. K Rodgers, the Manager of the Nickel Plate, has been endeavoring to secure a site for the works in the vicinity of the mine and that the only site available is on a portion of the Indian Reserve. The efforts to secure this site by negotiating with the Dominion Government and the Indians have resulted in the Indians agreeing to surrender for an equivalent reservation elsewhere in the valley and the offer of 100 acres by the Government to Mr. Rogers for a smelter site, but this is not satisfactory to Mr. Rogers, and he now announces that if he builds a smelter he will build it in United States just south of the boundary line.

Early in April there was some little newspaper talk over the possibility of building a smelter on Valdez Island in the gulf of Georgia, due probably to the visit of Mr A. J. Jordan of Seattle. These rumors are probably due to the fact that there are a large number of prospects and producing properties at various points along the coast of British Columbia north of Vancouver. Some of these properties are already shippers in a small way, their product going to Crofton, Tacoma, and Everett. They have a large factor in their favor since most of them are within reach of tidewater thus permitting of cheap transportation for the ore. It is predicted, and with reason, that these properties would work on a very much larger scale if there were abundant facilities for the purchaser and cheap smelting of their ores.

Rumors have it that the somewhat notorious Britannia Copper Mine on Howe Sound is to be resuscitated and actively developed. A new organization known as the "*Howe Sound Mining Company*," has been organised with a capital of $2,000,000, and which has absorbed all of the original shares of the old Britannia Company; one half of the capital or $1,000,000 in paper was paid for the Britannia and $500,000 of the remaining stock has been taken at 50% at par, so it is reported, by the new interests. Messrs. G. H. Robinson of Salt Lake, Jas. Bellinger of Spokane, Stevens of New York City, are said to be the United States representatives, Mr Frank Leonard continues as Manager of the property. It is proposed to begin work at once by the erection of a wharf and ore bunkers and to proceed with the construction of a concentration plant; the ore will probably be sent to the Crofton smelter.

YUKON.

Spring has come early on the Klondike, the 26th. of March being reported as very warm.

To facilitate service to the new Alsek gold diggings during the present season, the White Pass and Yukon Navigation Company will operate a steamship service between the town of White Horse on the Yukon, and Mendenhall Landing on the Takhena river, this being the best route to the new gold fields.

The Canadian Pacific Railway announces that, beginning on the 15th of June, two daily trains will be run between Montreal and Vancouver, instead of one train as heretofore. This doubled service is necessitated by the very large increase in travel to the Western Provinces.

Reports from Hunker, Dominion and Sulphur Creeks are to the effect that the past season has been one of the most successful these creeks have ever had, and that if the supply of water holds, the cleanups will be record ones. Dominion has taken out more wash dirt than any other creek, and promises the largest return. Most of the work on Dominion has been on the twelve claims immediately below No. 1. Most of the work on Hunker has been from 40 to 50 below discovery. The results from the working of the dredge put on Bonanza Creek have been most satisfactory. The difficulties previously encountered have been overcome, and report says that two new large dredges are to be put, this season, on Forty-Mile.

A man who has recently returned from the Alsek district reports that over 2000 claims have been recorded and that the Government has promised some money for the building of trails. Wages in the district are reported to be $5 per day and board, or $8 per day without board. It is also stated that once a person gets into the district it is difficult to get out again as there is not an abundance of employment for labor. Men tempted by tales of big pay in this northern country should take heed to the warning that the chances of getting work in these new districts are slim.

INDUSTRIAL NOTES.

The A Leschen & Sons Rope Co. have issued a very useful form of advertising in the shape of a celluloid rope guage, which calipers rope from 1¼" diameter down to ¼" diameter. Anyone using or handling wire rope will find this guage most convenient, and the A. Leschen Co. offers to furnish it to any and all who use wire rope. This firm is increasing its sales rapidly, and its customers report uniform satisfaction.

The well known advertising agency of Franklin P. Shumway has been incorporated as the "Franklin P. Shumway Co.," under the laws of Massachusetts, with a capital of $30,000. The offices of the corporation are situated at 373 Washington St., Boston, Mass., and are well equipped for handling both American and European advertising. Newspaper publishers who have had the satisfaction of dealing with Mr. Shumway will wish the new corporation every success.

Our esteemed and always instructive contemporary—*Mines and Minerals* has devoted the greater portion of its April issue to a collection of authoritative articles on the subject of wire ropes. Each of these articles is written by an authority, in admirably clear style and language, each is copiously illustrated, and the issue is even worthy of a permanent binding and a place on the shelves of every mining engineer, mine operator and mechanical engineer.

Mines and Minerals is one of the most valuable exchanges coming to our desk; its pages are full of original, timely and valuable matter, presented in a clean faced type on good paper. We have found the reading of its pages to be accompanied with less eye fatigue than almost any other sheet meeting the editorial eye.

The Allis-Chalmers Co. have organised a Department of Publicity, of which Mr. Arthur Warran is the Manager. This step has been necessitated by the extension of the business into so many fields. The firm has long been favorably known for its mining, rock crushing, milling and blowing machinery, and for its perseverence as Engine Builders; it is now in the field for Gas Engines, Steam Turbines, and both electric and hydraulic machinery.

The Leschen & Sons Rope Co. of St. Louis, have just issued a neat little pamphlet on the Transportation of Ores by Aerial Rope Tramways. This firm have the distinction of having built and equipped the largest wire rope tramway in North America, viz: that of the North American Copper Co. at Encampment, Wyoming, which has the length of 16 miles. An unusual point in this Tramway is that, although some sections have very steep gradients, no section has sufficient fall to permit of operation by force of gravity, hence, engines have had to be used to operate the system. The tramway has a capacity of 400 tons in 10 hours, with a longest span of 2,300 feet.

The tramway is of the double rope type, having a stationery track cable and an endless traction rope for propelling the buckets. The latter are attached to the traction rope by a patented clip. The sheaves used on the towers over which the ropes pass have their flanges and grooves so arranged as to accommodate the clip on the traction rope, so that the rope always rests on the sheave groove whether a bucket is passing over a tower or not. This is essentially different from most other wire rope systems, as the enormous strain to which the rope is subjected in systems where the traction rope is carried under the saddles, are not encountered.

The various novelties are well worth the investigation of any engineer proposing a new installation for a mine.

There are newer features in the bucket clip, which is moulded to the lay of the rope thereby avoiding both slipping and abrasion; and also in the pendants from which the buckets are hung. The grip wheels take hold of the rope from the outside, and (it is claimed) do not injure the rope.

The Ottumwa Box Car Loader has come into such general use in the United States that it is attracting the attention of coal operators in Canada. There are already several of these loaders in use in Canada, one having been in operation at the Canadian Pacific Railway Company's docks at Fort William, Ontario, for nearly a year. The Lake Erie Coal Co. is installing one of these loaders at their Walkerville, Ontario, dock. The Acadia Coal Co. of Stellarton, Nova Scotia, and the Intercolonial Coal Mining Co. of Westville, have each one machine. There is hardly a coal mining district in the United States that does not use these loaders which are made by the Ottumwa Box Car Loader Co., of Ottumwa, Iowa, U.S.A., whose advertisement appears in this issue. Coal operators in Canada should investigate this labor saving device.

The American Forged Steel Flange Company, Chicago, Ill, are putting in the market a new departure from anything of this kind that has heretofore been available The flanges are made from a high grade soft steel which permits of punching and rivetting with a power rivetter without fear of leaking.

Nova Scotia Steel and Coal Co., Ltd.—The Company has in course of erection at Sydney Mines, the following additions to their plant:—

A Blast Furnace with a capacity of 250 tons per day.

30 Bauer Coke Ovens and 120 Bernard Ovens; 4 open hearth Basic furnaces.

The Blast furnace is nearly completed and will probobly go into blast in July.

They have also opened up at Sydney Mines two new collieries known as Sydney No. 2 and Sydney No. 3, and it is expected that the output for the three collieries for the year 1904, will be about 600,000 tons.

NEW COMPANIES.

BRITISH COLUMBIA.

"The Ferguson Mines, Limited," "Non-Personal Liability" Incorporated under the Statutes of British Columbia, 14th March, 1904. Authorized capital, one million four hundred thousand dollars, in one million four hundred thousand shares of one dollar each. Formed to acquire the properties known as "The Ferguson Mines, Limised."

"Spokane Falls Placer Mining Company, Limited," "Non-Personal Liability."—Registered as an Extra-Provincial Company, 21st March, 1904. Authorized capital, two hundred and fifty thousand dollars, divided into two hundred and fifty thousand shares of one dollar each. Head Office: Spokane, Washington U. S. A. Canadian Office: Trout Lake City, B. C., G W. Carothers, Trout Lake City, B C. Attorney. Formed to acquire the properties known as the "Spokane Falls Placer Mining Company, Limited."

Rose Gulch Hydraulic Mining Company, Limited.—Incorporated under the statutes of British Columbia, 26th March, 1904. Authorized capital, fifty thousand dollars, divided into one thousand shares of fifty dollars each. Formed to acquire the properties known as the "Rose Hydraulic Mining Company, Limited."

Imperial Coal and Coke Company Limited.—Licensed to carry on business in the province of British Columbia, 5th April, 1904 Authorized capital $4,500,000 in shares of $100,00 each. Head Office: Montreal, Que. Head Office in British Columbia, James Harvey, Barrister, Cranbrooke, B. C.

Slough Creek, Limited.—Licensed to carry on business in the province of British Columbia, 15th March, 1904. Authorized capital £200,000 in shares of £1 each. Head Office in Canada: John Hopp, Mining Engineer, Stanley, B. C.

The Imperial Coal and Coke Co. Limited.

This Corporation has been formed under Dominion laws to work an exceedingly large area of coal land which is situated on the west slope of the Rocky Mountains some seven or eight miles north of the town of Michel, in the Crow's Nest Pass region. Our company notes show the capital to be registered as $4,500,000 in shares of $100 each. An option on the control of the stock has been given to Montreal men who have organised with Mr. W. Herbert Evans as President and Mr. Humes Hall as the Secretary; the company's Head Offices at present are located in the Canada Life Building, Montreal The property, which embraces something over 60,000 acres, is at present held under License but if the promotion is successful Crown Grants will be issued upon payment of $5 an acre to the British Columbia Government. The property was acquired by Mr. Andrew Laidlaw and Mr John Brown, Jr., of Spokane, Wash., twelve months ago, which gentlemen bought out all the locators, and transferred the title to the New Imperial Coal Company.

From present information the Company has a season of prospecting ahead of it as no developments have been made upon the property, a force of men will be put at work as soon as the snow is off the ground and openings will be made at such points as may seem most favorable for permanent workings No estimates of tonnage can be reliably made at present but on the assumption of continuous coal beds the aggregate tonnage contained in the 95 sq. miles would be very large. It is reported that there are ten seams of workable widths outcropping on the property and that these ten seams aggregate 110 ft. in thickness; the outcrops are reported to be visible over a north and south running extent of 25 miles Large payments will have to be made by the Montrealers on their options during the coming summer in order to make good their title.

The Great Western Mill, Lardeau District.

This mill is being constructed near Ferguson in the Lardeau District, and is expected to start in a few weeks at the latest. It has been constructed to treat the gold and silver ores of the Nettie L, and the Silver Cup mines, and also such custom ore as may offer. It has twenty stamps of the ordinary type with a crushing capacity of about 50 tons daily. It is built on the side hill plan so that all handling is done by gravity; there are five floors in the mill. The fourth and fifth floors are occupied by ore bins and the terminals of two tram-lines of the Riblet system; the third floor has a Blake rock breaker run by an electric motor, below are the batteries. On the fourth floor are four Dodds buddles for the treatment of galena ores and two Frue vanners for the treatment of heavy iron sulphides; the concentrates, whether lead or iron, are to be shipped to smelters for treatment.

The first floor, which is the lowest is devoted to the treatment of zinc blend, containing dryers, and two Bruckner cylinders in which the zinc concentrates are roasted with salt forming a chloride of zinc which is volatile, the baser metals remaining in the roasted product. The roasted product is then worked in amalgamating pans by a modification of the old Washoe system and treated with quick-silver and ground. The pulp is then discharged into agitators and afterwards into settlers for the collection of amalgam, and the stream from the settlers is passed through a gold amalgamator (patent type) to save such portion of the free gold values as may have escaped the preceding appliances. The mill is driven by two three-foot Pelton water wheels, each with a double nozzle, working under a head of 150 ft. of water. These wheels actuate two Westinghouse alternating current dynamos which furnish the power and light for the plant.

The April Issue of the *Crop Reporter*, which is published under the authority of the United States Secretary of Agriculture, has an article clearly showing and recognizing the agricultural importance of the Canadian Northwest. The rapid advance in the yield of the most important cereals is emphasized by the quotation of statistics, *e.g. In 1898 the total yield of* Spring wheat was 5,717,149 bushels, in 1903 the yield was 16,534,308 bushels, a yield of 300% in six years; the yield of oats in 1898 was 3,136,122 bushels, in 1903 it was 14,626,578, nearly five times the crop of 1898; the yield of barley in 1898 was 463,678 bushels. in 1903 it was 1,706,083, an advance of almost four fold. The principal crops of the Northwest in 1898 totalled about 9,000,000 bushels, whereas in *1903 they totalled about* 35,000,000 bushels. The significance of these figures is not the fertility of the land which is shown thereby, but the demonstration they afford that a region which has, for years, been supposed to be barren on account of its *severe climate*, has such a *good* climate that cereals flourish and are profitable. Canada can have no better advertisement of its climate and fertility than the publication of these figures.

THE CANADIAN MINING INSTITUTE 1898

CANADIAN MINING INSTITUTE

Incorporated by Act of Parliament 1898

AIMS AND OBJECTS.

(A) To promote the Arts and Sciences connected with the economical production of valuable minerals and metals, by means of meetings for the reading and discussion of technical papers, and the subsequent distribution of such information as may be gained through the medium of publications.

(B) The establishment of a central reference library and a headquarters for the purpose of this organisation.

(C) To take concerted action upon such matters as effect the mining and metallurgical industries of the Dominion of Canada.

(D) To encourage and promote these industries by all lawful and honourable means.

MEMBERSHIP.

MEMBERS shall be persons engaged in the direction and operation of mines and metallurgical works mining engineers, geologists, metallurgists, or chemists, and such other persons as the Council may see fit to elect.

STUDENT MEMBERS shall include persons who are qualifying themselves for the profession of mining or metallurgical engineering, students in pure and applied science in any technical school in the Dominion, and such other persons, up to the age of 25 years, who shall be engaged as apprentices or assistants in mining, metallurgical or geological work, or who may desire to participate in the benefits of the meetings, library and publications of the Institute. Student Members shall be eligible for election as Members after the age of 25 years.

SUBSCRIPTION.

Members yearly subscription.....$10 00
Student Members do 2 00

PUBLICATIONS.

Vol. I, 1898, 66 pp., out of print.
Vol. II, 1899, 285 pp., bound red cloth.
Vol. III, 1900, 270 pp., " "
Vol. IV, 1901, 333 pp., " "
Vol. V, 1902, 700 pp., " "
Vol. VI, 1903, 600 pp., now in press.

Membership in the Canadian Mining Institute is open to everyone interested in promoting the profession and industry of mining without qualification or restrictions.

Forms of application for membership, and copies of the Journal of the Institute, etc., may be obtained upon application to

THE SECRETARY,
Orme's Hall, Ottawa

Dominion of Canada

SYNOPSIS OF REGULATIONS

For disposal of Minerals on Dominion Lands in Manitoba, the North-west Territories and the Yukon Territory.

COAL.

Coal lands may be purchased at $10 per acre for soft coal and $20 for anthracite. Not more than 320 acres can be aquired by one individual or company. Royalty at the rate of ten cents per ton of 2,000 pounds shall be collected on the gross output.

QUARTZ.

Persons of eighteen years and over and joint stock companies holding free miner's certificates may obtain entry for a mining location.

A free miner's certificate is granted for one or more years, not exceeding five, upon payment in advance of $7 50 per annum for an individual, and from $50 to $100 per annum for a company, according to capital.

A free miner, having discovered mineral in place, may locate a claim 1500 x 1500 feet by marking out the same with two legal posts, bearing location notices, one at each end on the line of the lode or vein.

The claim shall be recorded within fifteen days if located within ten miles of a mining recorder's office, one additional day allowed for every additional ten miles or fraction. The fee for recording a claim is $5.

At least $100 must be expended on the claim each year or paid to the mining recorder in lieu thereof. When $500 has been expended or paid, the locator may, upon having a survey made, and upon complying with other requirements, purchase the land at $1.00 an acre

Permission may be granted by the Minister of the Interior to locate claims containing iron and mica, also copper, in the Yukon Territory, of an area not exceeding 160 acres

The patent for a mining location shall provide for the payment of a Royalty of 2½ per cent. of the sales of the products of the location.

PLACER MINING.

Manitoba and the N. W. T., excepting the Yukon Territory.—Placer mining claims generally are 100 feet square; entry fee, $5, renewable yearly. On the North Saskatchewan River claims are either bar or bench, the former being 100 feet long and extending between high and low water mark. The latter includes bar diggings, but extends back to the base of the hill or bank but not exceeding 1,000 feet. Where steam power is used, claims 200 feet wide may be obtained.

Dredging in the rivers of Manitoba and the N. W. T., excepting the Yukon Territory.—A free miner may obtain only two leases of five miles each for a term of twenty years, renewable in the discretion of the Minister of the Interior.

The lessee's right is confined to the submerged bed or bars of the river below low water mark, and subject to the rights of all persons who have, or who may receive entries for bar diggings or bench claims, except on the Saskatchewan River, where the lessee may dredge to high water mark on each alternate leasehold.

The lessee shall have a dredge in operation within one season from the date of the lease for each five miles, but where a person or company has obtained more than one lease one dredge for each fifteen miles or fraction is sufficient. Rental, $10 per annum for each mile of river leased. Royalty at the rate of two and a half per cent collected on the output after it exceeds $10,000.

DREDGING IN THE YUKON TERRITORY.

Six leases of five miles each may be granted to a free miner for a term of twenty years, also renewable.

The lessee's right is confined to the submerged bed or bars in the river below low water mark, that boundary to be fixed by its position on the 1st day of August in the year of the date of the lease.

The lessee shall have one dredge in operation within two years from the date of the lease, and one dredge for each five miles within six years from such date. Rental, $100 per mile for first year and $10 per mile for each subsequent year. Royalty, same as placer mining.

PLACER MINING IN THE YUKON TERRITORY.

Creek, gulch, river and hill claims shall not exceed 250 feet in length, measured on the base line or general direction of the creek or gulch, the width being from 1,000 to 2,000 feet. All other placer claims shall be 250 feet square.

Claims are marked by two legal posts, one at each end, bearing notices. Entry must be obtained within ten days, if the claim is within ten miles of mining recorder's office. One extra day allowed for each additional ten miles or fraction.

The person or company staking a claim must hold a free miner's certificate.

The discoverer of a new mine is entitled to a claim of 1,000 feet in length, and if the party consists of two, 1500 feet altogether, on the output of which no royalty shall be charged, the rest of the party ordinary claims only.

Entry fee, $10. Royalty at the rate of two and one half per cent on the value of the gold shipped from the Yukon Territory to be paid to the Comptroller.

No free miner shall receive a grant of more than one mining claim on each separate river, creek or gulch, but the same miner may hold any number of claims by purchase, and free miners may work their claims in partnership by filing notice and paying fee of $2. A claim may be abandoned, and another obtained on the same creek, gulch or river, by giving notice and paying a fee.

Work must be done on a claim each year to the value of at least $200.

A certificate that work has been done must be obtained each year: if not, the claim shall be deemed to be abandoned, and open to occupation and entry by a free miner.

The boundaries of a claim may be defined absolutely by having a survey made and publishing notices in the Yukon Official Gazette.

PETROLEUM.

All unappropriated Dominion Lands in Manitoba, the North west Territories and within the Yukon Territory are open to prospecting for petroleum, and the Minister may reserve for an individual or company having machinery on the land to be prospected, an area of 640 acres. Should the prospector discover oil in paying quantities, and satisfactorily establish such discovery an area not exceeding 640 acres, including the oil well and such other land as may be determined, will be sold to the discoverer at the rate of $1.00 an acre, subject to royalty at such rate as may be specified by order-in-council.

Department of the Interior,
OTTAWA, February, 1904.

JAMES A. SMART,
Deputy of the Minister of the Interior.

PROVINCE of QUEBEC

The attention of Miners and Capitalists in the United States and in Europe is invited to the

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ORNAMENTAL AND STRUCTURAL MATERIALS IN ABUNDANT VARIETY.

The Mining Law gives absolute security to Title, and has been specially framed for the encouragement of Mining.

Mining concessions are divided into three classes :—

1. In unsurveyed territory (*a*) the first class contains 400 acres, (*b*) the second, 200 acres, and (*c*) the third, 100 acres.

2. In surveyed townships the three classes respectively comprise one, two and four lots.

All lands supposed to contain mines or ores belonging to the Crown may be acquired from the Commissioner of Colonization and Mines (*a*) as a mining concession by purchase, or (*b*) be occupied and worked under a mining license.

No sale of mining concessions containing more than 400 acres in superficies can be made by the Commissioner to the same person. The Governor-in-Council may, however, grant a larger extent of territory up to 1,000 acres under special circumstances.

The rates charged and to be paid in full at the time of the purchase are $5 and $10 per acre for mining lands containing the superior metals* ; the first named price being for lands situated more than 12 miles aud the last named for lands situated less than 12 miles from the railway.

If containing the inferior metal, $2 and $4 according to distance from railway.

Unless stipulated to the contrary in the letters patent in concessions for the mining of superior metals, the purchaser has the right to mine for all metals found therein ; in concessions for the mlning of the inferior metals, those only may be mined for.

*The superior metals include the ores of gold, silver, lead, copper, nickel. graphite, asbestos, mica, and phosphate of lime. The words inferior metals include all other minerals and ores.

Mining lands are sold on the express condition that the purchaser shall commence *bona fide* to mine within two years from the date of purchase, and shall not spend less than $500 if mining for the superior metals ; and not iess than $200 if for inferior metals. In default, cancellation of sale of mining lands.

(*b*) Licenses may be obtained from the Commissioner on the following terms :—Application for an exploration and prospecting license, if the mine is on private land, $2 for every 100 acres or fraction of 100 ; if the mine is on Crown lands (1) in unsurveyed territory, $5 for every 100 acres, and (2) in unsurveyed territory, $5 for each square mile, the license to be valid for three months and renewable. The holder of such license may afterwards purchase the mine, paying the prices mentioned.

Licenses for mining are of two kinds : Private lands licenses where the mining rights belong to the Crown, and public lands licenses. These licenses are granted on payment of a fee of $5 and an annual rental of $1 per acre. Each license is granted for 200 acres or less, but not for more ; is valid for one year, and is renewable on the same terms as those on which it was originally granted. The Governor-in-Council may at any time require the payment of the royalty in lieu of fees for a mining license and the annual rental - such royalties, unless otherwise determined by letters patent or other title from the Crown, being fixed at a rate not to exceed three per cent. of the value at th mine of the mineral extracted after deducting the cost of mining it.

The fullest information will be cheerfully given on application to

THE MINISTER OF LANDS, MINES AND FISHERIES,

PARLIAMENT BUILDINGS, QUEBEC, P. Q.

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—AND—

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GOLD AND SILVER.

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

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

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

MINES OTHER THAN GOLD AND SILVER.

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

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

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

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

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

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

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

THE HON. A. DRYSDALE,
Commissioner Public Works and Mines,
HALIFAX, NOVA SCOTIA.

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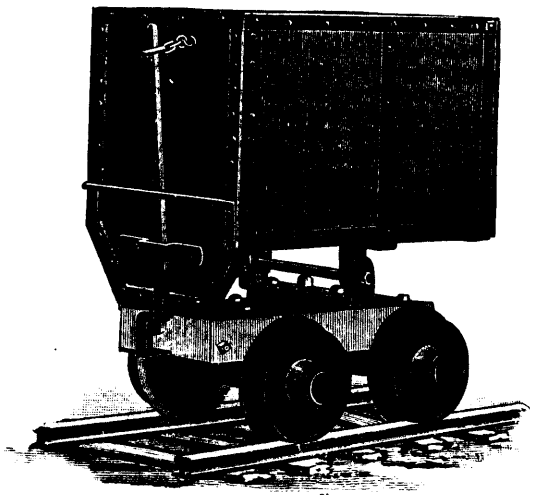

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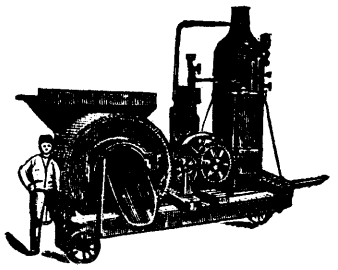

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