FEBRUARY 15, 1915 Single Copies 15 Cents

CANADIAN MINING JOURNAL

VOL. XXXVI TORONTO No. 4

The Canadian Mining Journal, 2nd Floor, 44-46 Lombard St., Toronto, Ont.

Synopsis of Coal Mining Regulations

COAL mining rights of the Dominion, in Manitoba, Saskatchewan and Alberta, the Yukon Territory, the North-West Territories and in a portion of the Province of British Columbia, may be leased for a term of twenty-one years at an annual rental of $1 an acre. Not more than 2,560 acres will be leased to one applicant.

Application for a lease must be made by the applicant in person to the Agent or Sub-Agent of the district in which the rights applied for are situated.

In surveyed territory the land must be described by sections, or legal sub-divisions of sections, and in unsurveyed territory the tract applied for shall be staked out by the applicant himself.

Each application must be accompanied by a fee of $5 which will be refunded if the rights applied for are not available, but not otherwise. A royalty shall be paid on the merchantable output of the mine at the rate of five cents per ton.

The person operating the mine shall furnish the Agent with sworn returns accounting for the full quantity of merchantable coal mined and pay the royalty thereon. If the coal mining rights are not being operated, such returns should be furnished at least once a year.

The lease will include the coal mining rights only, but the lessee may be permitted to purchase whatever available surface rights may be considered necessary for the working of the mine at the rate of $10.00 an acre.

For full information application should be made to the Secretary of the Department of the Interior, Ottawa, or to any Agent or Sub-Agent of Dominion Lands.

W. W. CORY, Deputy Minister of the Interior.

N.B.—Unauthorized publication of this advertisement will not be paid for.—58782.

THE CANADIAN MINING JOURNAL

VOL. XXXVI. TORONTO, February 15, 1915. No. 4

The Canadian Mining Journal

With which is incorporated the

"CANADIAN MINING REVIEW"

Devoted to Mining, Metallurgy and Allied Industries in Canada.

Published fortnightly by the

MINES PUBLISHING CO., LIMITED

Head Office - - 2nd Floor, 44 and 46 Lombard St., Toronto
Branch Office - - - - - - - 600 Read Bldg., Montreal
London Office - - - Walter R. Skinner, 11-12 Clement's Lane London, E.C.

Editor
REGINALD E. HORE

SUBSCRIPTIONS—Payable in advance, $2.00 a year of 24 numbers, including postage in Canada. In all other countries, including postage, $3.00 a year.

Advertising copy should reach the Toronto Office by the 8th, for ssues of the 15th of each month, and by the 23rd for the issues of the first of the following month. If proof is required, the copy should be sent so that the accepted proof will reach the Toronto Office by the above dates.

CIRCULATION.

"Entered as second-class matter April 23rd, 1908, at the post office at Buffalo, N.Y., under the Act of Congress of March 3rd 1879."

CONTENTS.

THE NICKEL ENQUIRY

The decision of the Ontario Government to appoint a Commission to study and report on the problem of refining nickel in Canada will be received with much interest. The Minister of Lands, Forests and Mines, Hon. G. Howard Ferguson, promises that great care will be taken in choosing the men to serve on the Commission. If this is done some useful information should be contained in the Commissioners' report. If men unfamiliar with the mining industry are chosen, they will probably spend most of their time and efforts in gathering such information as is already in the possession of the average mining man. A commission to investigate the nickel industry should be composed of men who know something about ore deposits and methods of treating ore.

While the war has been responsible for a new interest in the nickel question, the action of the Ontario Government is not to be regarded as a war measure. In spite of the sensational statements being made in some of the daily newspapers it may be confidently stated that nickel from Canadian ores is not reaching Germany. The Canadian public should not be misled by the newspaper agitation into believing that the Government's assurances are not to be relied upon. From the articles appearing in the newspapers it seems that many Canadians actually believe that the export of nickel matte from Canada during the war is an advantage to Germany.

It is the duty of Canada to prevent nickel from reaching the enemy. The Dominion Government has shown that it can be depended upon to handle the situation. As long as the war lasts careful supervision of shipments will be necessary; but for the present we are advised that all is well.

MINE, QUARRY AND DERRICK

The many friends of Mr. J. C. Murray will be pleased to learn that he is now editing Mine, Quarry and Derrick, a fortnightly magazine published in Calgary. The first issue has just been received and bears the date Feb. 3rd, 1915. It contains articles by J. B. Tyrrell, L. S. Kempher, W. G. Worcester, R. W. Coulthard and E. H. Cunningham Craig.

While chiefly devoted to the oil industry, the magazine presents information on all phases of the mineral industry. Mr. Murray says:

"No one branch of the mineral industry will receive attention to the exclusion of others. Naturally, exploration for oil will for a time at least be a leading topic. But it will be our endeavor to give due promi-

nence to coal, metals, building materials and all the various minor mineral deposits, heretofore neglected, in which the Canadian West abounds. We shall also publish articles treating of their exploitation and uses."

The mineral resources of the Prairie Provinces are large; but information concerning them is not readily available. Mine, Quarry and Derrick should be well received by those interested in the development of the mineral resources of the Dominion.

Mr. Murray was for six years Editor of the Canadian Mining Journal, and is well known throughout Canada. We wish him every success in his new work.

THE MINERS' "V.C."

"Coal Age," a New York weekly devoted to the literature of coal mining, in a recent issue, asks: "Is it not about time that someone was suggesting a suitable method of rewarding the individual bravery displayed in mine rescue work?" This editorial evidently has in mind the saving of life after mine disasters, or explosions in coal mines, and makes specific reference to the "Rescue Men in the employ of the Bureau of Mines" (U. S.). The writer does not express himself with absolute clarity, but he hints at a national organization in the United States for mine rescue-work, points out that jealousies spring up when several crews offer their services simultaneously, and makes the following curious observation:

"It is a fact that just now any coal operator might feel justified in preventing even a U. S. Bureau of Mines instructor from entering his mine, following an explosion, if he felt so inclined."

There are circumstances which would fully justify a coal operator, or a colliery manager, from preventing any would-be rescuer from entering a mine after an explosion. It is the tendency of "rescue crews" to rush into an exploded mine without proper leadership, plans or equipment, that is bringing disrepute and justifiable criticisms upon so-called "rescue-work." The number of lives saved after coal mine explosions is disappointingly few, and only too often the original death roll has been increased by ill-advised or ill-conceived attempts at rescue. It is just here that we think the writer in "Coal Age" is venturing on dangerous ground, particularly when he hints at a possible conflict of opinion between a Bureau of Mines instructor and a responsible mine official, for nothing can, or should, relieve the mine manager of his responsibility and authority. We agree that the advent of oxygen breathing apparatus, a specialized device requiring specially trained men to satisfactorily use it, has marked out a certain group of men as peculiarly fitted to undertake "rescue-work" after mine explosions, and that some scheme of national organization whereby these men would be recognized somewhat in the same way that paid firemen are recognized, is desirable, and preferable to the present haphazard arrangements; but there is a danger of attaching too much importance to this particular phase of bravery among miners. Catastrophic happenings like a great coal mine explosion always bring out some hitherto unknown hero, but it is in the daily routine of underground work that the miners' bravery is best and most often exemplified.

We offer for the consideration of our mining friends in the United States a report from the London Times of the 14th January, describing an Investiture by the King, where amongst a list of those who received orders of knighthood, Victoria Crosses, Distinguished Service medals, and decorations for conspicuous gallantry, we notice three awards of the "Edward Medal," the "Miners' V. C.," as it is sometimes called, the decoration instituted by Edward VII. for bravery in mines. The official particulars are given in another column of this issue. Each of the three medals was granted for a deed of bravery arising out of the ordinary duties of the mine, that involved sheer dogged bravery, but nothing spectacular. It is interesting to note that one of the medals went to South Africa, and was given for the rescue of two native "boys." One of the things which endeared King Edward to his loyal people was his recognition of the heroes of industry and of civilian life, a tradition that is being worthily maintained by King George, and no decoration was ever conceived in a happier spirit or had more justification than the "Miners' V. C." So far as we are aware no grant of this medal has yet been made to a Canadian miner; but there was one case in the West where, if the hero had survived his act of self-sacrifice, the decoration was richly earned. It is a significant commentary on our national character that in the midst of our world-wide combat against a stubborn and unscrupulous enemy, the King can find an opportunity to recognize the unassuming bravery of those who labor among "the stones of thick darkness and the shadow of death."—F. W. G.

CORRESPONDENCE

CANADIAN MINING INSTITUTE BY-LAWS

To the Editor of the Canadian Mining Journal:

Sir,—In response to your invitation to your readers to express opinions on this subject, I would briefly review the features of the proposed amendments that seem to call for comment.

A system of representation on Council by sections or provinces is proposed, in which representation shall be proportional to the number of members resident in each of the various provinces at the time of nomination. The candidates for office are to be nominated by members living in the province they may represent, and of which they must themselves be residents. Owing to the wide distances to be traveled, members for more than two of the proposed provinces can rarely, if ever, attend meetings of Council wherever they may be held. Consequently, the remaining provinces would as rarely be represented. On the other hand, many members who reside in one or other of the cities in which meetings of Council are usually held, have their

interests in the more remote provinces, and in fact are members owing to those interests. Such men are now commonly selected for offices for this reason; but by this seemingly ill-judged clause of residence, they could no longer represent the provinces in which their interests lie. To give even a semblance of equity to provinces far distant from the place of meeting, at least one-half of their representatives should be selected from the membership at large, so as to secure those who could attend executive meetings.

Another clause that seems equally unjust is that although a province may nominate its own candidates, they shall be elected by the votes of the entire Institute. Judging from such lists of members as are at hand the twenty elective members of Council would, under the proposed scheme, be distributed at the present time somewhat as follows:

British Columbia and Yukon	4
Alberta, Saskatchewan and Manitoba....	2
Ontario.....	10
Quebec.....	2
Maritime Provinces	2

Now if two candidates are nominated for the same office in Ontario, the selection between them would be made by a vote to which this province would contribute only one-half; if in British Columbia, one-fifth, and in the other provinces, one-tenth, with the corresponding chances that the candidate so elected would be the choice of the province he represents. When we reflect that under the condition of residence that is imposed on candidates, three of the proposed provinces could only nominate representatives to stay at home anyway, and that they would then have only from one-fifth to one-tenth of the final voice in selecting even these, this amendment can hardly be called a brilliant stroke for representative government. It would seem to be rather a kind of representation that does not represent much.

Underlying these particular features, however, is the general and more important question whether the elections of the Institute would be better conducted in provincial divisions, or under the broader national system that has been hitherto followed. It is of the first importance to hold the Institute closely together as a truly national organization. Sectional divisions, even in such minor matters as elections of officers do not tend to unity. The Institute represents an industry rather than a profession, and consequently its activities are distributed more according to the needs of the industry and the opportunities of usefulness, than with regard to the ever-changing place of residence of its members. The splendid growth and activity of the Institute during the seventeen years of its existence has been attained under a national system.

However, if any change for the better can be made, one that will strengthen the entirety of the Institute or increase its usefulness, let us by all means be ready to adopt it. But let us be sure that it is a change for the better, investigate it thoroughly and give it deliberate consideration before trying any experiments with it, especially in this, which is bound to be a year of trial to all such organizations.

Yours, etc.,

JOHN A. DRESSER.

Sault Ste. Marie, Ont., Feb. 6th, 1915.

B. C. MINERAL PRODUCTION IN 1914

To the Editor of the Canadian Mining Journal:

Sir,—You were good enough to publish in the Journal of January 1 a letter in which I called attention to what appeared to me to be an inaccuracy in the printed address of the president of the Bank of Montreal, in which it was stated that "it is estimated that the total mineral production of British Columbia for 1914 will be 75 per cent. of last year." As compared with that statement, I submitted that my own estimate was that it had been approximately 85 per cent. Since then there has been printed in western newspapers what I take to be an authorized account of the address of the general manager of the Royal Bank of Canada, at the annual meeting of the bank held in Montreal on January 14, in which it is stated that "the mineral output of British Columbia for 1914 is estimated to be 80 per cent. of the output of the previous year, or about $25,000,000 in value, against $30,000,000 in 1913. This decrease is caused by the inactivity of the smelters on account of market conditions and by labor troubles among the coal miners."

Now, while it is pleasing to find the general manager of the Royal Bank conceding this Province an output in value five per cent. higher than did the president of the Bank of Montreal (though he might have been fairer by giving it credit for the 83 per cent., the totals he quoted showed it be entitled to), I shall be glad to be permitted to call attention to the fact that an official estimate is now available and that this shows a total value of $26,189,020, or 86.4 per cent. of that for 1913.

My chief object in now writing, though, is to take exception to the assertion of the general manager of the Royal Bank of Canada that the decrease in production was caused partly "by labor troubles among the coal miners." On January 15 there appeared in the Journal, pp. 58-60, a review of "Coal Mining in British Columbia in 1914," which gave some detail relative to the output of the different parts of the Province that produce coal, so I shall not here do more than show totals for districts as under:

	Gross Production of Coal 1913.	1914.	Increase or Decrease.
District.	Long tons.	Long tons.	Long tons.
East Kootenay	1,331,725	972,507	D. 359,218
Nicola & Similkameen	265,542	136,140	D. 129,402
Total, Interior ...	1,597,267	1,108,647	D. 488,620
Vancouver Island ...	973,493	1,064,913	I. 91,420
Total, Province ...	2.570,760	2,173,560	D. 397,200

There were no labor troubles at Interior coal mines in 1914, yet there was decreased production. On the other hand, there was increased production on Vancouver Island, where the United Mine Workers of America, although there was available all the independent labor required, and more, too, for working the coal mines, did not "call off" their strike until after the year had been well advanced. So that the long-distance opinion expressed by the banker was not justified by the facts of the case.

The mining industry has troubles enough, without men holding prominent positions in the financial world of Canada adding to them by making inaccurate statements as to its difficulties.

Yours, etc.,

E. JACOBS.

Victoria, B.C., Feb. 1, 1915.

CALGARY OIL

To the Editor of the Canadian Mining Journal:

Sir,—I beg to call your attention to an article appearing on page 87, February 1st. issue of the Canadian Mining Journal, under the heading Calgary Oil, in which there are statements quoted that I am supposed to have made regarding the Calgary oil fields, in my address at the annual meeting of the Conservation Commission recently held in Ottawa.

The statements that I did make on this subject, and which will appear in the report of the Commission of Conservation, are:

"The great need of discovering new sources of supply of petroleum to meet this ever-increasing demand led to the employment by the Mines Branch of Mr. Clapp, one of the ablest petroleum experts of the United States, to make an investigation of the oil and gas resources of the Dominion, with special reference to the geological indications of the existence of oil in the Province of Alberta. While the indications of the existence of petroleum in Alberta are promising, no large producing oil wells have as yet been developed."

Yours, etc.,

EUGENE HAANEL,

Ottawa, Feb. 8, 1915. Director of Mines.

ENQUIRY INTO THE NICKEL INDUSTRY ORDERED

The Minister of Lands, Forests and Mines, Mr. G. Howard Ferguson, has given out the following statement:

Conditions that have arisen out of the present war have made the nickel industry of Ontario the subject of a great deal of discussion.

The nickel lands of the Canadian Copper Company, the Mond Nickel Company, the British American Nickel Corporation, and other corporations and individuals, were sold years ago under a former government in fee simple, without any restrictions or limitations as to the working of the mines or the disposition of the products thereof.

The question, however, of refining nickel in Ontario is by no means a new one. It has received the attention of successive governments, and it was the well-known policy of the Whitney Government, as it is of the present government, to do everything possible to secure the refining of nickel in Ontario, when satisfied that it was commercially practicable so to do.

To this end legislation was passed in 1907, authorizing the payment of a bonus of 6c. per pound on nickel refined in this province, and that legislation is still in force. Moreover, the Department of Mines has constantly had this matter in view with the same object. The nickel industry in Ontario is a very large and important one, expending several millions of dollars in labor and supplies in this province, and up to the present time the government has not been convinced that any action preventing the export of nickel would not have the effect of transferring the nickel business, or a substantial part thereof, from Ontario to New Caledonia, Norway or elsewhere.

Up to the present there does not appear to have been any known process of refining the Sudbury copper-nickel matte that would have permitted of the operation being a commercial and economical success in Ontario.

Metallurgical science, however, has made rapid advances in recent years, and it may be that the conditions with respect to the nickel industry have materially changed. In order to ascertain all the facts and acquire full knowledge of the situation, it has been decided to appoint a commission to investigate the whole question. If the report of the commission makes clear the practicability of refining nickel in Ontario, the necessary steps will be taken to see that this is brought about.

This commission will also consider whether the nickel and other mining industries of the province are paying their full share of provincial taxation, and the proper basis upon which such taxation should be levied. The commission will have plenary power to exhaust every possible source of information and make a careful study of every phase of the question and make a complete report thereon to the government.

It is scarcely necessary to add that a subject of such magnitude and complexity can only be properly dealt with by men of exceptional ability, and those to be selected will be men of special qualifications, who will command the fullest confidence of the public.

"THE LION LED THE LINE"

(Vide Admiral Beatty's Despatch, 24th Jan., 1915.)

The Lion and the Tiger were sailing on the sea,
And with them sailed a Princess allied to royaltee,
Also a buxom damsel who wore the Southern Cross,
A cruising all together—and Beatty was the Boss.

Said the Lion to the Princess, as he "led the line,"
"Could we only sight those wharf-rats, wouldn't it be fine?"
Quoth Miss New Zealand, briskly, "You've voiced my very wish,
"As we did at Heligoland, we'll feed them to the fish."

"I've just got back," the Princess said, " 'cross the Herring Pond,
But not a single German rat my keen-eyed tars have conned.
From Halifax to Boston, Mass., Sambro to the Naze,
Not a 'baby-killer' passed within my anxious gaze."

Just then, the Lion roared, for you see he "led the line,"
And he had spied a wharf-rat, skedaddling for the Tyne.
The ladies both tucked up their skirts, and started for to run,
They said: "It is a LONG time since we have had such fun."

The Lion plunked the Blucher first, as he "led the line,"
The Tiger passed—plugged her too—it—certainly was fine!
The saucy Arethusa gave her the final bump,
And throwing out the life-belts, yelled: "Jump, ye beggars, Jump!"

The Derflinger she ran away—Moltke he ran too.
Then—the Lion hurt his toe—the atmosphere turned blue!
The language of the sailors came from their inmost souls,
As the fleeing foes went limping, squeaking, to their holes.

Next time the Scarboro murderers slink out to raid our coast,
They'll hear again from Beatty, and sailormen may boast;
"Our babes shall sleep in safety, in Scarboro' and on Tyne,
So long as Tiger watches, and Lion leads the Line."

—F. W. Gray.

PERSISTENCE OF ORE IN DEPTH

By F. Hille.

It is not a rare experience to find otherwise clever professional men become, owing to over-confidence in their ability, often blindly one-sided, and sometimes even reckless in their conclusions and assertions regarding certain subjects.

This was again impressed upon me by reading in the Canadian Mining Journal an excerpt of a paper by Mr. T. A. Rickard, entitled "Persistence of Ore in Depth," that was presented to the Institute of Mining and Metallurgy in London during its December meeting. Of course, the readers of Mr. Rickard's publications should be, by this time, well accustomed to his often brusque nonchalance, in treating certain topics, and this is repeated again in the above mentioned paper, the subject of which has become, I might also say, his hobby. His illustrations used in trying to make a case, although very entertaining, should have hardly been necessary, because the subject is of sufficient interest and importance; however, "de gustibus non est disputandum," it is the underlying abrupt conclusiveness to which I object principally.

Everyone of any experience in economic geology knows how extremely hazardous it is to draw a parallel between two ore deposits in two different or even in one and the same locality, on account of the basic differences underlying, in most cases, their origin. How still more risky it is to attempt to treat in this matter the whole multitude of ore deposits, and to patch up, out of certain similitudes, a hypothesis that is to fit the whole question. The practical geologist or mining engineer finds in his mine or field operations very soon that the experience gained in one region or camp is not, or if so but rarely, applicable in another. Therefore the quicker he discards his former experience or preconceived ideas the better for everyone concerned.

Depth is the gist of the paper in question, but what does the author mean by "depth"? "Persistency of Ore in Depth," does not exist, he says. Why not? He does not explain. Now I thought every theory propounded had to be based on a law that is to prove its correctness, and that if this cannot be done, then the theory is wrong. To prove his contention by citing a few mines in which payable ore has not been found in depth, is no proof; because an equal number of other mines could be enumerated upon which the above assertion would not hold good. Even some of those very mines cited would disprove his contentions.

Depth is undoubtedly necessary in case of a low grade deposit, that is, if the width does not make up for a deficiency in the former, because the mass or quantity of the ore has, in this case, to be the profit bringer. With a rich deposit depth would not be so essential, at least not in the same measure as in the former, although, of course, desirable. Let me cite here the Cobalt silver mines which have paid largely even at shallow depth; the same can be said with some of the Port Arthur silver mines and of the Comstock. The money expended on these mines was surely not "the transferring the earnings of the many to the pockets of the few."

What depth then, in the opinion of Mr. Rickard, would be necessary to constitute a paying mine? Without knowing this, it is difficult to offer an effectual refutation of his claim. I do not attribute to him, as someone mentioned in discussing his paper, that he meant the depth of every ore deposit to cease only at its antipodian region; neither also that they need to go farther into the bowels of our globe than our present or future mining methods would permit. But he will not deny that 4,000 to 5,000 ft., at which a number of mines are working with a profit to-day, is not exactly a shallow depth. These same mines, who knows, may go even as many feet deeper yet without our finding the ground too poor for profitable working. And why should they not? How many mines would be in operation of equal depth or more to-day, had no erosion, glacial action or later plutonic activities deprived us of thousands of feet of those deposits of which we are working the truncated parts now.

However, depth is not the only factor in which we have to decide the value of an ore deposit. There are others equally as important, genetic occurrence, width, horizontal extent, mineralization, occupation and form in the rocks by which they are encased, communications, market, labor, etc., etc.

Now then, what is depth? Depth, as I understand it, is: (a) That place from where the contents of our metal veins originated, and (b) That place in which the contents of our metal veins found their lowest rest or seat.

In this class I include only such deposits as are produced by volcanic emanations.

(a) The place of origin is deep seated; plutonic rock intrusions, the source of gaseous emanations, may have come to rest in their upward pressure miles below our earth's surface, and in course of time gradually cooled to such an extent that a continued deposition of mineral matter reached down to almost its starting point.

(b) Apophyses of a volcanic rock injected into the upper horizon of our earth's crust created an exit for gas emanations along their course; but owing to the long retained heat of the rock the gases mingled with their own and meteoric waters, and then deposited their mineral contents close to the earth's surface, that is, in certain horizons of cooled rock strata.

It will be seen that between these two extremes, any depth would be produced according as the conditions were favorable one way or another.

Now to find out these depths involves a patient study of the stratigraphical geology, and an equally patient observation of the mining operations in progress in each mineral region.

During the course of our labors we will then have observed, also, what role the rock or rocks of the immediate vicinity have played as affecting the distribution of the minerals and metals throughout them, whether they are formed in connecting solid deposits—veins—or scattered throughout a shattered rock, forming mineralized zones that may allow or not allow a profitable working. Further, we have to consider whether the mineral contents of veins were uniformly deposited or whether intermittently.

All these conditions give to each mineral district special characteristics which have to be considered in our calculations. If we enter upon our duty with an air of infallibility, or a notebook full of preconceived ideas that are dispensed upon every occasion, we usually damage ourselves as well as our clients, and, in no less a degree, the country or locality in which these deposits occur. Such superficialities are then, not merely excusable professional errors, but inexcusable professional sins.

And I am compelled to accuse Mr. Rickard of the latter when he claims that the ore deposits of the Rainy River district belong to that class, with no "persistence of ore in depth," and that consequently "they have had their day." Mr. Rickard will see the day when the deposits of that district will not only show depth, but will also show themselves to be the most important on this northern continent; some of them will rank with the Treadwell and Homestake, and some with the best of the Nevada mines. That these mines were closed in years gone by, was not due to the diminishing of values in the ore, or giving out of the ores. On the contrary, some of them have steadily widened, in some instances with an increase of value. I may mention only a few.

One of the most important widened from 8 ft. at the surface, and with an $8 to $10 ore, to 25 ft., and over $20 in 600 ft. depth, and is still widening.

Another has some ore shoots in the 300 ft. level that assay over $20, and have a width of about 20 ft. There was no sign of these at the surface, where only a small vein, although persistent in strike, was encountered.

I may mention also one of the low grade deposits, being of immense size and having a horizontal extent of over two and three-quarter miles, and a width from 150 ft. at both ends to over 400 ft. at the centre, assaying as far as ascertained in the neighborhood of from $3.50 to $4.00 on the average.

I could cite a number more of these low grade ore bodies that exist here, which are mineralized zones of a sheared granite along faults, and to which we can attribute a depth equal to that of the granite.

The reason that most of these deposits are not under full exploitation at the present time is partly owing to such careless and unfavorable criticisms by persons who know absolutely nothing about them, but use, like Mr. Rickard, "hearsays" to prove a hypothesis which is absolutely indefensible.

The illustrations and similes used by Mr. Rickard for proving his point may be entertaining, but must have been absolutely unconvincing to the audience which he was addressing; proof of which is the discussion on his paper. It is difficult to understand why a man of Mr. Rickard's calibre succumbed in a weak moment to the temptation of bringing this subject before the Institute. Did he wish to show his sympathy and to prove that he has an ever vigilant eye for the dear, poor, stock-buying public? Vain attempt, the stock buyer is usually shrewd enough and keen-eyed enough not to be humbugged; he sees, as well as others, that there are many dividend paying mines in the world, and that, consequently, mining must be as legitimate a business as any other one. It is difficult enough to convince mining companies that in order to assure success to a mining enterprise, money is necessary. Why then block the way to success?

Preaching ethics to a whole industry or profession is very laudable, that is, if I have a cause or base for my sermon; but "fighting a cyclone with windmill wings" is a peculiar undertaking.

Mr. Rickard should know that flamboyant prospectuses or highly colored reports, have the sign of failure on their forehead, and are therefore not to be taken seriously. Mines are rarely started nowadays by small capitalists; usually large mining companies or exploration companies are interesting themselves in the developing and exploitation of ore deposits, and these companies are well supplied with good, responsible engineers. Why should it be necessary to warn them to beware of "make believes" or "reckless optimism," and what else not?

WETTLAUFER.

Wettlaufer Lorrain Silver Mines, Limited, report for 1914 shows a credit balance of $29,680, with sundry investments set down in the balance sheet at $109,912. Proceeds from sale of ore amounted to $11,913. Other receipts brought the year's income to $17,530. Expenses were $12,367. Profits were thus $5,163, despite the fact that the mine was not open.

The president, Henry Lockhart, Jr., said: Your properties have been opened since October 31, 1913, and the only expense the company is now under at the property is that of keeping a watchman, and pumping. It was decided at the last annual meeting to devote such of the company's resources as your directors might decide to the acquisition of other properties, and while several have been considered during the past year, we have not found one sufficiently attractive to warrant investment. Your board is continuing its endeavors in this direction with the hope of finding, in due course, a suitable property.

General Manager Livermore, in his report states: During the year no mining operations were carried on. The mine was allowed to fill up with water to the fourth level, but was kept free above that level, in order to keep the mine open for possible further work. So as to avoid the expense of running the compressor, a Gould plunger pump, electrically driven, of capacity ample to handle all water made by the mine, was installed at the fourth level.

The mine and property has been left in charge of a caretaker, who lives at the shaft, and who keeps the mine pumped out. All plant and equipment have been kept intact and in good order on the property. Occasional visits are made by your manager.

The question of the advisability of doing further work in the mine was thoroughly considered, but on account of the barren results obtained from development up to the time of shutting down, lack of good surface indications on that part of the property not opened underground, and because of the expense of putting the caved-in shaft in condition, no work was undertaken.

Meanwhile, a considerable amount of examination of new prospects and mines has been done in the Lorrain, South Lorrain, Kirkland Lake, Elk Lake and Cobalt districts and elsewhere. Some of these have been of no worth, while others have offered some prospective value, but no suitable terms could be obtained.

The situation regarding possible new finds in the Wettlaufer mine has not changed from that detailed in the last annual report, that is, the prospects are poor, although it is barely possible that some of the development being done at the time of shutting down was not carried far enough to disprove absolutely the existence of other veins.

Arrangements have been made whereby the ordinary rate of two cents per ounce, applicable to all letters sent from Canada to the United Kingdom, will apply to letters addressed to British and Canadian troops on the continent. The rate on ordinary letters from Canada for the continent is five cents for the first ounce, and three cents for each subsequent ounce, so that this extension of the two cent an ounce rate to letters addressed to our soldiers on the continent, is a decided reduction in favor of correspondence going to the soldiers.

METALLURGICAL PRACTICE IN THE PORCUPINE DISTRICT*

By Noel Cunningham.

Many excellent descriptions of the mills of the Porcupine district have been written, but no discussion exclusively devoted to the metallurgical technology has been given. These notes are intended to cover this feature briefly. They are based upon 2½ years' mill operation in the district—i.e., practically since the beginning of metallurgical operations.

Character of the Porcupine ore.—There is no oxidized ore in the district, the surface having been deeply planed by glacial action in recent geologic time. The precious metal content is about in the proportion of 85 of gold to 15 of silver by weight; hence, the silver is practically negligible. There are two classes of Porcupine ore, having very different characteristics; these will be referred to throughout this paper as Class A and Class B.

Class A ore is a pure quartz with inclusions of schist. Generally it is heavily fractured and breaks down readily to sharp, hard grains, about minus 10 plus 20 mesh, requiring further comminution to release the gold. It carries very little pyrite; the gold is entirely free and apt to be coarse, but often spongy, going into solution readily on that account. This gold is 60 per cent. to 85 per cent. free milling, depending on the grade of ore.

Class B ore is an iron silicate schist, strongly laminated, carrying 4 to 5 per cent. pyrite; its specific gravity is 2.8 to 3.0, depending upon the amount of mineralization. In breaking the ore in the mine, generally over 25 per cent. of material through a ½ in. ring is made; the ore readily breaks down in milling and makes a comparatively large amount of non-crystalline slime; owing to its high specific gravity, however, it is quick settling. In my opinion, the gold in this ore is free, but so finely divided that it will neither pan nor amalgamate; it appears to be disseminated through the rock and not chiefly associated with the pyrite.

Veins of Class A ore occur with or without side walls of Class B, and veins of Class B occur unassociated with Class A; more often the veins are closely banded, Class A and Class B alternating, generally with Class B in excess. Both classes of ore are more or less blocky at times, and with reference to Class B this is indicative of low gold content.

From a treatment standpoint neither class of ore introduces any important difficulty, although there seems to be a tendency toward reprecipitation, due probably to some element in Class B material. Practically no cyanicides are present in the ore, chemical consumption being about 0.2 lb. of cyanide per ton of ore; 1 lb. cyanide solution is sufficient for extraction, and protective alkalinity may be carried very low. With a well designed battery and tube mill installation, a stamp duty of 15 tons or better can be readily maintained.

Outline of Treatment and Development at the Principal Mills.

Although excellent descriptions of the mills and treatment methods of the Porcupine district have appeared in the technical press, it will be of benefit to outline the treatment in the five principal mills of the district in chronological order, and to comment briefly on the metallurgical trend indicated.

First Hollinger Mill.—Destroyed by fire before ready to operate. Treatment intended: Fine crushing, plate amalgamation and concentration of tailing.

First McIntyre Mill.—Designed for treating Class A ore. Crushing by 10 light stamps, fine grinding, plate amalgamation and concentration of tailing from amalgamation. As the mine developed, chiefly Class B ore was produced, from which an extraction could not be made by amalgamation. This mill was shut down after about a year's run.

Vipond.—Mill of 100 tons capacity, treating a mixture of Class A and Class B ore. Treatment: Fine grinding and plate amalgamation. Simple amalgamation did not make a satisfactory recovery of the gold and the mill was shut down after a few months' run. Recently the mill resumed operation, amalgamation having been abandoned and a cyanide plant added. Treatment: Fine grinding in cyanide solution, agitation and complete counter-current decantation.

Dome.—A 40 stamp mill, recently increased to 80 stamps, treating a mixture of Class A with a less amount of Class B ore. Treatment, at start: Stamping in water, primary amalgamation, fine grinding, secondary amalgamation, dewatering, agitation in cyanide solution, Merrill filters, to waste. Later: Stamping, tube milling, and plate amalgamation in water, cone classification to three products; (a) slime, dewatered and agitated in cyanide solution, Merrill filters to waste; (b) sand, leached; (c) concentrate, reground in tube mill in closed circuit with classifier and amalgamation plate; classifier overflow to slime treatment.

Hollinger.—A 40 stamp mill, recently increased to 60 stamps, treating a mixture of Class A and Class B ore, the latter predominating. Treatment, at start: Stamping in solution, fine grinding, concentration, concentrates amalgamated in solution and returned to table tails, table tails to agitators, to Moore filter, to waste. Later: Stamping in solution, fine grinding and concentration, concentrates agitated in strong solution, washed and impounded; table tails to two steps of continuous decantation, to filters, to waste. Now building: Plant for agitation and complete counter-current decantation for one-third of the tailing from table concentration.

Porcupine Crown.—Plant with 10 light stamps, later increased to 20, treating Class A ore entirely. Treatment, at start: Stamping and fine grinding in water, followed by plate amalgamation. Later: Stamping and fine grinding in solution, with plate amalgamation in closed circuit with tube mill and classifier, followed by agitation and complete counter-current decantation.

Second McIntyre Mill.—Plant of 150 tons capacity recently increased to 300 tons, treating a mixture of Class A, with large preponderance of Class B ore. Treatment, at start: Fine grinding in solution, agitation, Burt filter to waste. Later: The capacity was increased from 150 to 300 tons, the treatment being unchanged except that continuous decantation replaced filtration in the new unit.

Acme Mill.—Now building with 40 stamps, to treat a mixture of Class A and Class B ore, the latter preponderating. Treatment: Stamping and fine grinding in solution, agitation, concentration, concentrates to be reground in solution, agitated, washed and impounded, table tails to be treated by decantation.

*A paper to be presented at the New York Meeting of the American Institute of Mining Engineers, February, 1915 and at the Toronto Meeting of the Canadian Mining Institute, March, 1915.

Analysis of the Milling Practice.

A tendency toward extensive alteration in treatment methods will be at once apparent from a consideration of the above outline of milling practice and development. This is chiefly due to the fact that large bodies of Class B ore are now being developed and treated, whereas the design of most of the mills was determined almost entirely from tests upon Class A ore. The entire failure of straight amalgamation is obvious. Amalgamation in conjunction with cyanidation is practised only at the Dome, where large bodies of Class A ore are yet to be treated, and at the Porcupine Crown, where to date only Class A ore has been found. At the latter mill, however, only a small plate area is used in the classifier tube mill closed circuit, as the ore contains a large amount of coarse free gold which is readily caught at this point.

The equipment of the Porcupine mills offers good opportunities for comparison of various machines for doing the same work.

Stamps versus Rolls and Hardinge Ball Mills.—At the Vipond and the McIntyre mills, rolls and ball mills are doing the work done by stamps at the other mills. The ore is chiefly soft schist and the ball mills have been entirely satisfactory; power per ton of ore ground appears to be slightly higher than with stamps for the production of identical results. Steel consumption is about the same, the stamps perhaps having a shade the better of the argument in this respect; cost of operation and repairs is in favor of the ball mill, while first cost and uniformity of operation (what might be termed lack of operating "grief") are decidedly in favor of the ball mill. While my own experience in the district has been entirely with stamps, and their performance was satisfactory, I am of the opinion that the ball mill is preferable for breaking down the Porcupine ore ahead of the tube mills.

It may be of interest to note in passing that at the McIntyre a first-class Chilean mill was discarded in favor of the ball mill after the two had run side by side for a year. At the Vipond, Hardinge pebble mills are used for fine grinding, while cylindrical mills are in use in all the other plants. I do not know how the conical mills compare with the cylindrical mills in first cost, power required, performance, etc., but on theoretical lines I favor the cylindrical mill, where coarse gold is to be dissolved in solution, as more effectively trapping the gold particles and wearing them down to microscopic fineness, owing to the vertical end of the mill.

Stamping in Water and Amalgamating versus Stamping in Solution with No Amalgamation.—Probably the best opportunity for studying this point is afforded by a comparison of the Dome and Hollinger practice. The advantages claimed for stamping in water and amalgamating are a better recovery of the coarse free gold and the saving in treatment cost, due to a smaller amount of solution to precipitate and a smaller amount of precipitate to handle. At first sight it would also appear that a saving in dissolved losses from the filters would be made, owing to the smaller amount of gold in solution going to the filters.

While at the Hollinger there is a smaller percentage of amalgamable gold in the mill heads than at the Dome, on the other hand, the coarse free gold per ton of ore in the mill heads is about the same due to the fact that the head assay is nearly triple that of the Dome. Hence, if amalgamation is necessary in order to assure the dissolution of coarse gold in cyanide solution, difficulty from this source should be experienced at the Hollinger, where crushing is in solution with no amalgamation.

This is not the case, however; all the coarse gold goes into solution in the classifier tube mill closed circuit. This is proved by two facts in connection with the Hollinger operations. Table concentration after fine grinding is practised at the Hollinger, and any coarse free gold passing the tube mill classifier closed circuit would be caught on the tables. No coarse gold is present in the table concentrates, however, no color of free gold ever showing on the tables; also practically no amalgam was produced (under 1 per cent. of the total values recovered) during six months, pan-amalgamation of concentrates from the tables.

Facts also indicate that crushing in solution without amalgamation has the best of the argument in regard to amount of solution precipitated and dissolved gold mechanically lost. With the head assay at the Hollinger about three times as high, the precipitation ratio is only about twice that at the Dome, and the mechanical loss of dissolved gold and cyanide only about one-half. Nor is any saving in dissolved losses or treatment cost proved in favor of crushing in water followed by amalgamating. On the other hand, there are added to the treatment cost (1) cost of amalgamation, (2) cost of increased cyanide consumption due to "waste" solution precipitated and thrown away, and (3), in winter the cost of heating to mill temperature the quantity of water—equaling several times the weight of ore treated and introduced at nearly a freezing temperature—to replace the water and waste solution discharged with the tailing, which would not be necessary if crushing were done in solution. The loss of gold left in "waste" solution after precipitation must also be added to the cost.

In comparing Dome and Hollinger metallurgical practice, it is only fair to state that since the Dome ore is harder and more compact, the gold may be less spongy and therefore less amenable to cyanidation. The only deduction which can be drawn from the facts, as far as I know them, is, that apparently in treating average and low grade ore of the district amalgation can be eliminated; that if amalgamation is eliminated and solution introduced at the stamps, a considerable saving in operating cost, cyanide and dissolved gold losses is possible.

Unquestionably more extensive study has been given to the treatment of the Dome ore than to any other in the district. Hence one hesitates to make what may appear to be a criticism of an operating system probably justified by a careful balancing of co-ordinate factors by an eminent firm of metallurgists. However, no metallurgical discussion would be complete without touching upon this point, which is the salient difference between the two metallurgical systems of the district.

Concentration versus Non-concentration.—The Hollinger is the only mill making a table concentration. About 16 per cent. of the gold in the ore is recovered in the concentrate, and the advantages claimed would indicate that the possibilities justify careful consideration. The pulp, with the concentrate removed, needs much less careful treatment than the entire pulp, concentrate included, would require, hence a small tonnage of concentrate may be given whatever treatment it demands to get the best result, while the large tonnage of pulp free from concentrate may receive the much smaller amount of attention it requires.

Table concentration at the Hollinger costs about 5c. per ton of ore treated and recovers about 80 lb. of concentrate per ton of ore, assaying about 2½c. per lb., worth, therefore, about $2. In the careful treatment given the concentrate the value per lb. of concentrate is brought down to about 0.3c.; in other words, a sav-

ing of $1.76 is made from the 80 lb. of concentrate from each ton of ore, which is a large enough amount to warrant the expenditure of 5c. to safeguard. The performance of the thickeners and filters is improved if a feed can be maintained composed of particles of one specific gravity, so that from the standpoint of better mill performance, due to keeping the concentrates out of the thickeners and filter, I am of the opinion that the expenditure of 5c. per ton of ore is justified where the concentrates taken out amount to say 4 per cent. or more of the total tonnage. Another advantage is that even after a very careful treatment the concentrate tailing assays from $5 to $7 per ton of concentrate, equal to 12c. to 20c. per ton of ore. Also the saving in treatment cost, due to the less agitation required for the pulp freed from concentrate, should be credited to concentration. Hence, I should say that if table concentration cost 20c. per ton, instead of 5c., it would still be justified when a considerable amount of Class B ore is to be treated.

Agitation.—The ore particles composing the pulp coming to the agitators are extremely quick-settling and largely granular; after only a few minutes' shutdown the pulp compacts solidly in the bottom of the agitator so that, mechanically, agitation is a difficult problem. At the Dome four Pachucas in series are in operation, but all the other mills use the Dorr agitator, which seems to be peculiarly adapted to the local requirements. From the trouble experienced in keeping the Hollinger pulp in suspension in the filter loading vats I judge that the Pachuca agitator is expensive in power required to prevent the filling up of the cone. With a trifling amount of power and a normal air consumption the Dorr agitator meets all the mechanical difficulties.

Metallurgically the quicker-settling particles need longer treatment than the lighter material. Selective agitation of the quick-settling particles is therefore essential if the best results are to be obtained.* The Dorr agitator, allowing as it does control over the rate of flow through the tank of material of greater or less than the average settling rate, meets the metallurgical requirements of the ore very nicely.

Filter Methods of the District Compared.—The Merrill filter is in use at the Dome, and while direct treatment in the presses has been tried, it has been found that the use of agitators for the dissolution of the precious metals is preferable, as a very large and expensive filter installation would otherwise be required. The Moore filter at the Hollinger has indicated that the ore contains such a large proportion of quick-settling material that vacuum filtration is not altogether satisfactory. In the loading vats, six air lifts are used, requiring 40 h.p. at the compressor, and even with this intense circulation the heavy slime accumulates on the 60 deg. hopper bottoms, resulting in such damage to the leaves that about one-third of the filter-operating cost is represented in repairs to filter leaves. Then, too, with the strong circulation, due to the air lifts, the cakes are channeled and uneven. On the whole, I do not consider that vacuum filtration is adapted to the Porcupine ore.

At the McIntyre mill, a Burt filter is doing very good work and is stated to have been entirely satisfactory. At the Hollinger and the McIntyre mills, the pulp from the new sections will be treated by continuous counter-current decantation, while the pulp from the original sections will continue to be put through the filters, so that shortly some interesting comparative figures on the two methods should be available.

Continuous Counter-current Decantation.—It has been previously mentioned that no oxidized ore occurs in the district, and the clean undecomposed rock breaks down to give an ideal product in the thickeners. Class A ore makes no colloid, and Class B ore, while grinding to an extremely fine, amorphous product, gives little trouble in settling, owing to its high specific gravity. Class A ore can be thickened to 30 per cent. moisture and Class B to 35 to 45 per cent., depending upon the percentage of concentrate. The critical moisture is 45 per cent., when 5 per cent. of concentrate is present, and about 35 per cent. moisture with Class B pulp, free from concentrate. On account of being able to get such unusually low moistures in the thickeners, a very high recovery of dissolved metals is possible by continuous decantation. Also, the fact that the cyanide strength of the solution from agitators to thickeners need only be carried at slightly above 1 lb. per ton favors the decantation system, where the mechanical loss of cyanide is generally higher than in ordinary filter practice. At the Porcupine Crown, with about $13 going into solution per ton of ore and using four steps of decantation, with no filter, the dissolved gold loss is only 5c. and the mechanical loss of cyanide only 0.32 lb. per ton of ore.

The Hollinger mill put in two steps of continuous decantation early in 1913, and the complete counter-current decantation system was installed in the cyanide extension of the Porcupine Crown later the same year. Later still, the Vipond installed the counter-current decantation system, as did the McIntyre when the mill was enlarged. The Hollinger has a complete 300 ton plant under construction, and the Acme mill a 600 ton plant, both to use this system.

Mill Design.—The proper design for a mill treating Porcupine ore will depend upon the proportions of Class A and Class B ore to be handled. Unless there is to be a large excess of Class A ore, amalgamation may be dispensed with, as the recovery by amalgamation will not warrant its use. If Class A ore is in large excess it would still be an open question, but from a recovery standpoint amalgamation is unnecessary.

The Hardinge ball mill may not show up as well on Class A as on Class B ore, but I am inclined to think that it would. With an excess of Class B ore the ball mill will be superior to stamps. I am of the opinion that a cylindrical tube mill should be used for fine grinding, rather than a conical mill, if only for a theoretically better dissolution of coarse gold.

For the treatment of any considerable proportion of Class B ore, table concentration, with separate treatment of the concentrates, will probably pay.

Agitation should be arranged to be continuous, preferably in a series of flat-bottomed agitators, allowing a preferential treatment for the quicker-settling portion of the ore.

If filtration is used, a pressure filter will be more satisfactory than a vacuum filter; however, the ore is so perfectly adapted to continuous counter-current decantation that this would seem to be the proper treatment.

On account of the severe winter conditions and the high cost of fuel, the object to strive for in the design should be as compact an arrangement of the equipment as possible, so as to minimize the cubic area of buildings to be heated.

In the district, the water supply is ample, the sites for mills are good, and the facilities for convenient tailing disposal are adequate.

*For an exposition of the term "selective agitation," see the paper by J. V. N. Dorr, in Bulletin No. 92, p. 2072 (August, 1914).

PYRITIC SMELTING

At a recent dinner of the New York section of the Mining and Metallurgical Society of America, Mr. Robert Sticht, general manager for the Mount Lyell Mining and Railway Co., Queenstown, Tasmania, spoke informally of his experience in pyritic smelting in that country during the past 20 years. His remarks were discussed in an interesting manner by several members of the society. The following notes on the discussion are from an account published in the February issue of Metallurgical and Chemical Engineering.

Mr. Sticht said in part: "When I arrived at Mount Lyell the pyrite method was still a problem. I had enjoyed opportunity to carry it out in its purity, for short periods, whenever the ores were suitable, in Montana and Colorado, and had no fear, on an empirical basis, that it would not be possible to carry it on continuously where the ore was so favorable as at Lyell. But, for my own satisfaction in fully understanding what went on inside of a furnace, I was made general manager too soon. I then had to look after the pounds, shillings and pence, and investigations of metallurgy, as such, had to be postponed.

Briefly, we started with three blast furnaces in 1896 and then installed converters. This plant was gradually enlarged to six blast furnaces. A second plant was built with five furnaces. When we abandoned hot blast, after six years' use, we pulled down the first plant and did all the work in the second. This plant received an extra furnace in the course of time, so that it has six, but we usually run only three furnaces. The most interesting development, perhaps, was the discarding of hot blast. I do not think I would now recommend it under any conditions.

"Our furnace column reaches 18 ft. above tuyeres, and we use 64 oz. blast pressure. We base our work on the assumption that the inside of a furnace is occupied by a honeycombed mass of quartz, the passages of which are traversed by the blast and the molten sulphide, in opposite directions, the incandescent silica effecting simultaneous oxidation of the latter, by the oxygen of the blast, and the union of the FeO, thus formed, with the silica itself. This forms the slag, while the unoxidized portion of the sulphide makes the matte. Our matte runs from 45 to 50 per cent., rarely under 35 per cent., and sometimes as high as 60 to 65 per cent. (a 20.1 concentration). When the matte becomes too high, we reduce the siliceous ore; when too low, we increase the latter. The proportion of pyrites in the charge is constant; also the limestone. The only variables are siliceous ore and coke, but the latter is changed much less frequently than the former.

"As regards the percentage of coke used, I regret to say that the time when we got along with only 1½ per cent. (and sometimes as little as 1-10 per cent., with hot blast) is now merely historic. We are now under the necessity of smelting more of the siliceous ore, and, at the same time, the iron and sulphur in the pyritic ore have diminished, owing to the inclusion of a little galena and zinc-blende and a little more gangue. As a consequence, we now employ from 3½ to 5 per cent. coke, figured on the materials charged (except coke). The coke is our own make, but high in ash, and wet from the rainfall, which is 110 in. annually. Our slags are also more siliceous than they used to be, averaging 35 to 37 per cent. SiO_2, as against 30 to 32 per cent. in the past. The campaigns used to be three months or less; now they are a good deal longer, easily six months, the stoppages being caused by leaky jackets or the forehearth.

"Concerning shape of bosh, I am unable to see that it makes any difference. The furnace creates its own internal lines, which may be entirely different from those of the designer. One can alter the position of the smelting zone, i.e., the focus, by changing the blast. The focus can be driven up by increased blast, in fact it may be driven clear to the top of the column.

"You might think our works old-fashioned. We have kept fully in touch with all modern improvements and tendencies in the United States, but have not found that we could advantageously make use of the most striking ones. This is true as well of economic as of purely metallurgical points. Each furnace is run individually as regards momentary composition of charge, and the principal factor in their operation is the feeding. We have to be very particular about this, and cannot resort to mechanical appliances intended to serve unchanging average conditions of feed, because our process is so sensitive to variations in the relative proportions of silica, sulphide and air, and to the physical way in which these three come together. You cannot run a number of pyritic furnaces all in the same manner and obtain our present grades of matte with satisfactory constancy. You would have to reduce the grade to, say 20 per cent., and be satisfied to re-treat this."

Mr. D. H. Browne called attention to the fact that the practice outlined by Mr. Sticht was not applicable to all ores which contain sufficient iron and sulphur to smelt them. Sudbury ores, for example, containing 35 per cent. iron and 20 per cent. sulphur, are theoretically amenable to pyritic treatment, but many attempts had been made without success.

Mr. J. Parke Channing said: "About 15 years ago, when I was starting the operations of the Tennessee Copper Co., I heard of what Mr. Sticht was doing at Mount Lyell, in Tasmania, and Mr. Frank Klepetko kindly laid my problem before Mr. Sticht. He advised me that I had better not begin with pyritic smelting in Tennessee, but stick to heap roasting. We spent $70,000 putting in roast yards, then smelted the ore with 13 per cent. coke, making a 40 per cent. matte in the first operation, which was then converted. We made money, and everyone was satisfied. I fear that if we had started on pyritic smelting I might have made a failure of it.

"Shortly after this, Mr. Freeland, manager of the Ducktown Sulphur, Copper and Iron Co., whose property adjoined that of the Tennessee Cooper Co., began pyritic smelting. At first his slags were too siliceous, and to correct them he tried adding iron ore. This only made matters worse; and eventually, after pounding away at it and trying all the various combinations, he found that what was necessary was to cut down the coke and add silica. To him is due the credit for the pioneer work in pyritic smelting in the Ducktown district.

"Having the benefit of his experience, I took one of our 56 x 180 in. furnaces, ran the ordinary roasted ore charge down low, filled it up with the pyritic charge, with a minimum amount of coke, and the furnace ran perfectly. We found, however, that it did not make much better than 10 per cent. matte, which was then concentrated in a second furnace and bessemerized. We were soon able to clean up the roast yards and operate entirely by the pyritic method. Incidentally, we noted an increased extraction, as apparently some inexplicable loss occurred in the roast yards, which we

were never able to trace. We were never able to reduce the coke so far as Mr. Sticht did, nor were we able continuously to get so high grade matte as he. As the furnaces are now operated, the question of matte-fall is of secondary importance, the most important object being to produce a gas which can be used in the acid chambers for the production of sulphuric acid.

"The present aim is to yield a gas which will run about 6 per cent. SO_2 and 9 per cent. free oxygen, so that there may be enough oxygen to convert the SO_2 to SO_3, in the chambers. If the SO_2 is high, and the oxygen low, it will not do to add atmospheric air, because of the large amount of nitrogen thereby introduced, which dilutes the SO_2 below working requirements. The best way is to keep the coke down to a small amount, so that too much of the free oxygen will not be consumed in burning this carbon.

Experiments at Copper Cliff.

"For many years I had maintained to Mr. Browne that there was no reason why he should not smelt the Sudbury ores pyritically. He haunted the works of the Tennessee Copper Co. for over a year, trying to learn how to do it. About two years ago he engaged Mr. George A. Guess, who had been in charge of the Tennessee smelter, to try the experiment at Copper Cliff. Mr. Guess was given a furnace and blowing engine, and any kind of ore and flux that he wanted. After about three months I received two letters in the same mail; one from Mr. Browne saying that Mr. Guess had given it up, and the other from Mr. Guess himself saying that he could not smelt the ores pyritically and did not know why.

"I have grave doubts whether nickel-copper ores can be smelted pyritically. Possibly there is some peculiar characteristic of the nickel sulphide which prevents the pyritic action from taking place. In addition, a large amount of the silica in the Sudbury ore is combined as a bisilicate, and the conditions in the furnace are not suitable for breaking up this combination. There is just a possibility that in a very high furnace the desired result might be obtained, though I am of the opinion that Mr. Browne will have to continue with his roast heaps, for the present at least. There is a possibility that in the Knudsen furnace the problem may be solved. There, none of the materials can get away, and possibly the complicated reactions may take place."

Mr. Sticht was asked whether the difference in the action of the Australian and Sudbury ores might not be due to the fact that the former was a pyrite and the latter a pyrrhotite, the extra atom of sulphur in the former exercising a favorable influence on pyritic treatment. In reply, Mr. Sticht said that he believed there was a strong misconception regarding the utility of the extra atom of sulphur in pyrite as a source of heat in the pyritic process. This extra atom is not burned, but distilled. The FeS_2 turns practically to pyrrhotite at once, and even to something like Fe_5S_4 or Fe_4S_3 in the lower part of the furnace, and it is this particular sulphide which supplies the heat.

"In many ways, I think, a pyrrhotite ore is probably easier to smelt than a pyrite ore, but I may repeat that the most essential condition for the process is to have free SiO_2. What experience I had with pyrrhotite ores in Colorado made me feel that they were easier to treat than pure pyrites. In addition to keeping the throat more free, they seem to run hotter. But it was necessary not to be afraid to reduce coke, i.e., to a minimum which would ordinarily seem dangerous.

"One ought to have several feet leeway in the height of his smelting column. In reconstructing the Mount Lyell works, I raised the charge floor eight feet above the former one. A separate blower for each furnace is desirable if one can afford it, but that is only a minor point when there are not too many furnaces. When formerly using hot blast the stoves standing between blowers and furnaces, it complicated matters to have a blower for each furnace, and we did not do that at Mount Lyell. Our practice now is to supply about 20,000 cu. ft. of cold, free air per minute to each furnace. The 64 oz. pressure is only an incidental feature of the blast, and is due merely to the resistance encountered in forcing a given volume of air through a certain size of tuyere in a given time. Roughly speaking, it is volume rather than pressure that counts.

"Regarding the composition of our furnace gases, since the figures were first published, we have occasionally repeated the analyses, and still find practically no oxygen in the gases leaving the furnace, nor at a depth of 7½ ft. below top of the column. The determinations were last made a few months ago, with a water-cooled apparatus."

"The furnaces at Mount Lyell appear to be running with hot tops. This is due to the large amount of sulphur distilling off, which burns as it comes in contact with oxygen of the air above the charge. It is possible to run the furnace on matte and pyrrhotite with a satisfactorily cold top. On pyrites, however, this is impracticable, for this low temperature can be achieved only by operating in a manner which leads to rapid formation of crusts around the throat. We run, therefore, so as to avoid crusts, and thus appear to have a fiery throat. One must, however, not contemplate the combustion of the sublimated elemental sulphur, but judge throat conditions rather by the phenomena at the top of column. The top of the furnace is really not hot, for the pieces of charge glow slightly only around the walls, and are black and cold over the full inner area of the top. Between these cold pieces a whitish flame is visible, which changes into a heavy cloud of sulphur vapor a foot or two above the top of charge; this then ignites and forms the usual dense white smoke characteristic of the work. The furnace acts as its own crusher; all materials are charged in as massive lumps as the men at the mines and quarries can readily handle. Possibly, if we crushed them first, they would so decrepitate in the furnace that the latter would choke tight, and we could not practise pyritic smelting."

JAPANESE MINING EXHIBIT AT THE PANAMA-PACIFIC INTERNATIONAL EXPOSITION.

In the Japanese exhibit, now being installed in the Palace of Mines and Metallurgy, all branches of mining will be represented by raw specimens as well as the finished product.

The exhibit, which is one of the largest individual showings in the building, covers about 7,500 square feet of floor space.

Built entirely by native workmen, the booths and kiosks are Oriental in style, and the same scheme is carried out in the furnishings.

One of the most interesting features of the exhibit is a large relief map of the Japanese mining region, done in colored clay.

Among the more important exhibitors are the Kaijima, the Japan Sulphur, and the Sumitomo Besshi Copper Mines and a number of valuable exhibits of coal, lead, copper and gold supplement the display.

WOULD STANDARDIZE SILVER.

The Mining and Engineering World, Chicago, states that at the recent meeting of the Colorado Metal Mining Association, held at Denver, a movement was started with the ultimate object in view of stabilizing the price of silver and making that metal a world standard. Under the leadership of T. R. Henahen, state mining commissioner, plans were adopted and a resolution drafted for holding a silver convention in Denver during the present year, the object of which will be to fix a standard price for silver and to arrange for an international convention at which free coinage of silver will be urged upon all the civilized nations of the earth.

Following is the resolution introduced by Commissioner Henahen and published in the Mining and Engineering World:—

Resolved, That the staggering cost of the war in Europe is depleting the treasuries and forcing governments to issue large amounts of paper money, which paper, together with the gold supply, will not be sufficient, and a demand must be made for a larger supply of coin. An international agreement of commercial nations to fix a standard price for silver is possible, practical, and necessary at this time.

The executive committee is directed to frame a bill calling for sufficient funds to defray the expenses of holding in Denver during 1915 a national silver convention, such as was held in St. Louis Nov. 26, 1889.

The governor of each state is empowered to appoint one delegate from each congressional district and ten delegates at large from the respective states and territories. The president is given the power to appoint ten delegates at large from each state.

The executive committee of this association is to be given power to appoint five delegates from each state and territory and five from the District of Columbia. It is recommended that the national convention appoint a committee, asking that the president and congress appoint an international conference, to meet before Sept. 30, 1915, in a convention with similar committees from all other civilized nations.

The purpose of the international convention will be to agree, if possible, upon some ratio between gold and silver, to the end that our mints be opened to the full and unlimited coinage of both metals.

DUTIES OF DIRECTORS.

John Pierpont Morgan, who took the witness stand before the United States Commission on Industrial relations, was asked by Chairman Walsh:

"To what extent are stockholders in a corporation responsible for the labor conditions in those corporations?"

"I don't think a stockholder has any responsibility," answered Morgan.

"What is the responsibility of a director for the conditions of the laborers?"

"The directors are not at all responsible, I should say.

"Who is responsible?"

"The officers of the corporation, the executive officials," answered Mr. Morgan.

Mr. Morgan said his chief duty as director was in receiving with other directors reports of the financial condition of the various corporations and reports on the business outlook.

SWEDISH IRON AND STEEL.

H.M. Legation at Stockholm reports that the Swedish Association of Iron Works (Svenska Jarnverksforeningen) published in its quarterly report figures of the output and export of Swedish iron and steel during the first three months of the war, from which it appears that exports of Swedish iron to some of the principal consuming countries considerably decreased, while the export to other countries entirely stopped. This decrease has to a certain extent been compensated for by the new markets that have been opened, while at the same time prices have remained firm. August was the worst month, the exports of iron and steel only amounting to 13,584 tons, as compared with 47,761 tons in August, 1913. These figures increased to 32,430 tons in September, and 34,210 tons in October, but even then they were very much less than in the corresponding months of 1913. This heavy decrease in exports naturally brought about a corresponding diminution of production, and during the three months July to September the output of pig-iron was only 140,300 tons, as compared with 175,800 in the corresponding period of 1913; blooms, 23,800 tons, as compared with 38,600 tons; Bessemer castings, 21,100 tons, as compared with 27,700 tons, and Martin castings, 90,900 tons, as compared with 119,900 tons.

NIPISSING.

It is expected that the annual report for the year 1914 of the Nipissing Mines Co. will show an increase in ore reserves as a result of the year's operations, notwithstanding a large production. The company distributed $1,200,000 in dividends during the year and increased the surplus about $400,000.

CANADIAN MINING INSTITUTE.

A meeting of the Toronto Branch of the Canadian Mining Institute was held at the Engineers' Club on Saturday, Feb. 6, at 1.15 p.m.

The chief topic of discussion was the question of nickel export. Numerous arguments in favor of and against a prohibition of export of nickel matte were presented.

The next meeting of the Toronto Branch will be held on Feb. 27.

CALUMET AND HECLA.

Houghton, Mich., Feb. 5.

Employees at Calumet and Hecla mines, mills and smelters, Isle Royale, North Kearsarge, Allouez and Ahmeek go on full time this week. This affects 10,000 men and adds 20 per cent. to output of all these mines.

MINERS AT THE FRONT.

Miners who have gone and those who are going to the front will be relieved from the obligation to work their claims so many months in each year and the claims will be kept open for them. Hon. G. Howard Ferguson, Minister of Lands, Forests and Mines announced this decision last week. The miners also will be relieved from paying their licenses.

Hedley Gold Mining Co.—The Gazette, published at Hedley, Similkameen, states that the motors and new compressors for this company have been received and are being installed in the new power house. The motors are of 400 and 440 h.p.; they will be used to drive the compressors. The new compressor is a Rand engine, similar to the one put in here several years ago.

A LABORATORY SAMPLER

By J. T. King*

During the past year the writer has built and tried out a mechanical sampler, especially adapted for finely ground ore. It operates on a principle somewhat different from that of other samplers. As it has proved to be very satisfactory, a description may be of interest especially to those interested in sampling operations. Before explaining the features of the apparatus a few of the conditions which influenced the writer to construct the same will be given.

The sampling of large lots of ore is carried out by hand methods or by mechanical ones, and there usually comes a stage in the latter when hand sampling is resorted to. The reasons for favoring the hand methods in the final stages of the sampling are not clear. It is maintained by some that after a certain stage in the reduction, more accurate results are obtained by these hand methods, coning and quartering, riffles etc. Provided this is so it can only be because a suitable mechanical sampler for finely ground ore (as it would be in the final stages of sampling), is not available. That is, the reason for using these hand methods is due to necessity rather than to choice. Experience has shown that whilst properly constructed mechanical samplers will consistently give uniformly good samples, in season and out of season barring accidents, the accuracy of hand samples depends so much on the personal equation and vagaries of the performer as to be often open to doubt and suspicion.

In principle, mechanical methods are an approach to the ideal condition, the elimination of the personal element which is ever present in hand methods. From the psychological point of view hand methods are wanting. A machine has no judgment, no conscience; but it has methods due to its construction. It has no interest in the ultimate assay of the sample, whereas the hand sampler may have, and unfortunately sometimes is influenced prejudiciously by this interest. Hand work offers possibilities of introducing fraud discrimination and bias in favor of either buyer or seller as the case may be. With the most honest intentions a man may be too fair. He may be truly impartial in his motives; but quite partial in his methods. Sampling should be performed in a mechanical manner, so that judgment does not conflict with the so-called laws of chance. It is nigh impossible to teach men the importance of adherence to the rules and details, so necessary in hand sampling. Does it not seem that the introduction of mechanical methods offers a means of placing the sampling of ores on a more ideal basis?

Generally speaking the assayer is not responsible for the accuracy of the sample submitted to him for assay. He is expected to determine its contents and to report the same. But the report of the assayer is used as a criterion of the value of the original lot of ore that has been sampled. And if the results are higher or lower than were anticipated, the discrepancy is often ascribed to poor assaying, when quite often the error is due to poorer sampling. The most careful and painstaking assaying will not produce the correct value of an ore if the sampling has been improperly performed.

In the Assaying Laboratories of the Department of Mining Engineering in the University of Toronto, emphasis is laid on the accuracy expected in the students' assays. Assays are repeated until satisfactory results are obtained. It is only fair then that true samples be submitted for assay. Random ones will not do. In the past the bag samples of pulp submitted to the classes for assay were selected from the original ores by hand methods, usually by riffles. It is a difficult matter to cut several samples from a lot of pulp by hand methods, and have them agree closely in value among themselves. Those with most experience will testify to this. As an ore sample when returned by a student after assay, is not given out again to another student, thus eliminating any excuses that the sample had been salted by the other student, it is necessary to prepare several thousand individual samples each year. The labor of this undertaking and the time required, will at once be evident to anyone who has say, cut lot of pulp into 32 samples by a riffle sampler, or worse still by coning and quartering.

Aside from the tediousness of sampling down to halves, to quarters, etc., until 32nds or 64ths are obtained, the introduction of the numerous pans offer sources of error due to salting. The whole operation is dusty, tedious, and conducive to bad temper rather than to good sampling.

Further, the assays of students, working on several samples from the same ore often did not agree as they should. Beginners might be excused for discrepancies; but with advanced students close agreement should be obtained. Cases occurred where good students repeated their assays, and got the same disagreement. Sometimes a student with a higher or lower result than his more fortunate fellows felt that the fault was probably not his; but due to the sampling that had been done for him. In other words he believed that the sampling error might be greater than his, and it was sometimes difficult to convince him otherwise. Since the whole object in doing the sampling for the students was to localize possible errors directly to the assaying, it was apparent that a more satisfactory sampling method must be devised, and due to the objection stated it was decided to try some mechanical method.

As no sampler was known that would divide a lot of ore into more than four parts at one operation, it was necessary to build one especially for our purposes. Several means of dividing an ore suggested themselves, and on attempting to test these a real and unexpected difficulty was found. The simplest way to sample mechanically is to cut the samples from a falling stream of ore, and this method was tried. While it may be a fairly easy matter to run lump ore at a fairly constant rate from an inclined hopper, 100 mesh pulp behaves quite differently. It was soon learned that the pulp must be dry to run at all. To give a stream of pulp uniform in cross section, a conical funnel with a small hole at the apex was used for a hopper. It was soon found that the hole must be at least one inch in diameter to give anything like a steady feed. The pulp runs for a short time; but soon a circular wall forms in the pulp, surrounding the central space where the pulp has run from. Agitation by tapping the funnel was a help; but the pulp ran only spasmodically, and a one inch stream was too large for two or three pound lots of pulp such as it is often necessary to sample. By placing an inclined trough under the hole and agitating it back and forth, it was found that streams of pulp as small as one-eighth inch in diameter could be run continuously. The vibration of the pulp in the trough is apparently transmitted to the pulp in the funnel above, loosening it up and thus preventing the packing of the

*Lecturer in Mining Engineering, University of Toronto.

pulp or the formation of a circular wall with a central space. Fig. (4) will illustrate this more clearly.

Having obtained a method of inducing the pulp to flow in a steady, uniform small stream, the next question was how to sample the stream, the primary object being to obtain a large number of individual samples, rather than one or two, as is usual. The first method tried was to pass 32 paper bags, arranged in a row, back and forth in a horizontal line under the stream. This is practically what is done in all mechanical samplers, the sample compartments passing through the stream at right angles, at regular intervals. They act on the whole of the stream part of the time. With the bags thus arranged in a row, it was necessary to move them back and forth, and as the speed could not be kept uniform, especially near the ends, all the bags did not get their proper proportion of the pulp. Arranging the bags in a circle overcame this difficulty. Much dust and spilling of pulp was caused by the bags passing through the stream, and it was considered that not

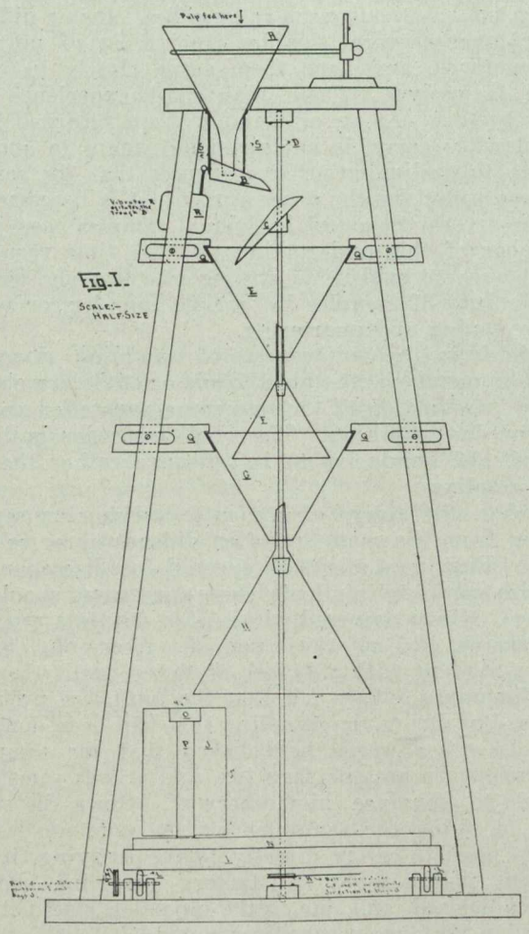


Fig. 1

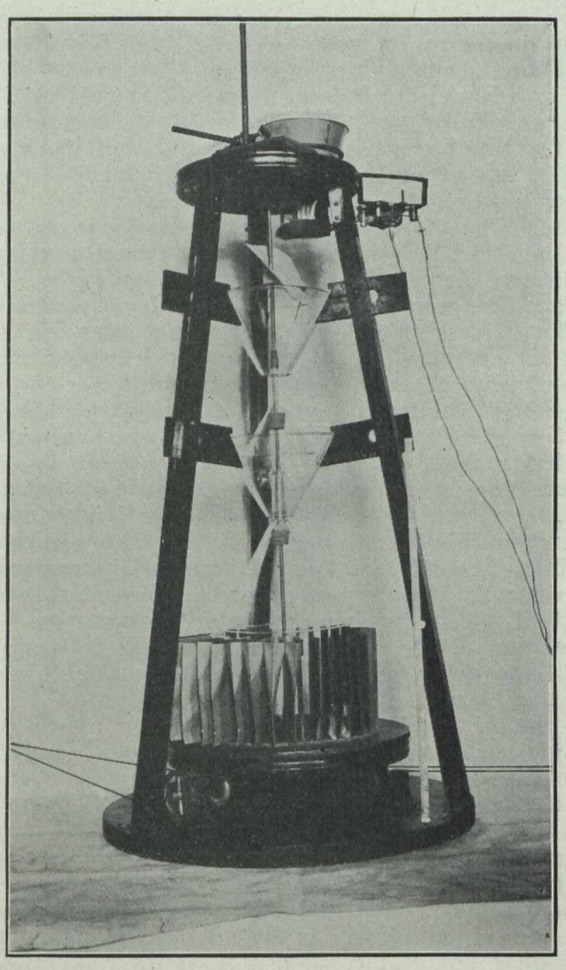


Fig. 2

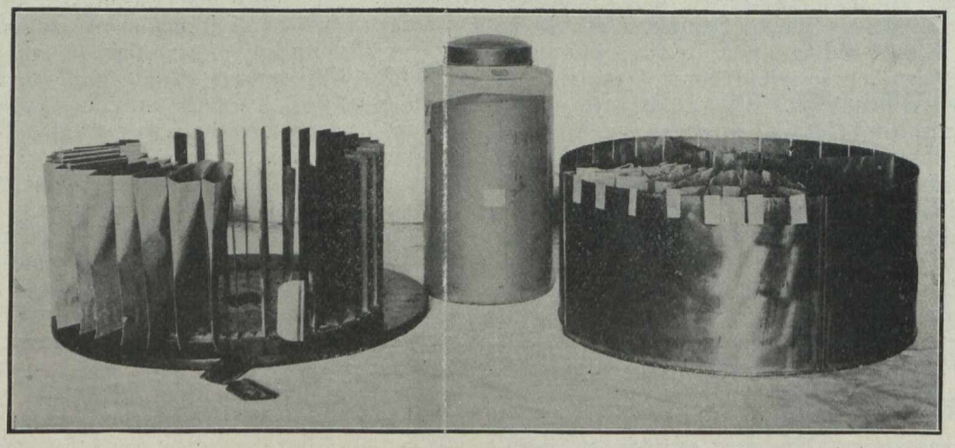


Fig. 3

A LABORATORY SAMPLER

enough cuts were made to give good samples. Either the bags must travel very fast, thus increasing the dust and spilling, or the stream must be so fine as to make the process monotonously long.

The next step was to let the pulp stream fall onto the apex of an inverted cone, the pulp rolled down the sides, and was caught in bags arranged around the base. Next the oven was revolved in one direction, and the bags in the opposite direction, to counteract any tendency of one part of the feed always going to the same bag. This was the vital departure from the usual machanical method of sampling. The usual stream was spread over the cone and fed into all the compartments at once, rather than to one compartment at a time. And note, each compartment does not obtain its feed from but one part of the stream, but from all parts in an impartial manner. This method of sampling was such an advance on others that it was adopted. Minor de-

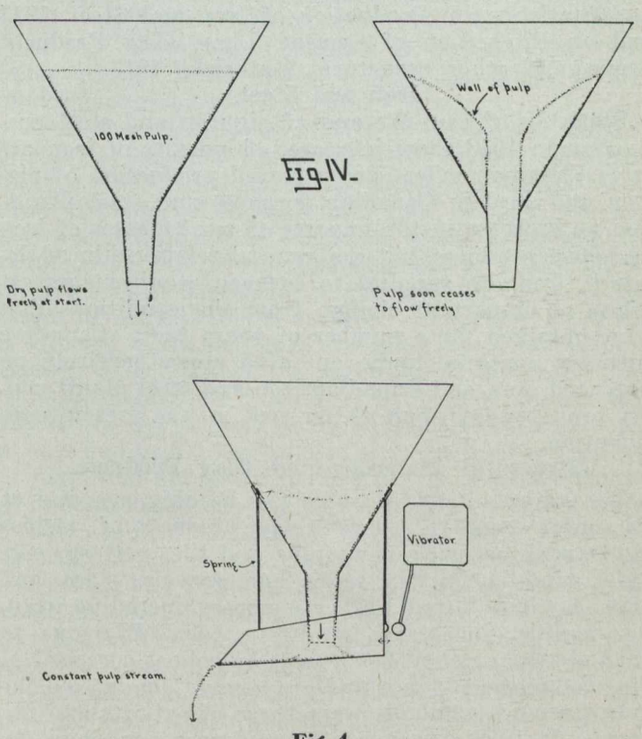


Fig 4

fects of a mechanical nature were corrected until the apparatus took the form shown in the illustrations.

Fig. 1 is from a photo of a diagrammatic drawing, showing the method of feed more clearly. Pulp is fed into the funnel A at the top, the neck of which enters a trough B. A vibrator R, agitates this trough, and also the funnel through springs S. This agitation causes the pulp to flow in a continuous stream onto a scoop C. This scoop is rigidly attached to a central rod or axis, which also supports glass funnels H and F, resting on rubber corks. This axial rod is rotated by a belt on a pulley H near the base, thus rotating the scoop C and funnels F and H in the same direction. E and G are glass funnels with necks cut off, resting on adjustable supports Q. I is a platform supported on three rubber tired wheels L, and held in position by the axial rod passing through its centre. This platform is rotated in the contrary direction to the funnels and scoop, by a belt on a pulley M, which turns one of the supporting wheels L. The bags or other containing devices are placed in a circular row on the platform I. Thus pulp fed at A falls onto C, E, F, G and H in succession, and is caught in the rotating bags. A couple of batteries operate the vibrator, and a one-eighth h.p. motor supplies ample power for steady rotation.

The original method of supporting the paper bags is shown in the photo of the sampler Fig 2, and at the left of Fig. 3. On each of two boards which form a circle, were spaced seventeen upright brass strips. Between these the paper bags were placed and held in position by clips as shown. The number of bags, 32, was chosen due to the various combinations of samples that could be made. Thus combining alternate bags gave sixteen samples. The original parcel of pulp could in this way be divided into 1/32, 1/16, ⅛, ¼, or ½.

A better form of container is shown at the right of Fig. (3) and in Fig. (5). Four brass boxes are segments of a circular ring, the inner and outer walls being the width of a sample bag apart. The upper edges are slotted at regular intervals, and brass strips are inserted in these slots. If it is desired to cut a lot of pulp into four samples, it is run direct into the boxes. Thirty-two bags can be placed between the strips, and held in position by clips over the overturned edges. Again if only one sample is desired only one bag is used, the reject falling into the boxes. This form of container is now used entirely in preference to the first form.

Now let us examine the underlying principles of the apparatus, with reference to the general philosophy of sampling. The element of chance is ever present in all sampling operations. We must sample and must combat chance. In the long run chance is a fair master, and follows the law of averages. In sampling, the more impartial chances taken, the more likely is it that the high and low deviations from the true value will cancel each other, and the average of the sum of the errors be zero. In sampling the object is to eliminate the probability of errors not balancing. The law of averages cannot safely be depended upon to compensate for the individual errors, if too few averages are taken.

If there is complete impartiality in the method by which the particles fall into their respective lots, then a proper balancing of possible errors will be the result. In this sampler the free flow of particles is spread out into a thin stream, which revolves in one direction while the bags revolve in the other. Each bag takes a minute bite absolutely uniformly, out of each part of the stream, and takes a great many of these bites, so that we have not only impartiality, but a great many chances for any possible errors that might possibly occur to balance each other.

Mechanical samplers either act on a part of the ore stream all the time, or on all of the stream part of the time, the latter type being considered the better. Any sample compartment of the laboratory sampler acts on a part of the stream all the time. The objection to sampling one part of a stream all the time is that an ore stream is not constant in value across its width. But here the stream of pulp from the feeder is fairly distributed to the funnels, and is spread out into a circular ring at the base of the lowest funnel. The sample compartments pass through this feed in cyclic order and are always in the stream. Each compartment selects from all parts of the stream impartially, at regular intervals, rather than from one part of the stream all the time, or all of the stream part of the time. The advantage of this method of selecting the small bites is at once apparent.

The jar of pulp shown in Fig. (3) contains 9,000 grams. Ordinarily this amount would be sampled in about ten minutes, though the time can be varied by adjusting the vibrator tension. A bag would obtain about one-half gram of pulp each second. The funnels revolve about sixty times each minute, in the opposite direction to the bags, which revolve about thirty times each minute. Hence a bag passes all parts of the lower edge of the funnel one and one-half times each second, in obtaining one-half gram of pulp, or one-third of a gram each revolution. Of course the pulp selected per revolution can be varied at will; but this rate gives samples that can be banked on.

An attempt to test the accuracy of the sampling was made. To do this is not as easy as it might appear. The only fair way is to test the whole of each product delivered, as sampling a sample by another method would introduce errors not chargeable against the sampler. Further the errors of any scheme of assaying the products would not be the fault of the sampler. Two kilograms of limestone were placed on top of the same weight of silica in a box, both were finer than eighty mesh. This was fed to the sampler without any attempt at mixing. From 32 samples 8 were selected at random, and each was tested for insoluble matter in the standard way, the whole of each sample being treated. The results of this test are given in the adjoining table, and are not to be interpreted as a yard stick to measure the absolute accuracy of the sampling, owing to the reasons stated, but rather as showing the

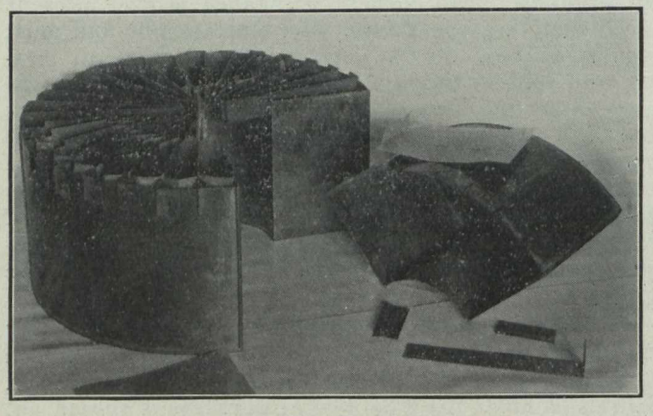


Fig. 5

agreement that still obtains after the errors due to the analysis have been introduced. The extreme variation between high and low is less than one in seven hundred.

No. 1, 55.74%; No. 2, 55.72%; No. 3, 55.67%; No. 4, 55.74%; No. 5, 55.73%; No. 6, 55.68%; No. 7, 55.70%; No. 8, 55.71%. Average, 55.71%.

The sampler was constructed out of material available about the laboratory, such as glass funnels, corks, vibrator, brass rod, motor, etc. It is so constructed that it can be readily taken down in case of injury to the funnels. Outside of the motor and the brass containers, the parts are comparatively cheap. Very little dust is created during the sampling, and any remaining on after sampling is easily brushed or blown off. Arranging the bags, sampling and cleaning for the next run will average 15 minutes. An attendant in one afternoon of four hours sampled 16 jars of pulp into over 500 samples of around 200 grams. Any range from 1 to 32 or more samples are delivered, and the sampler is easy to operate and keep in order. Arrange the bags, fill up the funnel with pulp, start the motor and vibrator, the sampler does the rest.

And above all other advantages claimed, the marked improvement in the assaying done by the classes is ample reward for the time spent on the sampler. The psychological effect on the students is good and is plainly to be seen. They have taken increased interest in their assaying, and excuses have been eliminated. The sampler is so evidently beyond suspicion that the students see at once that any errors must lie in their work, and that it is up to them to get good results. Furthermore it is not a case of comparing results with some standard result made by the staff in a previous month or perhaps previous years, but it is a comparing of student with student, on a product that is unquestionably beyond suspicion or criticism.

RECENT PUBLICATIONS OF THE MINES BRANCH

The Mines Branch has published bulletins by John McLeish, Chief of the Division of Mineral Resources and Statistics, on Production of Iron and Steel, 1913 and on Production of Cement, Lime, Clay Products, Stone, and other Structural Materials, 1913.

Iron and Steel.

Statistics of iron ore and of pig-iron and steel production in 1913 show increased shipments of iron ore from Canadian mines, an increased production of pig-iron and steel in Canadian furnaces and steel plants, and an increase in the imports of most classes of iron and steel products, but the general relationship of domestic iron ore supplies to furnace requirements exhibits no important change from the conditions that have obtained for a number of years past. Canadian furnaces continue to be operated almost entirely on imported ores, and Canadian iron and steel plants supply probably less than 30 per cent. of the present consumption.

Structural Materials and Clay Products.

The subjects included under this heading comprise, in the order treated: cement; clay products of various kinds, such as brick, sewerpipe and tile, pottery, etc., lime; sand-lime brick; sands and gravels; slate, and stone for building and other purposes, including granite, marble, limestone, sandstone, etc. Previous to 1912 no attempt had been made to collect a record of the production of sands and gravels in Canada, and the only statistics available were those of exports and imports. In 1912, however, a beginning was made in the collection of these statistics; but owing to the incompleteness of the available lists of producers and the failure of many to answer correspondence, only a very partial record was obtained. In 1913 the scope of the collection was extended to cover sands and gravels used by railways for ballasting, etc., but at the time of closing the statistics several important and comprehensive returns had not been received. The statistics of stone production do not include the stone used in making cement or lime, but are as complete as possible for all other established stone quarries; nevertheless there is undoubtedly a large production of stone for foundation work, road-making, and railway construction of which no record is available.

The total value of the production of these structural products in 1913, according to the record obtained, was $30,809,752, as compared with a value of $28,794,869 in 1912, an increase of $2,014,883, or nearly 7 per cent. The total production in 1911 was valued at $22,709,611, compared with which the 1912 production showed an increase of $6,085,258, or 26.8 per cent. The total production in 1910 was valued at $19,627,592, and in 1909 $16,533,349.

ANNUAL REPORT, HOLLINGER GOLD MINES, 1914

The fourth annual report of Hollinger Gold Mines, Limited, has just been issued. It covers operations during 1914.

President N. A. Timmins says in part:

While the production of gold during the year 1914 has shown an increase of only $222,134.56 over the production for the year 1913 (an increase of approximately ten per cent.), the improved condition of the property as a whole, has been very marked. The 1914 output has been attained without undue exertion, a statement which could hardly be made of the outputs of previous years, and not only has the output been increased with comparative ease, but at the same time the amount of new ore developed has added greatly to ore reserves.

The gold won in 1914, namely $2,688,354.80, was the result of milling 208,936 tons of ore, and the gross profits from our operations amounted to $1,786,679.66, this latter amount being almost exactly two-thirds of the total values recovered.

From the gross profits must be deducted the amount of the depreciation which has been written off plant, namely $165,621.11, and a subscription of $10,000.00 to the Canadian Patriotic Fund, thus leaving the net profits at $1,611,058.55. The net profits have been accounted for, first by the disbursement of $1,170,000.00 in dividends to shareholders, and secondly by a net addition of $451,058.55 to surplus. Particular attention is directed to the details of the make up of the surplus account as it stood at the beginning of the year. The total surplus carried forward to the new year is $1,126,743.11 and of this amount $664,603.48 is in the form of cash and gold. The balance of the account is made up of plant and development work, which items are valued at approximately seventy per cent. of their actual costs, a fact which demonstrates the conservative nature of the accounting. A subscription of $10,000.00 to the Canadian Patriotic Fund has been noted above, and it gives your directors pleasure to state that apart from this company subscription, the employees have independently subscribed approximately $3,000.00 to the above fund.

Expenditures for plant amounted to $305,621.11 during the year, and, while the amount is large, yet it is justified by the greatly increased capacity of our mining and milling plants. When the present additions to the mill are completed we shall have increased our milling capacity from 500 tons per day to 1,600 tons per day, a very decided expansion.

Development work was also a heavy charge during the year, but with the great increase in milling capacity it has been necessary to put the mine into shape to supply the increased demands for ore.

The results of milling 208,936 tons of ore have shown an average value of $13.67 per ton. The average value of the ore reserves, estimated at the first of 1914, was $13.71 per ton, hence it is obvious that no attempt has been made to select the higher grades of ore.

Good progress has been made towards a solution of all metallurgical problems, and our milling practice has kept pace with the most modern developments, although we still adhere closely to the lines of practice originally installed.

The matter of working costs has received strict attention during the year, and the promised reduction to $4.50 per ton has been fully realized, the costs for the year (exclusive of depreciation), amounting to $4.42 per ton. It is expected that improved conditions will enable a still further reduction to be made during the present year, and it is the hope of the management that before the end of the year, a cost of $4.00 per ton will be reached.

It is interesting to note that although a reduction in operating costs has taken place, it has not been at the expense of our employees, for not only are we paying the highest scale of wages, but we are also disbursing considerable amounts in the form of bonuses to men, for loyal services.

Mining operations have progressed without interruption, and our position as regards the physical condition of the property is very strong. Underground development has increased the estimated value of developed ore reserves from $11,604,800.00 at the beginning of 1914 to $13,358,420.00 at the beginning of 1915. Diamond drilling has shown that there is no change in the characteristics of the ore bodies at a depth of 1,500 ft., and the directors can assure shareholders that they know of no reason why the persistence of ore should not continue to much greater depths.

The attention of shareholders is directed to the fact that only a small number of the veins known to exist upon the property have been opened up at all, and while not wishing to appear over sanguine, we do commend to shareholders a careful study and consideration of that portion of the general manager's report dealing with the possibilities of the future, it being our firm belief that the known facts merit a most liberal interpretation.

After four years of extensive development, the general manager is able to report a continual opening up of new ore bodies, and there is significance in his statement that "there have been no disappointments of any kind in the mine during the past year."

Shareholders have already received notice of the increase in dividend rate from 39 to 52 per cent. per annum. The condition of our surplus account, the reserve of broken ore in the mine, and the ability to mill increased tonnages, are conditions which make the payment of increased dividends advisable. It is possible that during the first few months of the year the larger dividends will interfere with the addition of any substantial sums to the cash surplus, owing to the fact that earnings not required for the dividends will be required for completing the extensions now being made to the mill and cyanide plant. By the end of April the heavy expenditures for plant should be about finished, and during the balance of the year the surplus account should show a regular increase.

It has been necessary to keep pace with the growth of mining and milling operations by increasing and improving the living accommodation for our employees. The thriving town of Timmins, which has been provided through the efforts of Canadian Mining & Finance Co., Ltd., is now caring for most of our men and their families. About 150 single men are still quartered at the mine bunk houses, but all others find accommodation in the town. The provision of a safe water supply was imperative, and in order to secure funds for the installation of the necessary waterworks, the town of Timmins has issued $95,000 of waterworks debentures. These debentures, which were all subscribed for at par by Hollinger Gold Mines, Ltd., bear interest at the rate of six per cent. per annum and run for two different terms, one lot of $50,000 being repayable in annual instalments extending over ten years, and a second lot amounting

to $45,000 over fifteen years. Payment of the first instalment has reduced this investment to $89,273.28. The debentures are authorized under the Ontario Trustee Act and have been validated by the Ontario Railway and Municipal Board. Considering the vital interest which we have in securing a good supply of water, they constitute a most proper investment for a part of our surplus funds.

It is a pleasure to your directors to review the experiences of the past year and to enumerate the gains which have been made, but this pleasure is tempered by regret over our great personal loss caused by the death of our fellow director, Mr. Duncan McMartin, whose untimely demise before reaching his prime, while most keenly felt by his co-directors, was also much regretted by many of our shareholders, to whom he was known as a warm personal friend. The vacancy on the Board thus caused was filled by the election of Mr. John B. Holden, who has been the company's counsel and solicitor since its organization and who is also an executor of the late Mr. McMartin's will.

Your directors would be unmindful of their simple duty if they omitted to express their unstinted praise for the efficient services of the general manager and of his most capable assistant, Mr. A. R. Globe, assisted as they were by the praiseworthy efforts of a loyal staff.

Balance Sheet, Dec. 31, 1914, Hollinger Gold Mines, Ltd.

Assets.

Capital Expenditures—			
Mining properties			$2,500,000.00
Plant. Brought forward from 1913		$500,000.00	
Additions during 1914		305,621.11	
		$805,621.11	
Less depreciation for 1914		165,621.11	
			640,000.00
Development. Brought forward from 1913		$175,000.00	
Additions during 1914		24,862.17	
			199,862.17
Deferred development charges			123,688.32
Town real estate			2,950.00
			$3,466,500.49
Current Assets—			
Cash on hand and in banks		$370,468.44	
Debentures, Town of Timmins		89,273.28	
Accounts receivable		21,163.68	
Materials and supplies on hand		117,949.34	
Insurance and charges paid in advance		4,278.09	
Guarantee deposits		500.00	
Bullion Assets, etc.—			603,632.83
Bullion shipped, not paid for		84,961.76	
Bullion on hand		89,000.00	
Solutions on hand		24,700.00	
Precipitates on hand		2,700.00	
Litharge, slags and miscellaneous		3,500.00	
			204,861.76
			$4,274,995.08

Liabilities.

Capital stock			$3,000,000.00
Current Liabilities—			
Wages unpaid		$53,024.81	
Accounts payable		69,694.41	
			122,719.22
Contingent liabilities			15,532.75
Subscription to Patriotic Fund			10,000.00
Surplus—			
Premium on shares sold, re-invested in plant as per 1913 Annual Report		$144,248.44	
Less written off 1914 plant (part only)		144,248.44	
Profit and Loss Account—			
Forward from 1913	$ 544,214.36		
Less adjustments	2,778.24		
		541,436.12	
Profits Jan. 1st to Dec. 31st, 1914		1,786,679.66	
		$2,328,115.78	
Less Patriotic Fund subscription	10,000.00		
1914 plant depreciation, not shown above	21,372.67		
Dividends paid, 1914	$1,170,000.00	$1,201,372.67	1,126,743.11
			$4,274,995.08

General Manager P. A. Robbins says in part:

Capital assets have been increased by:

Plant additions	$305,621.11
Development	24,862.17
Deferred development	123,688.32

The expenditure of $305,621.11 for plant is shown below. No explanation of this item is necessary, the expenditures being the natural outcome of increased operations.

Expenditures for plant and equipment during 1914 were distributed as follows:

Dwellings.		
Town cottages	$ 416.97	
Mine dwellings	2,252.30	
Mine bunk houses	7,290.62	
Mine boarding house	1,007.53	
		$10,967.42
Plant Buildings.		
Stamp mill	$45,364.16	
Cyanide plant	28,062.70	
Change house	4,755.26	
Crusher house	1,237.04	
Scrap store	705.87	
Shaft house	341.64	
Office	217.12	
Carriage shed	238.43	
Miscellaneous	317.73	
		81,239.95
Camp equipment		2,012.24
Equipment.		
Cyanide plant	$52,564.71	
Stamp mill	50,184.08	
Fire sprinkler system	51,955.25	
Water supply system	13,171.83	
Mine equipment	18,317.17	
Electrical plant	5,585.26	
Crusher, conveyor	2,373.52	
Machine shop	3,131.39	
General plant	7,443.41	
Oil tanks and pumps	2,668.53	
Hoisting plant	2,244.46	
Surface air lines	771.36	
Office furniture	785.08	
Miscellaneous	205.45	
		211,401.50
Total		$305,621.11

Development amounting to $24,862.17 was added to the amount (175,000.00) brought forward from 1913, thus bringing the total to $199,862.17. This is work of a permanent character which need not be charged off against operations until the mine begins to show reduced tonnages in the ore reserves.

"Deferred development" consists of the work of blocking out the ore, and preparing new levels for the regular operations of production. There is also a certain charge per ton carried against the gradually increasing reserve of broken ore. This reserve consists of ore upon which all mining operations have been completed, with the exception of tramming and hoisting to the surface. As a matter of policy it is our intention to continue to build up this reserve until we have enough broken ore available to insure the operation of the mill at full capacity over a considerable period of time, thus providing against any contingency which may interfere with regular mining operations.

The loss of interest upon the capital tied up in this broken ore reserve is more than offset by the strengthening of our position in the event of any future labor troubles.

The combined charges being carried in "development" and "deferred development" accounts, amount

Distribution of Working Costs, Hollinger Mine.

Account	Labor	Stores	Other Charges	Total	Per ton of Ore Milled
General charges	$32,602.41	$ 8,567.00	.....	$ 41,169.41	.197
Administration and management	40,200.00	10,584.83	.....	50,784.83	.243
Taxes	.....	.....	43,716.58	43,716.58	.209
Insurance	.....	.....	19,887.55	19,887.55	.096
Clearing surface, roads, etc.	6,147.17	370.23	.....	6,517.40	.032
Operating camp	11,746.51	14,844.04	.....	26,590.55	.128
Operating boarding house	572.87	9,438.76	.....	10,011.63	.048
Mining—					
Exploration	5,186.99	6,420.90	.....	11,607.89	.056
Development	55,790.08	28,514.72	.....	84,304.80	.403
Production	228,035.28	116,513.41	.....	344,548.69	1.646
Milling—					
Operations	101,080.06	146,686.73	.....	247,766.79	1.184
Alterations	2,826.52	4,465.56	.....	7,292.08	.035
Alterations to plant	3,275.65	504.23	.....	3,779.88	.019
Marketing bullion	.....	.....	12,204.25	12,204.25	.059
Fire protection	1,171.77	3,057.24	.....	4,229.01	.021
Prospecting	406.15	.....	.....	406.15	.002
Loyal service bonus	.....	.....	8,935.25	8,935.25	.043
	$489,041.46	$349,967.65	$84,743.63	$923,752.74	$4.421
Depreciation—					
Written off plant				$165,621.11	.792
Grand total of costs				$1,089,373.85	$5.213

This statement is self explanatory and shows a total net working cost of $4.421 per ton, to which has been added a cost of $.792 per ton to cover the amount written off plant for depreciation, thus bringing the total up to $5.213 per ton. In last year's report the figures were $6.11 per ton, net, and $6.97 per ton, gross costs.

to approximately twenty-seven cents per ton, when spread over the tonnage given in the "estimate of ore reserves."

"Materials and supplies on hand" are carried at $117,949.34, this comparatively large amount being due to stocking up with chemicals, pebbles and other supplies, at the outbreak of hostilities in Europe. A certain amount of plant is also being carried in stock which will be used presently in the new extensions to the mill and cyanide plant.

"Bullion assets" are self explanatory and are about normal in amount.

Under liabilities, the item "contingent liabilities" appears. These are deferred liabilities made up of balances which will be payable to certain manufacturers of machinery when they complete their contracts with us.

The item "premium on shares sold" appears for the last time in the balance sheet. It will be recalled that 50,000 shares of treasury stock were sold in 1912 at a premium of $250,000. The whole amount realized from the sale of shares was used for the purpose of completing plant, and it is only right that the amounts written off of plant should be applied to retiring this liability from our books. This has now been accomplished and our sole capital liability consists of the $3,000,000 capital stock of the company.

Hollinger Mining Costs, 1914.

The following table shows the distribution of the costs of mining:—

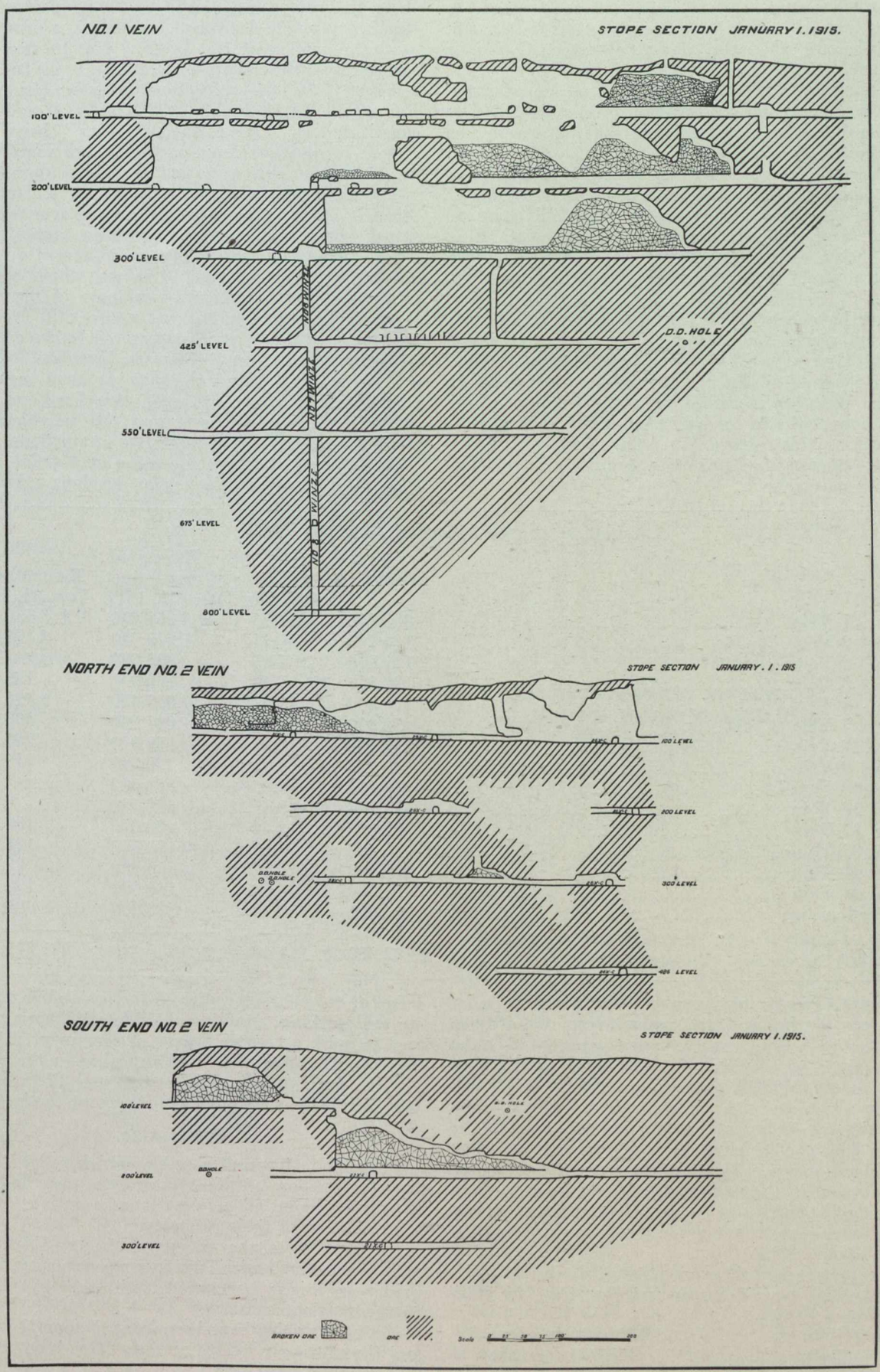
Account	Labor	Stores	Total	Per ton of Ore Milled	Per ton of Rock Broken
General mining charges	$ 4,361.23	$ 2,186.92	$ 6,548.15	$0.031	$0.022
Superintendence	14,454.14	.....	14,454.14	.069	.050
Diamond drilling	5,186.99	5,824.48	11,011.47	.053	.038
Cross-cutting	9,298.67	12,206.39	21,505.06	.103	.074
Shafts	6,722.94	3,700.69	10,423.63	.050	.036
Drifting	38,323.48	35,176.38	73,499.86	.352	.254
Raising	2,457.23	2,930.45	5,387.68	.026	.019
Winzes	4,531.34	1,984.17	6,515.51	.031	.022
Tramways	788.23	950.43	1,738.66	.008	.006
Timbering Shafts, Winzes, Raises	3,678.05	5,608.27	9,286.32	.044	.032
Stoping	90,818.54	63,994.73	154,813.27	.741	.534
Scaling	3,240.29	.....	3,240.29	.016	.011
Timbering drifts and stopes	20,235.74	9,065.48	29,301.22	.140	.101
Track laying	4,477.29	2,333.07	6,810.36	.033	.023
Tramming	84,884.66	1,876.75	86,761.41	.415	.300
Pipe-fitting underground	3,217.00	4,078.74	7,295.74	.035	.025
Mine drainage	2,807.21	4,097.25	6,904.46	.034	.024
Hoisting	29,638.09	11,370.40	41,008.49	.196	.141
Landing and dumping	8,317.86	5.42	8,323.28	.040	.029
Drill repairs	2,092.46	12,166.74	14,259.20	.068	.049
Sharpening steel	16,550.66	4,154.36	20,705.02	.099	.071
Collecting steel	8,066.50	45.69	8,112.19	.039	.028
Mine sampling	5,285.12	166.96	5,452.08	.026	.019
Assaying	885.53	460.66	1,346.19	.006	.005
Change house	916.67	1,043.25	1,959.92	.009	.007
Surveying	1,864.78	735.19	2,599.97	.013	.009
Mine lighting	374.80	4,511.33	4,886.13	.023	.017
	$373,475.50	$190,674.20	$564,149.70	$2.700	$1.946

Recapitulation of Mining Costs.

Account	Labor	Stores	Total	Per ton of Ore Milled	Per ton of Rock Broken
Exploration	$ 5,186.99	$ 6,420.90	$11,607.89	$0.056	$0.040
Development	55,790.08	28,514.72	84,304.80	.403	.291
Production	228,035.28	116,513.41	344,548.69	1.646	1.188
Deferred development	64,188.53	33,144.79	97,333.32	.467	.336
Broken ore reserve	20,274.62	6,080.38	26,355.00	.128	.091
	$373,475.50	$190,674.20	$564,149.70	$2.700	$1.946

The following figures show a comparison of expenditures for mining, in the two years 1913 and 1914:—

	Exploration		Development and Deferred Develop.		Production.		Total.	
Year	Amount	Per Ton	Amount	Per Ton	Amount	Per Ton	Amount	Per Ton
1913	$13,230.59	$0.096	$137,375.38	$0.993	$274,688.23	$1.986	$425,294.20	$3.075
1914	11,607.89	.056	207,993.12	.998	344,548.69	1.646	564,149.70	2.70



Stope Sections, Hollinger Mine, showing condition of orebodies on No. 1 and 2 veins, Jan. 1, 1915

Underground work was hampered during a greater part of the year by an insufficiency of compressed air for operating drills, but better progress has been made since November, when the new air plant of Canadian Mining and Finance Co. was put into operation.

In spite of the inadequate supply of air, satisfactory progress was made in underground developments. The 800 ft. level has been reached and the No. 1 vein has been found to persist to that level. The main shaft has been carried down to 550 ft. and will be continued to 800 ft. during the present year. The levels below 800 ft. will be opened up from the new central shaft of Canadian Mining & Finance Co., Ltd., although it is possible that a winze may be sunk below 800 ft. before the Central shaft workings reach the Hollinger ore bodies.

We now have between 65,000 and 70,000 tons of ore broken and ready for milling, in case any emergency should interfere with the regular operations in the mine. The gold contents of this ore amount to approximately $750,000. With the increased supply of compressed air which is now available for operating drills, it is intended to build up this reserve to a point which will insure continuous operation of the mill through any contingency which may arise.

No. 1 vein shows a falling off of $601,690 due to a lowering in grade from $19.56 to $14.85 per ton. No. 16 vein is a recently developed lens which is parallel to the southern portion of No. 1 vein. No. 10 vein has been reached by cross-cut upon the 200 ft. level, and has been removed from the collection of miscellaneous veins. Veins 9, 11, 12, 13, 14, 23, 33, 35, 36, 39, 42 and 43, which constitute the "Miscellaneous Veins" have been reviewed in previous reports, and do not require further mention as no new work has been done upon them.

The potentialities of the property are not indicated in the estimate of ore reserves. There are over forty known veins, which have thus far not been carefully investigated. Diamond drill holes have indicated a number of ore bodies carrying payable values, which have yet to be reached by underground workings. After four years of work upon the 100 ft. level we are still finding upon that level occasional and unexpected bodies of ore. Exploration work upon the 200 ft. level has also yielded gratifying results, and although we have been working steadily for three years upon this level, we are consistently finding new ore, and our neighbors (Acme Gold Mines) are within forty feet of our boundary driving upon one of their best veins at a point where we have done no work. Each year develops a fuller knowledge of the characteristics of the ore bodies with which we are working, enabling development work to be carried on with a greater degree of certainty. There have been no disappointments of any kind in the mine during the past year, and it is expected that the present year will show continued improvement in the property.

Summary of Ore Reserves, Hollinger Mine.

	Tons	Value Per Ton	Estimated Gross Value Dec. 31, 1914	Estimated at Dec. 31, 1913
No. 1 Vein	333,850	$14.85	$ 4,958,210	$ 5,559,900
No. 2 Vein (North)	165,720	10.71	1,775,740	2,129,500
No. 2 Vein (South)	111,150	7.96	885,690	.....
No. 3 Vein	22,600	7.47	169,000	169,000
No. 4 Vein	163,330	11.37	1,857,670	1,398,800
No. 5 Vein	50,900	12.53	637,760	406,500
No. 7 Vein	17,000	10.51	178,000	265,000
No. 8 Vein	45,910	8.52	390,740	326,000
No. 10 Vein	9,000	12.00	108,000	.....
No. 16 Vein	56,200	8.65	486,130	.....
No. 37 Vein	32,800	12.22	400,900	400,900
No. 38 Vein	5,800	16.17	93,800	124,000
No. 41 Vein	90,700	8.34	756,780	33,200
No. 44 Vein	8,000	20.00	160,000	192,000
Miscellaneous	50,000	10.00	500,000	600,000
	1,162,960	$11.49	$13,358,420	$11,271,400

The above estimate of reserves shows an increase of 317,660 tons of ore, and an increase from $11,604,800 to $13,358,420 in gold contents, as compared with the estimates made at the end of 1913. During the year we have milled 208,936 tons containing $2,857,397.54, which figures, taken with the increase in estimated reserves, show 526,596 tons, containing $4,611,017.54, to have been developed during the year. The average value of the ore now shown is $11.49 per ton, as compared with $13.71 per ton at the end of 1913, this falling off in grade being primarily due to the development of considerable tonnages of lower grade ores, thus lowering the over-all average value.

Large increases are shown in several of the veins by the development carried out during the year, the principal increases being:—

No. 2 Vein	$531,930 increase
No. 4 Vein	458,870 increase
No. 5 Vein	231,260 increase
No. 16 Vein	486,130 increase
No. 41 Vein	723,580 increase

Speculative.

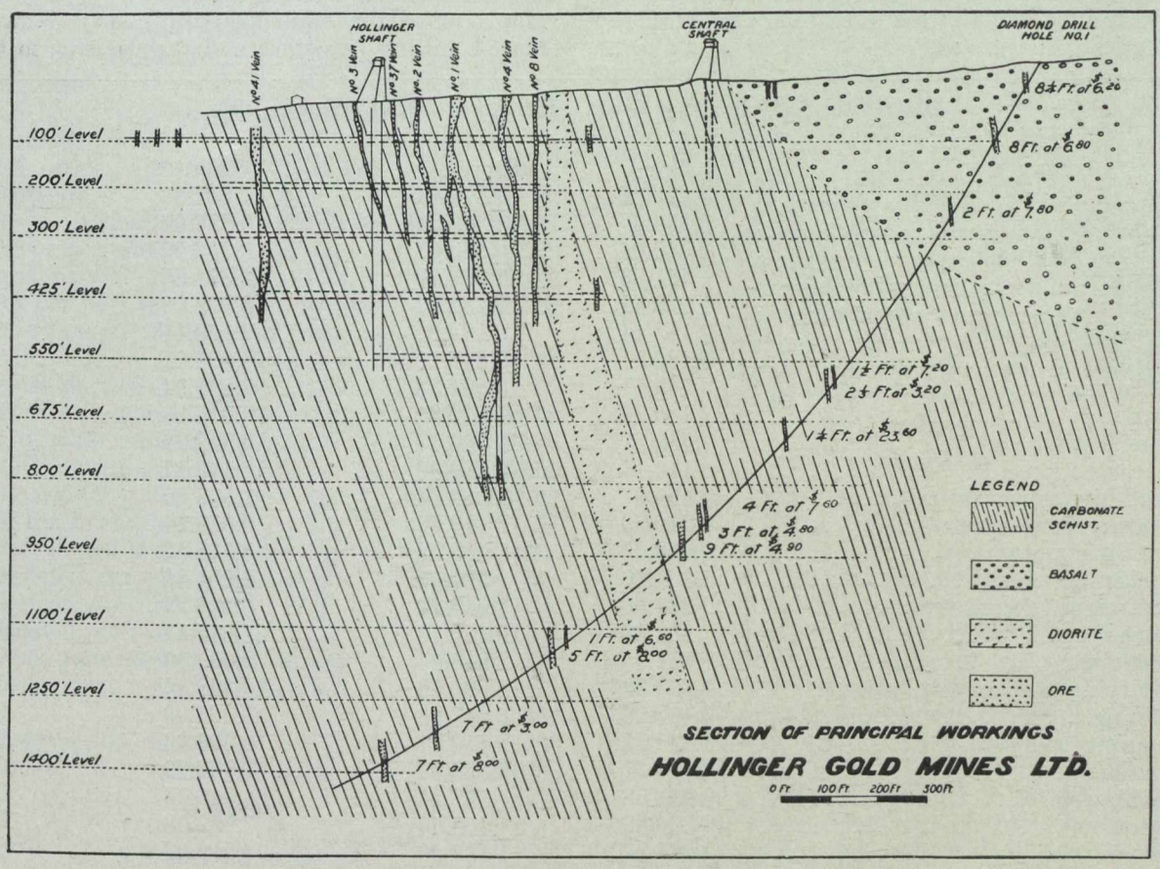
In order to forestall possible criticism, let it be noted that the purpose of this report is to place in the hands of shareholders all available information concerning the condition of their property.

In addition to the extent of the ore bodies which may be measured with approximate accuracy, the shareholder is chiefly concerned with the possibilities of future developments.

Fifty-four veins have been located upon the property, and thus far only twelve of these have been reached by underground workings.

Aside from this interesting multiplicity of veins, the all important feature is that of depth, and in order to

obtain some information upon this point we have done a certain amount of comparatively deep drilling. The accompanying "Section of Principal Workings" shows the results obtained by means of diamond drill hole No. 1. This hole was driven to an inclined depth of 2,000 ft. and when drilling was stopped had reached a vertical depth of 1,425 ft. below the surface.



Section of principal workings, Hollinger Mine, Porcupine

In the course of drilling, thirteen mineralized zones were passed through, the results of sampling being as given below:

Inclined Depth of Hole Feet	Vertical Distance Below Surface Feet	Width of Ore Body Feet	Average Value Per Ton
20	17	8.25	$ 6.20
180	140	8.00	6.80
350	275	2.00	7.80
770	600	1.50	7.20
790	610	2.30	3.20
925	710	1.20	23.60
1,160	875	3.80	7.60
1,175	890	3.00	4.80
1,225	925	9.20	4.90
1,560	1,120	.80	6.60
1.575	1,140	5.00	8.00
1,870	1,354	6.60	3.40
2,000	1,424	7.00	8.00

Note.—Vertical depths in bore hole refer to depths below the collar of the bore hole.

The values given are the averages in each case. The sampling of each piece of core gave the same erratic results as are obtained in the course of the regular work of sampling in the mine, the ore at depth varying greatly in value within a few inches.

In considering the widths of the various ore bodies passed through, it must be noted that the results given are calculated from the lengths of core obtained. The mineralized ground is usually somewhat friable, and consequently there is some loss of core when drilling through quartz and mixtures of quartz and schist.

The information furnished by the drill hole is twofold; first, there is no change in rock formation to a depth of 1,425 ft.; second, there is no change in vein characteristics to a depth of 1,425 ft. The gold values obtained by drilling are about those which might be reasonably expected if a drill hole were to be driven through the vein system at any random point below the 200 ft. level.

A second drill hole was started, to cross the ore bodies from the direction opposite to that of the first hole, but unfortunately this second hole flattened its course and at a depth of 900 ft. had assumed a position practically horizontal. As our mine workings were at the time approaching a depth of 800 ft., it was felt that the limited information to be gleaned from the second hole did not warrant the heavy expense of further drilling and the hole was consequently abandoned without having reached the vein system.

As a result of the diamond drilling, we may with considerable assurance anticipate the continuance of operations to a depth of at least 1,500 ft., with strong possibilities at greater depths, as nothing has yet occurred to indicate a limitation of the depth to which payable values will persist.

It is reasonable to assume that some of the ore bodies encountered in drilling are continuations of the veins being worked upon the upper levels, and such being the case, it is not unreasonable speculation to anticipate from the ore bodies now being worked, a production of something over twice the value of the ore shown in the "Estimate of Ore Reserves." Beyond this are the possibilities of production from the veins not yet de-

veloped, and also the value of ore which may be encountered at levels below the depth of the bore hole.

The Mill.

The work in the mill has produced satisfactory results, and after considerable experimenting, we have during the latter part of the year, developed our practice along lines which have enabled an increased tonnage to be treated while at the same time the extraction has been greatly improved.

Distribution of Milling Costs, Hollinger Gold Mines, Ltd.

Account	Labor	Stores.	Total	Per ton of Ore Milled
General milling charges	$ 5,226.62	$ 6,171.04	$ 11,397.66	$0.054
Superintendence	9,856.07	.....	9,856.07	.047
Tailings disposal	2,785.04	948.05	3,733.09	.018
Lighting	431.33	1,953.32	2,384.65	.011
Heating	1,023.41	7,282.32	8,305.73	.039
Shoveling in bins	2,463.14	.....	2,463.14	.012
Crushing	8,180.11	8,646.70	16,826.81	.079
Conveying	3,712.61	3,527.33	7,239.94	.034
Stamping	12,136.72	21,679.91	33,816.63	.160
Classification and tube milling	7,739.31	32,203.07	39,942.38	.188
Concentration	8,174.17	4,969.30	13,143.47	.062
Handling concentrates	491.01	1,084.04	1,575.05	.007
Treating concentrates	4,340.59	2,478.55	6,819.14	.032
Handling pulp	2,403.95	6,163.52	8,567.47	.040
Thickening	1,961.80	990.01	2,951.81	.014
Continuous decantation	4,834.00	1,644.22	6,478.22	.031
Filtration	11,581.36	10,233.75	21,815.11	.103
Neutralizing	751.95	1,848.05	2,600.00	.012
Clarifying and precipitation	1,732.30	11,626.16	13,358.46	.063
Refining	6,197.76	6,267.33	12,465.09	.059
Pumping solutions	1,948.29	2,410.07	4,358.36	.021
Cyanide	14.77	17,523.02	17,537.79	.083
Cleaning mill	3,913.58	133.17	4,046.75	.019
Alterations	2,826.52	4,465.56	7,292.08	.034
Assaying	2,086.87	1,132.20	3,219.07	.015
	$106,813.28	$155,380.69	$262,193.97	$1.237
Less treatment charges on Acme Gold Mines, Limited, ore—2,910 tons	2,906.70	4,228.40	7,135.10	.017
	$103,906.58	$151,152.29	$255,058.87	$1.220

The detailed costs are based upon the total tonnage treated.

Based upon the tonnage of Hollinger ore milled, 208,936 tons, the total cost per ton was $1.220.

During the year there has been stacked for retreatment 6,062 tons of concentrates of an average value of $8.85 per ton. The total value $53,686.00 is an asset not shown upon our books and hence whatever portion is eventually recovered by retreatment will result in an increased profit.

The costs of operation contain a direct expenditure of $7,292.08, amounting to $0.034 per ton for alterations to plant. Besides this there have been considerable expenditures upon alterations which have been directly absorbed by the costs charged to the different operations. Hence the actual working costs of milling have been in reality somewhat less than the costs shown. It is anticipated that a considerable reduction in milling costs will result during the present year, due to improved methods and to the larger tonnage which will be treated.

Three years ago the mill was designed for a crushing capacity of 300 tons per day, having 30 stamps installed, and cyanide equipment sufficient to treat 500 tons per day. In the second year of operation, ten additional stamps were provided, thus bringing the crushing capacity up to 500 tons per day. During the past year the number of stamps has been increased to sixty, and alterations have been made to the cyanide plant, with the net result that the capacity of the mill has been increased to 800 tons per day. The rapid development of the mine has continually demanded increased milling facilities, and the decision to treat ore from the Acme and Millerton properties now makes it necessary to add considerably to the milling plant. We are in the midst of alterations and additions, which when completed, will bring the capacity of the mill up to 1,600 tons per day. The expenditures for this greatly increased plant have all been met from profits, without interfering with the payment of regular dividends. It is expected that by the middle of February eighty stamps will be dropping, to be followed by twenty more about the middle of March.

Later in the year it is intended to install a screening plant and tube mills, for treating that considerable portion of the ore which comes from the mine in a condition fine enough for immediate grinding, without the necessity of stamping.

Present milling practice adheres closely to the lines laid down in the original mill, except that we are now about to resort to continuous decantation for the gritty, quick settling portion of the ore, while the more flocculent portions will continue to be treated in our filter plant. The treatment of concentrates has not yet been perfected and these are still being stored after making a partial recovery of their contained

values. Experience in the mill indicates strongly that the best results will be obtained by separating the ore into its component parts and providing a special treatment for each.

It is anticipated that the final practice in the mill will be: Amalgamation for nuggets. Settling or filtration for slimes. Continuous decantation for sands. Regrinding and increased agitation for concentrates.

Milling Record.

	Hollinger	Acme	Total
Tons of ore milled.	208,936	2,910	211,846
Average value per ton . . .	$13,676	$11.176	. . . . .
T'l values sent to mill	$2,857,397.54	$32,521.93	$2,889,919.47
Average tons per day			583.59
Per cent. of possible time run			92.2%
Aver. tons per 24 hours of running time			632.97
Stamp duty tons per 24 hours of running time.			13.30
Unrecovered Values—			
Concentrates stored for re-treatment			$53,686.00
Lost in filter tails			$116,879.00
Total.			$170,565.00
Values recovered			$2,719,354.47
Value per ton in tailings			$0.56
Cyanide consumed per ton of ore			0.525 lbs.
Lime consumed per ton of ore			1.557 lbs.
Zinc consumed per ton of ore			0.532 lbs.
Acid consumed per ton of ore			0.216 lbs.
Lead acetate consumed per ton of ore . .			0.0031 lbs.
Tons of solution precipitated per ton of ore.			2.315
Zinc added per ton of solution			0.230
Average value of pregnant solution . . .			$5.698

General.

The development of the Hollinger has led to greatly increased operations, and the persistent demands for additional facilities have been met from time to time by alterations and additions, and by working all available plant at an overload.

During the past year the opening up of the Acme mines has added another factor to the demand for more equipment, and it has become necessary to make a broad survey of the requirements of all companies controlled by Canadian Mining & Finance Co., Ltd.

The Hollinger system of veins extends to the south-west into the property of Millerton Gold Mines, Ltd., and to the north-east into the property of Acme Gold Mines, Ltd. For the purpose of securing maximum economy in operation, and a minimum of capital expenditure for equipments, it is desirable that the operations of the three properties should be centralized and carried on as one large undertaking, rather than as three separate, smaller undertakings.

The apparently logical course would be to incorporate the three properties into one. Such a course, however, is not feasible, owing chiefly to the large amount of development work which has been done upon the Hollinger claims, and the comparatively small amount of development which has been done upon the other properties. Under existing conditions it is not possible to arrive at valuations which would be satisfactory to all parties concerned.

It is therefore expedient to adopt another course in order to secure the desired economies, and we have worked out plans, whereby most of the advantages which would follow an amalgamation, will be secured. In the matter of capital expenditures it is proposed to make an equitable adjustment between the various interests.

The Canadian Mining & Finance Co., Ltd. (proprietor of the Acme and Millerton companies), has already constructed a central air compressing and water pumping plant, which will be sufficient for the combined requirements of the several companies for some years to come. They are also sinking a central shaft which will serve all three of the companies, and which will be equipped with a central coarse crushing plant.

The Hollinger Company is increasing its mill to accommodate Acme ore and will make further additions when the necessity arrives for treating Millerton ore.

By means of centralizing operations as indicated, considerable economies will ensue. Instead of having three separate deep shafts, each equipped with expensive hoisting apparatus, crushers, gathering locomotives, etc., and requiring the services of three sets of operators, we will have one central shaft which can be worked continuously at full capacity, and hence at minimum cost to each company, and the amount of ore to be handled will justify the installation of expensive and highly economical plant.

The Central Shaft.

This shaft will have six compartments with stations at 425 ft., 800 ft., 1,250 ft., and, it is hoped, much deeper levels. From each station, crosscuts will be driven to tap the various ore bodies on the different properties. Electric locomotives operating in the crosscuts, will collect the ore from each property and deliver it at the central shaft. The ore will pass through preliminary crushers, and will then be hoisted to the surface and delivered to secondary crushers, which will reduce it to a size suitable for stamping in the Hollinger mill. Two shaft compartments will be utilized for hoisting ore, two for handling men and supplies, one for carrying on development at levels below the working level, and one for ladder-way, pipes and electric conductors. While the levels at the central shaft will be at intervals of 450 ft., it is proposed to develop the various ore bodies by means of sub-levels spaced at shorter intervals.

The original Hollinger hoisting equipment has become entirely inadequate for the increased tonnage and greater depths, making the provision of increased facilities imperative, and in a lesser degree the coarse crushing plant is also in the same need of expansion. The Acme Company is faced by the same problem, its temporary plant being too small to meet the demands. Temporary expedients will be used at the Hollinger and Acme to tide over the time required for sinking and equipping the central shaft, and it is expected by the middle of 1916, that the latter will be in operation.

The Hollinger mill, when the present additions and alterations are completed, will have a capacity of from 1,500 to 1,600 tons per twenty-four hours, and space is available for bringing this capacity up to 2,000 tons per day should such a step become necessary to meet the increasing requirements of the Hollinger or other properties. The present Hollinger needs for milling capacity are about 1,000 tons per day, while the Acme will require 500 tons per day to be treated, within a few months. Centralizing all mill operations will result in reduced costs of treatment per ton of ore, a decided benefit to each company concerned.

In order that there may be no disagreement as to the ownership of the bullion produced, provision is being made to keep each company's ore separate through the

entire process of milling and refining. This requires a duplication of certain apparatus which otherwise would not be necessary; but it is felt that by so doing the most satisfactory results will be obtained.

Central Air Compressing Plant.

The demand for compressed air having entirely outgrown the capacity of the old compressing plants, and the knowledge that future requirements will exceed the present demands, has led to the construction (by Canadian Mining & Finance Co., Ltd.) of a modern plant containing the highest type of machinery. The building is of reinforced concrete and steel, being absolutely fireproof. Three compressors, having a capacity of 4,500 cubic feet of free air per minute each, have been installed with space for additional units. One compressor, a Fraser & Chalmers machine, is of special design, being constructed with valves which automatically adjust the output of the machine to the exact requirements of the demand for air, thus doing away with peak loads and thereby reducing the cost of power, which is purchased upon a basis of peak loads. The other two compressors, supplied by Nordberg, are also of special design, for not only are they a particularly efficient type of machine, but they possess the unique advantage of being reversible; that is, they may be operated as steam engines and their motors may be used for generating electric power. This provision was made with a view to providing a standby or emergency plant, which can supply a certain amount of power in case of failure in the usual supply of electricity developed by water power plants.

A boiler plant sufficient to meet these emergency requirements has also been installed, and while it is hoped that this may never be required, there is satisfaction in the knowledge that an interruption to our normal supply of power will not result in a complete cessation of operations. Incorporated with the air compressing plant is a pumping plant, for supplying water to the Hollinger mill and to emergency fire pumps.

While the Canadian Mining & Finance Co., Ltd., has met the entire expenditure for this plant, it is possible that the Hollinger Company may be asked to bear a portion of the cost, in view of the heavy outlay which the former company is contemplating in connection with the central shaft. This is a matter which will be adjusted when the relative investments for mill, air plant and central shaft are finally determined.

Costs of Operation.

In the last annual report a forecast was made that the costs of operation would be reduced to approximately $4.50 per ton. The average working cost per ton during 1914 amounted to $4.43 (exclusive of amounts written off for description). It is therefore evident that the expected reduction in costs was fully realized. Further reductions will follow, and it is hoped that by the end of the present year our working costs will be found not to exceed $4.00 per ton. It is highly probable that ultimately the costs will be reduced to approximately $3.50 per ton, but this result cannot be reached until the new central shaft is in operation and a very large tonnage of ore is being milled.

Labor conditions during the year have been good, and while there has been a gradual reduction in working costs, there has also been a gradual increase in the amounts paid to employees. A system has been adopted of granting a bonus to men, in proportion to the length of time that they have been in the company's service. After one year's service a man receives a bonus of 15 cents per day; after two years, 30 cents per day; after 3 years 45 cents per day. These amounts are not added to wages, but are paid by separate cheques and every man who works for day wages receives the same bonus, regardless of the position held by him. By this means there has been disbursed among employees, during the past year, the sum of $8,935.25.

The average number of men employed during the year has been 546, starting with 510 at the commencement of the year, and ending with 725. The men were engaged upon the following classes of work:

Mining	297
Construction	109
Mill, office, general	140
	546

The present year will not see any great reduction in the total number of employees. In the present year more men will be employed in the mine, while there will be a great reduction in the number of employed upon construction and general work. In the past there has been a large amount of work done in road building, surface clearing, etc., all of which has been charged to operations, but this will be very much less in the future, thereby reducing the number of men required for general work.

BRAVE MINERS REWARDED.

The London Times, January 14th, reports three awards for conspicuous bravery in mines. The "Edward Medal," or "Miners' V. C.," was won by Joseph Cook, David Easton and James Kennedy.

On the morning of the 31st of January, 1914, Joseph Cook was underground in the Blackhouse colliery, Durham, near the bottom of an old shaft, filled with rubbish. Water had accumulated in it, and the weight of the debris burst out the pack walls at the shaft bottom. Seeing the danger, Cook rushed in bye at the risk of his life to warn two shifters who were working there and had no way to egress except past the bottom of this shaft. Before the three could get out, the debris filled up the road from floor to roof for a distance of 35 yards, completely cutting off their escape. The three men were eventually released after 22 hours' confinement.

On the 11th of January, 1913, two native "boys" employed in the Hatting Spruit colliery, Natal, went without orders into a part of the mine which was filled with poisonous fumes from a gob fire, and before they could return, fell unconscious. David Easton was one of a party who at great risk to themselves entered the danger area, from which they eventually succeeded in rescuing the boys. The other men of the same party were awarded medals, with which they have already been decorated.

On the 2nd of June, 1914, about 1.50 p.m., a miner was engaged at the Earnoch colliery, Lanark, in taking down head coal when the coal fell, pinning down his foot. James Kennedy bravely went to his assistance and continued to make every effort to release him, notwithstanding two further falls, which occurred at short intervals, completely smothering him. With the help of others who had arrived, Kennedy managed after three hours' work to release the imprisoned man, who was unfortunately found to be dead.

THE TESTING AND APPLICATION OF HAMMER DRILLS*

By Benjamin F. Tillson.

The hammer drill rightly receives the credit for having made the one-man drill possible, and so many economies seem possible through the proper application of different types of hammer drills to various mining, quarrying, and excavating operations, that an indication of the economies effected by the New Jersey Zinc Co. at its Franklin mines may be of pertinent interest. When this company commenced its trials of hammer drills in 1907, these tools had not been developed to one-fourth the capacity and refinement which they have at present. At that time it was frequently stated that such a small tool, drilling holes of less diameter than the reciprocating rock drill, could not drill enough holes in a shift to permit the placing of sufficient explosive to break a tonnage of ore comparable with that produced by the "rock drills;" that the placing of small holes inclined upward, at angles steeper than 40 degrees above the horizontal, could not be expected to produce results equal to the large flat, wet or dry, holes in the breasted back of an overhand stope, and would only shatter the ground so as to make the back unsafe. In spite of these adverse opinions, the hammer drills first showed their superiority over both heavy and light reciprocating drills in raising and in stoping, and then in drifting and quarry work. As a result, all of the reciprocating drills at the Franklin mines were scrapped three years ago, all of the mining work being accomplished with increased efficiency, as shown in detail in this article.

With the advent of the hammer drill in this property, it was considered advisable to make comparative tests of all the tools accessible, and it has since been the policy to investigate the merits of any advance of the drilling art in order to get the maximum amount of work from the tools. The necessity of devising some means of standardizing drill tests, and of measuring the consumption of compressed air as well as the drilling speed, was early realized.

The common test was to fill a measured air receiver with compressed air at a certain gauge pressure, run the drill until the pressure had dropped to too low a figure, then compute from the time, drop in pressure, and capacity of the receiver, the cubic feet of free air used. This was not considered a fair indication of the drilling capacity of a machine, since the performance of some drills did not vary directly with the absolute pressures of the compressed air.

Air Meter.—It was, therefore, found expedient to build a water displacement air meter with which the drill test could be carried on for any length of time without serious variations in the desired air pressure. This apparatus, as shown in Fig. 1, consists of two tanks, half filled with water, and made of 12 in. pipe with blank flanges, gauge glasses being mounted on one, a four-way cock connecting the compressed air supply pipe with both tanks and the air line going to the drill. This device gives more accurate results than the common types of water or gas-meters; and since any errors are due to the human element of reading the gauge glasses and reversing the four-way cock, they tend to be compensating throughout a number of tests.

The procedure is as follows: Air is drawn by the drill from the receiver C, which tends to trap any moisture carried over the air from tanks A and B and assures a constant pressure while the four-way cock is reversed. In the arrangement shown in Fig. 1, the receiver draws its supply of air from the tank B and the water rises in this tank by virtue of the pressure of air admitted from the air main through the four-way cock to the top of tank A, where the water is being forced downward and through the 2 in. connecting pipe to tank B. When the water has risen to a certain point

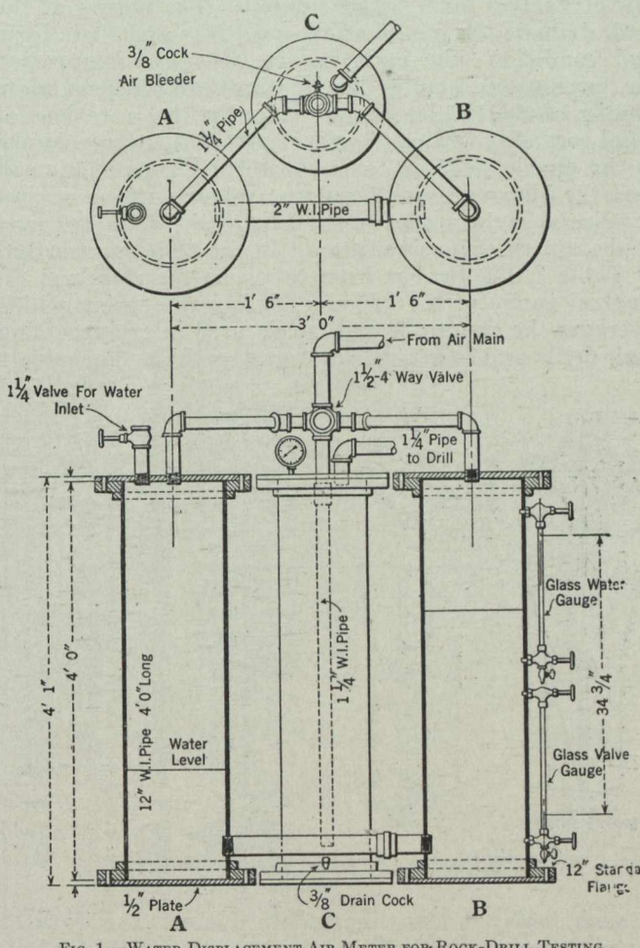


FIG. 1.—WATER DISPLACEMENT AIR METER FOR ROCK-DRILL TESTING.

near the top of the gauge glass in tank B, the four-way cock is reversed and the inlet air is supplied to the top of tank B; the drilling air is then taken from the top of A, the reversal of the cock again being made when the water in tank B has fallen to a point near the bottom of the gauge glass.

A pet cock is placed on the top of tank C so as to permit the bleeding of air to bring the water columns to the desired point for starting a run, and another pet cock is attached to the bottom of the same tank in order to permit the drainage of water. For convenience in measuring and computing, a run is made on the supply of compressed air indicated by a certain number of reciprocations of the water columns between fixed points on the gauge glasses; the pressures are measured on the air gauge mounted on tank C, the length of time is taken by a stop watch, and the consumption of free air per minute is computed. Unless a pressure regulator is installed between the four-way cock and

*Extracts from a paper published in the Bulletin of the American Institute of Mining Engineers, February, 1915.

the receiver C, or else a globe valve at this point is operated manually to throttle the air so as to maintain a constant pressure, it is evident that the air pressure at the drill will vary in accordance with the water column supported by the inlet air pressure, but since the gauge glass marks are in this instance set 34¾ in. apart, the maximum variation in pressures is about 1¼ lb. per square inch; it is difficult to find a pressure regulator which will control a pressure of 90 or 100 lb. per square inch to a closer degree of accuracy, and the sensitiveness of drills to air pressures and the accuracy of time and distance measurements rarely exceed this error.

It is obvious that in comparative drill tests the following factors must be considered: The nature of the rock drilled; the gauge of the drill bits and their form and condition; the maintenance of equal compressed air pressures; similar inclination and approximate depths of drill holes; equal vigor in the rotation of hand-rotated tools; and proper fit of the drill shanks in the chuck bushings, as well as their construction so that the blows are delivered on a plane surface of proper size at right angles to the axis of the drill steel and at the centre of its shank end. In the tests summarized in Table I, 1¾ in. has been taken as the standard diametral gauge of the bit, since it is a dimension which averages the gauges of drill steels used in reciprocating rock drills and is fair in determining the performances

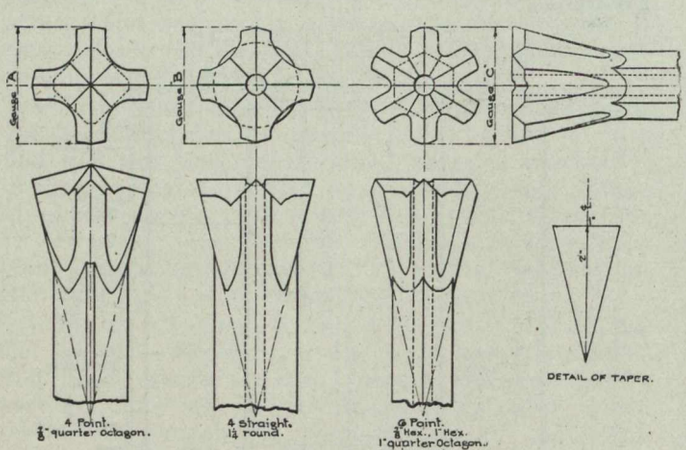


FIG. 2.—TYPES OF DRILL BITS USED AT FRANKLIN MINES OF THE NEW JERSEY ZINC CO

of such tools; it also represents almost the largest gauge necessary in hammer-drill stopers or block-holers, so that equal or even better performances may be expected from them as a hole is deepened with the smaller gauges in a set of drill steel.

At Franklin, the testing rock is a compact coarsely crystalline white limestone, which greatly resembles a marble, and this rock proves a fair average of the various qualities of ore met in the mining operations. Although it is not hard, for a well tempered drill bit can drill 3 or 4 ft. of hole before its cutting edges are materially dulled, and although it seems to chip freely, yet is possesses a compactness and toughness which is likely to prove surprising to one who has not previously tested a drill in it. Tests with various machines in Franklin, and elsewhere, indicate that this white limestone does not cut quite so fast as a sharp drill can achieve in Cripple Creek granite; is about on a par with Barre granite; and cuts slightly faster than Quincy granite. The chief difference is that a good drill will cut this limestone as fast in the second or third minute of its run, while it would have been dulled by the first minute's run in the granites, causing its cutting speed to fall off materially in the second and third minutes. Raised-centre cross bits are the standard type used with solid steel in these tests, and flat-faced six point bits are generally used with the hollow steels, in general the cutting speed of these bits being about the same if the rotation of the drill steel is free. Fig. 2 shows the forms of the drill bits used at the Franklin mines.

The results of Table I. indicate the improvements in hammer drills, from the operators' standpoint of efficiency, during four years of advancement in the art; and it may be interesting to note that, so far as we know, no drills of the present day surpass in drilling speed and low air consumption the best drills listed in this table, although several makes of hammer drills are on a par with them. In order to avoid invidious comparisons between the different makes of drills, symbols have been used to designate each certain make and design of drill. The following abbreviations have been used in this table:

Auto aux V = automatic auxiliary valveless control of rotations.

Auto rifle = automatic rotation caused by a piston reciprocating as though it were controlled by a rifle bar.

Dir. air = direct-air feed, or one in which the feed cylinder is rigidly attached to the hammer cylinder and in which the feed piston or plunger extends from the rear end of the machine by virtue of the air pressure applied to it.

Rev. air = reversed-air feed, or one in which the feed piston is rigidly attached to the hammer cylinder and the feed cylinder is free to extend backward, so readily adapts itself to the customary column mounting of stoping drills.

Some tests were included in this table for the consideration of points to be made later. Before studying the improvements in hammer drill efficiency it seems wise to explain the reasons for offering the figures in the last column of figures as representing a factor of "drill desirability."

Cost.—In determining the relative merits of rock drills, whether of the riciprocating or hammer type, the logical basis is one of cost. Therefore, the drill which bores a foot of drill hole of standard cross-section at the lowest cost rate for drilling labor, power and maintenance (including amortization), would have the highest "factor of desirability"; and a formula to express this may be developed as follows:

Let

F be the "factor of desirability,"
D be the cost of drilling labor per foot of hole,
P be the cost of power per foot of hole,
M be the cost of maintenance per foot of hole.

Then,

$$F = \frac{1}{D + P + M}$$

Let

t = Period of time for drilling speed test, in minutes.
d = Depth of hole drilled in time, t, in inches.
$S = \frac{d}{t}$ = Drilling speed during actual running of machine, in inches per minute.
L = Hourly wage of drilling labor, in cents.
O = Percentage of time spent in drilling to total operating time, including the changing of drill steels and shifting to new positions and starting of new holes.

Then

$$D = \frac{L}{\frac{60SO}{12}} = \frac{L}{\frac{5dO}{t}} = 0.2\,\frac{tL}{dO}$$

Let

p = Power cost to produce 100 cu. ft, of free air, compressed to standard drill-testing pressure, in cents.

v = Number of cubic feet of free air used in test by operating drill.

d = Depth of standard hole drilled, in inches.

Then

$$P = \frac{12pv}{100d}\,0.12 = \frac{pv}{d}$$

equation we obtain.

Substituting these values of D and P in the original

$$F = \frac{1}{0.20\frac{tL}{dO} + 0.12\frac{pv}{d} + M} = \frac{d}{\frac{0.2L}{O}t + 0.12\,pv + dM}$$

Since L is a constant for any particular mine, and O for a given number of steel changes with any particular type of drill—such as a column mounted reciprocating drill, a column mounted hammer drill, an air-feed hammer drill, and block holing drill, etc.—we may simplify the equation by substituting

$$k = \text{coefficient of drilling} = \frac{0.20L}{O}$$

Also, since p is a constant for any particular mine we may further simplify by placing

$$k' = \text{coefficient of power} = 0.12\,p$$

and we then have the general equation for any particular mining conditions and type of drill

$$F = \frac{d}{kt + k'v + dM}$$

However, the correct value for maintenance and amortization of any particular type and make of drill can be determined only after operations extending over months or years, so that this factor may well be left out of a formula which is to be used for classifying drills after drilling speed and power consumption tests, which may be completed in a short time. The consideration of the reduction of drilling speed and the increase of power consumption, which occur in a drill because of wear or any other normal results of service, may fairly be placed in the same class as maintenance. Judgment as to the materials, workmanship and design of any drill, as well as reports of its satisfactory service elsewhere, will lead to a rough estimate of the final desirability of a drill if it has shown a high standard, on testing based on drilling speed and power consumption.

The equation is thus simplified to the form

$$F = \frac{d}{kt + k'v}$$

Other factors.—But other highly important factors enter into the problem of selection of a drill, namely, the reduction in labor units, capital and overhead charges brought about by an increased drilling speed and increased tonnage per machine; the increased efficiency of supervision and work caused by the reduction and concentration of the number of working places; the possibility of producing a greater tonnage from any property with a limited number of working places; and the possibility of reducing the drilling equipment, with its attendant stock of spares, hoses and connections, and extensive air mains, if a drill with a greater drilling speed may be employed.

Factor of desirability.—It therefore seems that the following formula is more indicative of the actual merits of drills, although theoretically it has no derivation, and must be considered empirical; it also possesses the virtue of reducing to a simple form. This formula for a "factor of desirability" has been used for the past six years at the Franklin Furnace mines of the New Jersey Zinc Co. All coefficients have been omitted since the following drill tests have all been under the same standard conditions.

$$F' = \frac{1}{DPM}$$

TABLE I.—*Summary of Tests of Representative Drill Types Made by the New Jersey Zinc Co.*

Symbol for Drill	Date	Type of Drill: Rotation	Control of Piston	Style of Feed	Weight	Air Press. Lbs. per Sq. In. (Gauge)	Shape of Drill Bit	Free Air, Cu. Ft. per Min.	Drilling Speed, Inches per Min.	Free Air, per Inch Drilled	Factor, In. per Min. Divided by Free Air per Inch	Condition of Bit and Remarks
												General:—Air measured by displacement of water. Rock was white crystalline limestone. Gauge of bits was 1 1/16 to 1 1/4 in.
A	7/27/09	Hand.	Valve.	Dir. air.	75	93	Raised crux.	60.4	3.85	15.62	0.246	1 corner broken, with extension.
A_1	7/27/09	Hand.	Valve.	Dir. air.	84	92	Raised crux.	73.2	3.83	19.15	0.200	With extension.
B	7/27/09	Hand.	Valve.	Dir. air.	76	90	Raised crux.	90.0	3.20	28.20	0.118	
1B	7/27/09	Hand.	Valve.	Dir. air.	76	72	Raised crux.	76.8	4.28	17.90	0.239	Different drill of above model.
C	7/27/09	Hand.	Valve.	Dir. air.	64	90	Raised crux.	63.0	5.10	12.37	0.414	
D	7/27/09	Hand.	Valve	Dir. air.	74	90	Raised crux.	92.7	4.50	20.60	0.218	
D	7/27/09	Hand.	Valve.	Dir. air.	74	85	Raised crux.	86.2	5.52	15.6	0.354	Bit broken.
E	7/27/09	Hand.	Valveless.	Dir. air.	84	87	Raised crux.	42.0	1.93	21.7	0.089	
F	7/27/09	Hand.	Valveless.	Rev. air.	68	95	Raised crux.	69.8	3.38	20.3	0.167	
G	10/1/09	Hand.	Valve.	Dir. air.	78	88	Raised crux.	75.8	5.65	13.4	0.421	
G_1	10/8/09	Hand.	Valve.	Dir. air.	73	92	Raised crux.	79.5	5.91	13.4	0.450	
G_2	10/25/09	Hand.	Valve.	Dir. air.	73	88	Raised crux.	79.5	6.00	13.2	0.455	
G_3	12/8/09	Hand.	Valve.	Dir. air.	78	96	Raised crux.	83.5	7.00	11.9	0.588	
H	10/20/09	Hand.	Valveless.	Rev. air.	56	95	Flat hex.	29.8	2.46	12.1	0.203	No tappet.
1H	10/21/10	Hand.	Valve.	Rev. air.	..	93	Crux.	66.7	2.10	31.8	0.066	
J	12/15/10	Hand.	Valve.	Rev. air.	..	94	Crux.	66.9	7.30	9.15	0.800	High run.
J	12/15/10	Hand.	Valve.	Rev. air.	..	94	Crux.	66.3	6.70	9.92	0.675	Average 8 runs.
J	2/25/11	Hand.	Valve.	Rev. air.	..	94	Crux.	68.8	6.25	11.01	0.567	Average 23 runs.
K	3/2/11	Hand.	Valve.	Rev. air.	..	92	Crux.	77.6	7.29	10.65	0.684	
K	3/7/11	Hand.	Valve.	Rev. air.	..	94	Crux.	75.4	6.90	10.90	0.633	Average 10 runs.
L	4/10/11	Hand.	Valve.	Rev. air.	..	97	Crux.	58.0	6.29	9.21	0.683	
L	4/10/11	Hand.	Valve.	Rev. air.	..	97	Crux.	58.5	6.19	9.45	0.655	Average 7 runs.
L	4/18/11	Hand.	Valve.	Rev. air.	..	93	Crux.	55.8	6.55	8.52	0.769	Average 7 runs.
M	4/21/11	Hand.	Valveless.	Rev. air.	..	95	Raised crux.	54.7	9.35	5.85	1.600	High run to 1 1/4-in. bit.
M_1	6/24/11	Hand.	Valveless.	Dir. air.	..	99	Raised crux.	58.5	11.54	5.07	2.280	Bit a little soft.
1M	6/24/11	Hand.	Valveless.	Dir. air.	..	99	Raised crux.	58.5	9.09	6.45	1.410	Average 3 other runs, same machine.
M_2	8/30/11	Hand.	Valveless.	Dir. air.	..	100	Raised crux.	65.0	10.75	6.04	1.780	
M_3	8/30/11	Hand.	Valveless.	Dir. air.	..	99	Raised crux.	62.9	9.56	6.59	1.450	Average 11 runs.
N	9/27/11	Hand.	Valve.	Dir. air.	..	99	Raised crux.	36.0	5.28	6.82	0.774	
N	9/27/11	Hand.	Valve.	Dir. air.	..	99	Raised crux.	39.2	4.63	8.59	0.540	Average 11 runs.
N_1	10/24/11	Hand.	Valve.	Dir. air.	65	96	Raised crux.	66.4	2.67	24.8	0.108	Average 14 runs.
J	2/3/12	Hand.	Valve.	Dir. air.	..	97	Raised crux.	71.2	6.06	11.76	0.515	Drill "J" after 1 year's service.
× M_3	2/20/12	Hand.	Valveless.	Dir. air.	..	99	Raised crux.	62.9	11.10	5.66	1.982	High run.
× M_3	2/20/12	Hand.	Valveless.	Dir. air.	..	100	Raised crux.	63.5	10.43	6.06	1.739	Average 4 runs.
× O	3/5/12	Auto aux V.	Valveless.	Dir. air.	..	98	Flat hex.	79.1	10.34	7.65	1.350	Hollow bit, no air through it, high run.
× O_1	6/3/12	Auto aux V.	Valveless.	Dir. air.	87	100	Raised crux.	85.5	9.55	8.95	1.068	With pressure control on feed ½ Id., bit with soft center, No. 6.
× O_1	6/3/12	Auto aux V.	Valveless.	Dir. air.	87	100	Raised crux.	87.0	8.50	10.24	0.830	With pressure control on feed, fine bit No. 12.
P	2/16/12	Hand.	Valve.	Dir. air.	..	100	Raised crux.	67.0	8.43	7.94	1.062	Hard to rotate.
P_1	5/13/13	Hand.	Valveless.	Dir. air.	86	96	Raised crux.	55.8	10.76	5.18	2.080	Rotates freely.
P_2	5/13/13	Hand.	Valveless.	Dir. air.	86	97	Raised crux.	59.5	11.03	5.40	2.043	Rotates freely.
P_3	5/13/13	Hand.	Valveless.	Dir. cir.	86	96	Raised crux.	56.8	9.32	6.10	1.529	Average 9 runs.
P_4	5/13/13	Hand.	Valveless.	Dir. cir.	86	96	Flat crux.	57.1	7.98	7.17	1.110	Average 3 runs.
Q	5/16/13	Auto rifle.	Valve.	Rev. air.	..	91	Raised crux.	51.4	6.12	8.39	0.730	
Q	5/16/13	Auto rifle.	Valve.	Rev. air.	86	92	Db'le. chisel.	48.2	8.18	5.90	1.388	Hollow steel.
R	9/25/13	Auto rifle.	Valve.	Rev. air.	..	96	Raised crux.	112.0	6.85	16.25	0.421	Air bled to control feed press.
R	9/25/13	Auto rifle.	Valve.	Rev. air.	86	91	Flat hex.	102.2	7.50	13.63	0.550	Air bled to control feed press.

Since M is treated separately, as has been previously suggested, the equation becomes

$$F' = \frac{1}{DP}$$

Now if the same values previously deduced for D and P are substituted,

$$F' = \frac{1}{\frac{kt}{d} \times \frac{k'v}{d}} = K\frac{d^2}{tv}$$

where K is a new coefficient equal to the reciprocal of the product of k and k'.

Therefore, the "factor of desirability" equals the drilling speed, in inches per minute, divided by the power consumption, in cubic feet of free air, per inch drilled. It is quite evident that the factor gained from the quotient of inches drilled per minute divided by cubic feet of free air per minute (or the reciprocal of this quotient) gives merely the power consumption per inch of hole drilled and ignores the quantity of drilling which may be accomplished.

The application of both of these formulas for F and F' to a hypothetical problem may be of interest to show the comparative results within the limits of practice.

Let us assume that 30 h.p. is required to compress 100 cu. ft. of free air per minute to 100 lb. per square inch gauge pressure and deliver the same to a drill in the mine; that the power cost is 1c. per horse power hour; that a drill which shows a drilling speed of 10 in. per minute on test averages 20 ft. per hour under working conditions, and uses 60 cu. ft. of free air per minute on test; that another drill will show a drilling speed of 6 in. per minute on test with an air consumption of 36 cu. ft. per minute and will average 12 ft. per hour under working conditions, and that the wage scale for drill runners is 40c. per hour, then,

For the fast drill:

$t = 1$ min.

$d_1 = 10$ in.

$L = 40$c.

$$O_1 = 20 \div \frac{10 \times 60}{12} = 0.40$$

$$p = \frac{30 \times 1}{60} = 0.5\text{c.}$$

$v_1 = 60$

$$F_1 = \frac{d}{0.2\frac{L}{O_1}t + 0.12\,pv_1} = \frac{10}{\frac{0.2\text{x}40\text{x}1}{0.40} + 0.12\text{x}0.5\text{x}60} = 0.424$$

$$F'_1 = \frac{1}{\frac{0.20\,tL}{O_1d_1} \times \frac{0.12\,pv_1}{d_1}} = \frac{O_1d_1^2}{0.024\,tLpv_1}$$

$$= \frac{0.40 \times 100}{0.024 \times 1 \times 40 \times 0.5 \times 60} = 1.389$$

For the slow drill:

$d_2 = 6$ in.

$v_2 = 36$ cu. ft.

$$O_2 = 12 \div \frac{6 \times 60}{12} 0.40$$

$$F_2 = \frac{6}{\frac{0.2 \times 40 \times 1}{0.40} + 0.12 \times 0.5 \times 36} = 0.271$$

$$F'_2 = \frac{0.40 \times 36}{0.024 \times 1 \times 40 \times 0.5 \times 36} = 0.833$$

Thus the relative factors for the two drills by the first formula have a ratio of 0.424 to 0.271 or 1.56 to 1; and by the second formula (empirical) the ratio of factors is 1.389 to 0.833 or 1.67 to 1. In other words, by the empirical formula the fast drill is credited with about a 7 per cent. higher rating than by the theoretical formula, and this does not seem an undue allowance to cover the unestimated advantages previously enumerated.

Records made previous to July, 1909, have not been shown in Table I. since much of the work done in 1907 and 1908 was distinctly experimental in determining the desirable cylinder diameters, lengths of strokes, piston weights, valve weights, etc., but such records show drilling speeds of about 2 to 3 in. per minute with air consumptions of from 40 to 70 cu. ft. of free air per minute at 90 lb. per square inch gauge pressure. The listed tests made during 1909 cover most of the well-known American makes of hammer drills at that time, and if one excepts the drills denoted by symbols G, G_1, etc., since they were experimental tools, the design of which was developed by the New Jersey Zinc Co. at Franklin Furnace, N.J., it is noticeable that about 4½ and 5 in. were the highest drilling speeds obtainable at about 90 lb. pressure and with an air consumption of 60 to 90 cu. ft. or free air per minute; and for various drills the "factor" varied from 0.09 to 0.41. Those drills marked G, which were made exclusively for the New Jersey Zinc Co., increased the drilling speed about 40 per cent. above the best previous drill performances, and remained unequalled in drilling speed for a year and unsurpassed for about a year and a half. The fact that a number of these drills were included in the equipment at Franklin accounts for part of the increased stoping efficiency during the year 1911, as cited later. Although it was then the opinion of some unprejudiced persons, well versed in the drilling art, that such tools had reached their practical limit of drilling speed as well as the limit of strengths of materials, yet 18 months later a new type of drill was developed to achieve 20 per cent. more drilling with twice as good a factor, and a renewed equipment of these other drills again increased the mining efficiency. Again a period of 18 months sufficed for the production of a hammer drill which still further advanced the drilling speeds 20 per cent., and since the introduction of this drill we have been able to find several drills which surpassed it 10 to 20 per cent. in drilling speed.

In Table I. some seemingly freak runs are noticeable, which are included to call attention to the variability of results in presumably standard testing. For instance, under drills D it appears that a bit with two wings broken will drill faster and at a lower air consumption per minute than can be attained with a perfect bit; and again, with drill M_1, a bit which has proved a little soft and battered drills one-fourth more per minute than bits in proper condition and with the same air consumption.

Furthermore, the tests of one person indicate that, when the size and form of the drill bits are the same, faster drilling can be done with short steels than long ones, while another investigator shows a greater drilling speed with long steel than with short. The use of tappets or anvil blocks between the shanks of drill steels and pistons is generally estimated as causing a reduction of 20 to 30 per cent. in the drilling ability, but some tests do not confirm this and show even an increased cutting speed with the use of anvil blocks in a machine otherwise the same. With some drills the use of water to clean the cuttings from the hole seems to cause a cutting speed below that obtainable through the use of compressed air for the same purpose, but in other instances the advantages are reversed. In short, there seem to be so many variables in the drilling problem as to warrant a 10 per cent. variation in the results of supposedly standard tests, and a number of runs should be made to gain a fair average; or strict judgment of machines should not be made within this limit.

(To be continued.)

PERSONAL AND GENERAL

Mr. R. B. Lamb, of 501 Traders Bank Building, Toronto, is in California making an examination of two gold properties for investors.

Professor A. P. Coleman has returned to Toronto from Australia. He spent several months abroad.

Mr. J. W. Boyle, long actively connected with gold mining in Yukon Territory, arrived at Vancouver, B.C., from Dawson on January 31, on his way East.

Mr. E. P. Mathewson, of the Anaconda Copper Mining Co., was a recent visitor to Rossland and Trail, British Columbia.

Mining Press said editorially on January 30: "Arrangements have recently been completed whereby Mr. T. A. Rickard, editor of the Mining Magazine, will return to San Francisco, within the next few months, as editor of the Press, and Mr. H. Foster Bain will go to London as editor of the Mining Magazine."

Mr. Robert C. Sticht, general manager for the Mt. Lyell Mining and Railway Co., Ltd., left San Francisco, California, by the SS. Ventura on January 19, on his return to Queenstown, Tasmania, after having spent a vacation of several months in the United States.

Mr. F. M. Sylvester, general manager for the Granby Consolidated M. S. and P. Co., Ltd., is in New York City. He expects to return to Vancouver, B. C., about the end of February.

Mr. John Whittaker, manager for a company operating a coal mine in Yukon Territory, arrived at Vancouver, B.C., from the North on January 26.

Mr. Conrad Wolfle, manager for the United Copper Co., which is operating a copper mine near Chewelah, Washington, U.S.A., ore from which is being shipped to Trail, B.C., was at Rossland and Trail recently. He was met in the former city by his brother, Mr. F. R. Wolfle, manager for the Florence Silver Mining Co., which is developing a silver-lead mine in Ainsworth mining division, B.C.

Mr. Howland Bancroft, of Denver, Colorado, has been on a trip through mining districts in British Columbia. On his return to Colorado he resumed his professional work in that state.

The Western branch of the Canadian Mining Institute will shortly hold one of its periodical meetings, this time in Victoria. The date will probably be during the first week in March. Papers on Mine Timbering and First Aid to the Injured, having particular reference to instruction of metalliferous miners in this work, have already been promised; also a description of a recently constructed reinforced concrete and steel bankhead at a British Columbia coal mine. It is expected, too, that there will be discussion on Oxygen-Breathing Apparatus for Mine-rescue work.

Mr. David Fasken has returned to Toronto after visiting the property of the Nipissing Mining Co. at Cobalt.

Col. Carson, president of Crown Reserve Mining Co., who returned from England to attend the annual meeting of shareholders has left again for the front.

Col. Gear, a director of Crown Reserve, will command the 1st Battalion of the Montreal Home Guards.

Mr. B. A. C. Craig is a lieutenant in the second Canadian Contingent which will soon be on its way across the Atlantic.

SPECIAL CORRESPONDENCE

COBALT, GOWGANDA AND ELK LAKE

Power.—The companies of the camp are taking their turn in shutting down owing to shortage of power. While the weather has been moderate there has been no thaw which would affect the streams and there is not likely to be until April. Some of the companies are taking their enforced vacation of three weeks altogether, and so shutting off expense and taking the occasion to do needed repairs and make alterations. Others are closing down for a week each month and others again are idle for three days at a time twice a month. While the interruption of operations is very annoying to all the companies it is not so much resented as if silver had been at normal figures. It is felt that with the war over there must be a return of better prices and meanwhile the silver is in the ground; but on the other hand while the mills and mines are idle the overhead expenses continue.

Market for silver.—The price of silver has shown little change. There does not appear to be room for either undue pessimism or extravagant optimism in regard to the situation. There seems to be a disposition on the part of buyers to purchase outright rather than store or make part payment. This would lead to the belief that there is no uneasiness that the silver cannot be absorbed by the market. On the other hand when the market does show a tendency to advance a hoard of some million or two ounces is loosed and it falls again. There has been good buying from China and some from India, though the demand from India is rather disappointing. On the whole there is no disposition to believe that there will be any marked change in the situation until the war situation itself shows a marked change. The price of silver is inextricably bound up with the fortune of the Allies.

Beaver and Timiskaming.—The development of the new ore bodies on the Beaver and the Timiskaming has been of very considerable importance. The vein is still good in both faces and some very rich ore is being mined. As regards the Beaver it is by no means new. The same vein is being worked to-day on three levels, the 400 ft., the 460 and the 530 ft. But on the Timiskaming it is opening up virgin territory. The vein was followed across the Beaver line at the 530 ft. level and soon after the boundary was crossed a very rich pocket was struck. It has now been drifted upon for 80 ft. into the Temiskaming and the vein while split in the face is still quite good. The values are variable; but the ore is always

of excellent shipping quality and some of it is as remarkable ore as has ever been mined in the camp. All the ore is at present being brought up the Beaver shaft, trammed to the old ore house of the Beaver and teamed across to the Temiskaming. On the Beaver the same vein on the 530 ft. level has been followed for 155 ft. The shaft is now down to the 800 ft. level on the Beaver and a raise is being made from a crosscut. Work from the 530 ft. level of the Beaver mine is now being carried on on the Temiskaming by the Beaver company, the Beaver receiving a certain price per ft. for all rock drilled. At the Temiskaming crosscuts have been started from the 400 and 500 ft. levels to cut the vein found from the Beaver. It is expected that at the present rate of progress it will be possible to hoist the ore through the Temiskaming shaft in a month's time. Below the 750 ft. level of the Temiskaming a winze has been sunk to the 800 ft. There is a short ore shoot of very rich ore at the 750 ft., but it is lean in the winze. Drifting on the vein in the first part of the month was beginning to show very satisfactory results. As this is in the diabase several hundred feet below the Keewatin the results will be awaited with interest. The new ore body is running in a southerly direction parallel to the old vein system and about 300 ft. distant from it.

Both the mills at the Temiskaming and the Beaver are running to capacity. The ore bins at the Beaver in particular have been full to overflowing for some time. The Beaver and the Temiskaming have been shut down for three days already this month and will close down for three more days at the end of January.

The shortage of power is hindering the reopening of some old prospects. The York Ontario would have started up the old King Edward mine if they could have obtained power some time ago, and the Right of Way company had determined to make another attempt at finding ore, but there was no means of obtaining power and the compressor was sold some time ago.

Crown Reserve.—Ore reserves at the Crown Reserve are estimated at 1,500,000 ounces. When the report was made it was estimated that no ore had been put in sight during the year, and that therefore the output of 1,425,320 ounces reduced the ore reserves by that amount. Since then there have been some rather promising developments on the Crown Reserve itself and the discovery on the Silver Leaf in which the Crown Reserve has a 65 per cent. interest, is still holding good. The cost per oz. at the Crown Reserve was 28.95 cents, an increase of nearly six cents during the year. The profit per oz. was 22.97 cents, as against 36.43 cents for the previous year. The total ounces mined since the inception of the company is 18,429,141, of which the Carson vein produced 9,015,279 ounces. On the Silver Leaf lease $16,659 was expended during the year and a good find made. On the Drummond Fraction, worked jointly with Kerr Lake, a production amounting to $60,717 had been made, leaving a profit of $12,309.

Canadian Mining Institute.—At a meeting of the Cobalt branch of the Canadian Mining Institute the members present unanimously decided that it would be better to leave the by-laws of the Institute as they were for a year when the proposed alterations might be taken up again. The following resolution was proposed by Mr. E. V. Neelands, seconded by Mr. T. R. Jones, and carried unanimously:

"Whereas important amendments to the by-laws have been proposed, radically altering the present method of election of council and whereas this is an abnormal year on account of the war and many members will likely be hindered from attending the annual meeting, and whereas a considerable number of our members are at the front and cannot therefore vote, be it resolved that consideration of these important amendments be postponed until the annual meeting of 1916."

It was also unanimously resolved to circulate the resolution for the signatures of members not present at the meeting and to send a copy of it to all other branches of the Institute.

Some discussion preceded the passing of the resolution. Mr. B. Neilly, who was in the chair said that on the basis of the proposed amendments to the by-laws Ontario would have the absolute control of the council. If a heated debate took place at the annual meeting and the amendments went through it was quite probable that the Nova Scotia society would not come in and the Rocky Mountain branch would secede, as it would reduce their representation to almost nothing.

Mr. Neelands said that if the resolution went through Ontario would undoubtedly be accused of hogging the whole business.

Mr. E. B. Thornhill, superintendent of the Buffalo mill then gave an important paper on "The Recovery of Mercury from High Grade Residues." By the aid of the blackboard and demonstration he proved his contention that a great saving in mercury could be made by the process that he has discovered at the Buffalo mill. There was some discussion, Mr. Denny, of the Nipissing staff, taking the lead.

Mr. T. R. Jones, manager of the Buffalo mines, pointed out some of the economic advantages of the process. He said that it had reduced the loss in mercury from 50 pounds to the ton by 70 or 75 per cent., and it had reduced the cost of the treatment of the concentrates from $18 to $25 a ton. A very ready market was also found for the product, it being more free from impurities than commercial mercury, and he hoped that they would soon be able to get a premium on it for that reason. They had recently sold some for electrical transformers and the purchasers seemed much pleased with the product. The cost of the installation of the plant for treating the mercury was slight and inconsiderable.

A hearty vote of thanks was passed to the lecturer for his most interesting address.

PORCUPINE AND KIRKLAND LAKE

Tough-Oakes.—At the annual meeting of the Tough-Oakes mining company in Haileybury at the end of last month the old directorate was elected. It was reported that there was an ore reserve in the mine of a million and a half dollars. It is confidently expected that the mill will be running by the middle of March. Three or four drills are now at work underground.

Hollinger.—The annual report of the Hollinger was read with great interest in the camp largely owing to the information given as to the diamond drilling. This has been a matter of excited speculation for the better part of a year; but the secret had been so well kept that no exact details ever became general knowledge. It now appears from the annual report that the hole was driven to an inclined depth of 2,000 ft. and a vertical depth of 1,425 ft. The results as given can only be taken as conclusive that the same formation continues for 1,500 ft. and that there is ore, presumably of a fair grade. Other experience of diamond drilling in the camp leads to the conclusion that average results are generally below the actual value of ore rather than above it. Mr. Robbins states that the records obtained are about what he would have anticipated from diamond drill cores on the same grade of ore that he is now

working. And therefore under the heading of "speculative," he states "that it is not unreasonable speculation to anticipate from the ore bodies now being worked a production of something over twice the value of the ore shown in the estimate of ore reserves. Beyond this are the possibilities of production from the veins not yet developed, and also the value of ore which may be encountered at levels below the depth of the bore hole."

Wettlaufer gold.—The Nipissing Mining Company has taken an option on the Wettlaufer property which adjoins the Teck-Hughes. Development of the Teck-Hughes is proceeding quite satisfactorily. The plant of the Kirkland Lake gold mines has been leased in order to provide further power for more extended operations on the Teck-Hughes. On the lower level 88 ft. of drifting has been done on a wide vein of low grade ore.

Rea.—The success of the Rea Mines Leasing Company is reflected in the 6 per cent. dividend which has just been declared. This company took over the Rea from the Mines Leasing Company and has been running the little mill purchased from the Porcupine Pet at a profit ever since. The ore run is that blocked out by the old company in the early days, and during the past year the little mill has made a profit of $50,000. The mill makes an extraction of 87 per cent. on $8 to $10 ore. No new ore bodies have been found by the leasing company.

Porcupine Crown—The annual report of the Porcupine Crown mine shows that the property made an excellent recovery during the last four months of the year after a rather disappointing eight months. Mr. Summerhayes writes: "During the first eight months of the year the development was very discouraging, both in proving beyond the fault and on the 500 ft. level. The last four months of the year has not only proved the existence of ore at 500 ft., but has been most satisfactory south of the fault, and as a result at 300 ft. there is a 1,000 ft. ore shoot."

But south of the fault the vein is not as rich.

Ore reserves are estimated at 85,000 tons, valued at $1,510,000. The average heads were $17.18 per ton.

BRITISH COLUMBIA

East Kootenay.

The only ore shipper in this district during the first three weeks of the new year was the Sullivan group, which sent 2,115 tons of lead-silver ore to Trail.

The Kootenay Central Railway, the construction of which was completed recently, is now being operated, trains being run from Golden south up the valley of the Columbia river on stated days. There is also a regular schedule from the Crowsnest Railway line northward, up the valley of the Columbia. It is expected that the opening of this railway for traffic will lead to some of the lode mining properties in Windermere mining division being worked after having lain idle for many years.

West Kootenay.

Ainsworth.—With the exception of a carload shipment each from the Early Bird, situated on the western shore of Kootenay lake, near the town of Ainsworth, and the Utica, on Paddy's Mountain, there was not any ore received from mines in Ainsworth division at the smelting works at Trail up to January 22. Development work is being continued on the John L. Retallack & Co.'s Whitewater group, and on other mines in the division. With the return of spring ore production will be resumed, though probably on a comparatively small scale until market conditions shall improve and the sale of silver, lead and zinc be remunerative again.

Slocan.—Ore was received at Trail from five mines in this division during three weeks to January 22. From the Hewitt mine and concentrating mill, owned by the Silverton Mines, Ltd., 64 tons was received; from the Idaho-Alamo, west of Three Forks, lessees shipped 58 tons; from the Mercury, which had not been on the shipping list for a year or more, 17 tons was received; the Rambler-Cariboo sent out 117 tons, and the Reco made a new beginning with a car of 32 tons.

The Ivanhoe concentrator has been working on ore from the Surprise mine, and the concentrated product made is finding a market at Newark, N.J. The Surprise is one of the few mines in the district at which operations were continued uninterruptedly throughout the year, war troubles not having affected the carrying out of the development and production policy of the owners.

Nelson.—A car of concentrates has been sent from the Granite mill to Trail, the Granite-Poorman property having been leased by an enterprising resident in Nelson, Mr. J. P. Swedborg, who has had men at work in the mine through the winter, and latterly has been crushing ore in the mill.

Lead ore is still being shipped to Trail from the Emerald and H. B. mines, near Salmo; from the former there was received 126 tons and from the latter 123 tons. The Leadville, in the same part of Nelson division, has made its first carload shipment. Gold concentrate from the Queen mine, at Sheep creek, has also been going to Trail as usual; the output of that mine in 1914 was 5,517 oz. of gold and 1,557 oz. of silver from 9,801 tons of ore crushed.

Rossland.—The output of ore for the first three weeks of the year has averaged nearly 7,000 tons a week, of which 3,800 tons a week was from the Centre Star-War Eagle group and 2,760 tons from the Le Roi, the remainder having been from the Josie mine of the Le Roi No. 2, Ltd.

Approximate figures of production in 1914 are as follows: Ore, 295,000 tons. Metal contents: Gold, 140,080 oz.; silver, 133,460 oz.; copper, 5,138,000 lb. The shipping mines were: Centre Star-War Eagle group, 174,000 tons; Le Roi, 97,000 tons; Josie group, 24,000 tons. The smaller part of the ore from the Josie group was second-class ore and was concentrated, and the concentrate as well as the first-class ore was sent to the smeltery at Trail.

The payroll for December at the Consolidated Mining and Smelting Co.'s works—copper and lead smelting and electrolytic lead refining—at Trail is stated to have been about $57,000, with about 600 men employed.

Boundary.—At several small gold properties in the neighborhood of Greenwood, men are now working; not many at each, but an appreciably large number altogether. Among these are the Prince Henry, Strathmore, E. P. U., and Argo. Both the E. P. U. and Strathmore have recently taken out ore for shipment to the smeltery, and it is expected the others will shortly follow suit.

The Granby Consolidated Co. is working its mines near Phoenix and smeltery at Grank Forks, though not yet at full capacity. With copper now bringing a higher price than it was when work was resumed in December, the outlook for enlarged operations is brighter. The British Columbia Copper Co.'s smelting works at Greenwood are still idle. The Jewel gold mine and stamp mill are being operated; revised returns show a total production from this mine in 1914 of 16,526 tons of ore, from which there was recovered 6,512 oz. of gold and 33,236 oz. of silver.

MARKETS

TORONTO MARKETS.

Feb. 10—(Quotations from Canada Metal Co., Toronto)—
Spelter, 9 cents per lb.
Lead, 5 cents per lb.
Tin, 39½ cents per lb.
Antimony, 19 cents per lb.
Copper, casting, 15½ cents per lb.
Electrolytic, 15½ cents per lb.
Ingot brass, yellow, 10c. per lb.; red, 12 cents per lb.
Feb. 10—(Quotations from Elias Rogers Co., Toronto)—
Coal, anthracite, $8.00 per ton.
Coal, bituminous, $5.25 per ton.

GENERAL MARKETS.

Feb. 8—Connellsville coke (f.o.b. ovens)—
Furnace coke, prompt, $1.55 per ton.
Foundry coke, prompt, $2.00 to $2.50 per ton.
Feb. 8—Tin, straits, 37.12½ cents.
Copper, Prime Lake, 14.50 to 14.75 cents.
Electrolytic copper, 14.50 to 14.60 cents.
Copper wire, 15.75 to 15.87½ cents.
Lead, 3.80 to 3.85 cents.
Spelter, 8.25 cents.
Sheet zinc (f.o.b. smelter), 11.00 cents.
Antimony, Cookson's, 19.50 to 20.00 cents.
Aluminum, 19.00 to 19.50 cents.
Nickel, 40.00 to 45.00 cents.
Platinum, soft, $43.00 to $44.00 per ounce.
Platinum, hard, 10 per cent., $47.00 per ounce.
Bismuth, $2.75 to $3.00 per pound.
Quicksilver, $56.00 per 75-lb. flask.

SILVER PRICES.

	New York.	London.
January—	cents.	pence.
23.	48¾	22 11/16
25.	48⅞	22¾
26.	48⅞	22¾
27.	48¾	22⅝
28.	48¾	22⅝
29.	48¾	22⅝
30.	48⅝	22⅝
February—		
1.	48⅝	22⅝
2.	48⅜	22⅝
3.	48	22½
4.	48¼	22⅝
5.	48¼	22⅝
6.	48¼	22⅝
8.	48⅛	22 9/16

STANDARD EXCHANGE.

Toronto, Feb. 9, 1915.

Cobalt	Sellers.	Buyers.
Bailey	.01⅞	.01¾
Beaver	.28	.27¼
Buffalo	.90	.60
Chambers-Ferland	.15	.13
Coniagas	5.50	...
Crown Reserve	.75	.69
Foster	...	.02
Gifford	...	.01
Gould	.00¾	.00½
Great Northern	.04	.03¾
Hargraves	.01½	.01
Hudson Bay	40.00	...
Kerr Lake	4.80	4.50
La Rose	.72	.68
McKinley-Darragh-Savage	.46	.42
Nipissing	5.55	5.40
Peterson Lake	.24¼	.23¾
Right of Way	.02¼	.01¾
Seneca Superior	1.30	1.05
Silver Leaf	.03	.02½
Silver Queen	...	.02
Timiskaming	.17¾	.17½
Trethewey	.14	.10½
Wettlaufer	.06	.04½
York, Ont.	...	.05
Porcupine—		
Apex	.02⅛	.01⅞
Dome Extension	.07⅝	.07¼
Dome Lake	.29¾	.29¼
Dome Mines	6.75	6.00
Foley O'Brien	.20	.15
Gold Reef	.03½	...
Homestake	...	.10
Hollinger	22.70	22.50
Jupiter	.10½	.10
McIntyre	.27	.26¼
Pearl Lake	.02¼	.01½
Porcupine Crown	.84	.80
Porcupine Gold ex-r.	.00⅜	.00⅛
Porcupine Imperial	.01⅝	.01½
Porcupine Pet	...	.17
Porcupine Vipond	36½	.35½
Preston East D.	.02	.01½
Rea Mines	.20	.12¼
Teck-Hughes	.11¾	.11¼
West Dome	...	.08
Sundry—		
C. G. F. S.	.04¾	.04⅜

COBALT SHIPMENTS.

Four hundred and forty-four tons of ore was the Cobalt total for the week ending Feb. 5, 1915. These figures are the largest, save one, of any week in the past few months and represent 13 cars shipped from eight mines. Bullion shipments for the week were lower than last week, three companies shipping over 100,000 oz.

The Mining Corporation of Canada was the heaviest shipper in the week. From the Townsite-City mine, 256,815 lb. was shipped in three cars of high grade and concentrates. From the Cobalt Lake one car was sent to Deloro. Dominion Reduction had two cars to Denver during the week, while Coniagas and Trethewey each shipped two cars of high, the former shipped to Thorold and the latter to Deloro and Denver. From the Kerr Lake section the Timiskaming sent out a car of mixed concentrates and high grade to Denver and the Kerr Lake shipped to the same point.

Nipissing does not appear as a bullion shipper this week, and as a result the totals are lower than usual. The Dominion Reduction, Caribou-Cobalt and Crown Reserve sent out 109,000 oz. valued at $54,600 during the week.

Ore shipments for the week were:

Mining Corporation of Canada—	
Townsite-City	256,815
Cobalt Lake	65,650
Coniagas	115,061
Dominion Reduction Co.	172,400
Trethewey	86,791
McKinley-Darragh	84,030
Kerr Lake	50,520
Timiskaming	57,335

—Cobalt Nugget.

PROFESSIONAL DIRECTORY.

The very best advice that the publishers of the Canadian Mining Journal can give to intending purchasers of mining stock is to consult a responsible Mining Engineer BEFORE accepting the prospectus of the mining company that is offered them. We would also strongly advise those who possess properties that show signs of minerals not to hesitate to send samples and to consult a chemist or assayer Those who have claims and who require the services of a lawyer, with a thorough knowledge of Mining Law, should be very careful with whom they place their business.

ENGINEERS, METALLURGISTS AND GEOLOGISTS.

Dominion of Canada.

Ontario

Astley, J. W.
Cohen, S. W.
Campbell & Deyell.
Carter, W. E. H.
Evans, J. W.
Ferrier, W. F.
Forbes, D. L. H.
Graham, S. N.
Gwillim, J. C.
Handley, John.
Hassan, A. A.
Haultain, H. E. T.
Hille, F.
Loring, F. C.
McEvoy, Jas.
Scott, G. S.
Segsworth, Walter E.
Smith, Alex H.
Smith, Sydney.
Maurice W. Summerhayes.
Tyrrell, J. B.

Quebec

Burchell, Geo. B.
Cohen, S. W.
DePencier, H. P.
Hardman, J. E.
Hersey, Milton L.
Johnson, W. S.
Smith, W. H.
Ross, J. G.

British Columbia

Brown & Butters.
Fowler, S. S.

FOREIGN-New York

Canadian Mining & Exploration Co., Ltd.
Colvocoresses, Geo. M.
Dorr, Jno. V.N.
Hassan, A. A.

ASSAYERS, CHEMISTS AND ORE TESTERS.

Dominion of Canada

Ontario

Belleville Assay Office.
Campbell & Deyell
Heys, Thos. & Son

Canadian Laboratories, Ltd.

Quebec

Hersey, Milton Co., Ltd

Dr. J. T. Donald

Foreign-New York

Ledoux & Co.

ENGINEERS, METALLURGISTS AND GEOLOGISTS.

PROFESSIONAL : DIRECTORY.

CONTINUED FROM PRECEDING PAGE.

ENGINEERS, METALLURGISTS AND GEOLOGISTS.

GWILLIM, J. C.
Consulting Mining Engineer,
KINGSTON, ONT.

LORING, FRANK C.
Mining Engineer,
Home Life Building, Toronto, Ont.
Cobalt, Ont.

JOHN V. N. DORR
Consulting and Metallurgical Engineer
30 Church Street - New York City
and
First National Bank Building, Denver, Colorado.

HANDLEY, JOHN
Mining Engineer and Metallurgist
SUDBURY, ONT.
Code: Bedford McNeill, 1908.

MCEVOY, JAMES
Mining Engineer,
Stair Building,
TORONTO.

SEGSWORTH, WALTER E.
Mining Engineer,
103 BAY ST., TORONTO.
PHONE MAIN 2311

HARDMAN, J. E.
Consulting Mining Engineer
MONTREAL, CANADA.

PICKINGS, H. B.
Mining Engineer
METROPOLE BUILDING
HALIFAX, N.S.

SMITH, SYDNEY.
Mining Engineer,
HAILEYBURY, ONT.

HASSAN, A. A., COBALT, ONT.
Mining Geologist and Consulting Engineer.
61 WALDORF COURT, BROOKLYN, N. Y.
Examination, Management and Operation of Mines in Ontario, Quebec and Nova Scotia.
Any Code. Cable Address: "Aghar"

ROSS, JAS. G., B. Sc. McGill,
M. Amer. Inst. M. E.
Consulting Mining Engineer,
MILTON HERSEY CO., LTD.
171 St. James St., MONTREAL.

SUMMERHAYES, MAURICE W.
Mining Engineer,
Manager
Porcupine-Crown Mines, Limited
Timmins - Ont.

HILLE, F.
Mining Engineer.
Mines and Mineral Lands Examined and Reported On.
Port Arthur, Ontario, Canada.

SCOTT, G. S. TORONTO
Mining Engineer and Geologist
Valuations and General Reports.
Development of Ore Bodies Planned and supervised.
Geological Surveys.
Detail Prospecting of Properties Superintended.
Examination of Prospects.
Microscopic Examination of Rocks.
Care Canadian Mining Journal

TYRRELL, J. B.
Mining Engineer,
534 Confederation Life Building,
TORONTO, - - CANADA.

Phones { Office Main 6935 / Res Lachine 218

JOHNSON, W. S.
CONSULTING MINING ENGINEER
Canada Life Bldg, MONTREAL.

What is your specialty ?
What is your address ?
Our readers want to know.

LAWYERS

Telephone Main 3813
Cable Address: "Chadwick" Toronto Western Union Code
E. M. Chadwick, K.C
David Fasken, K.C.
M. K. Cowan, K.C.
Harper Armstrong
Alexander Fasken
Hugh E. Rose, K.C.
Geo. H. Sedgewick.
James Aitchison
Beatty, Blackstock, Fasken Cowan & Chadwick
Barristers, Solicitors, Notaries
Offices: Bank of Toronto, Cor. Wellington & Church Sts.
58 Wellington St. East Toronto

G. G. S. Lindsey, K.C.
Telephone Main 6070
Cable Address: "Lindsey," Toronto
Codes, Broomhall, McNeil's 1908
Commissioner for taking affidavits in British Columbia.
counsel with
Gregory & Gooderham, Barristers and Solicitors, Canada Life Building, Toronto

Phone Main 2311
Cable Address "Segsworth" Toronto
R. F. SEGSWORTH
Barrister, Solicitor, Notary, Etc.
JARVIS BUILDING
103 Bay Street - TORONTO

ASSAYERS, CHEMISTS AND ORE TESTERS.

MILTON HERSEY CO., LTD.
Chemists and Mining Engineers
Assays of Ores Tests of all Materials
DR. MILTON L. HERSEY, President
(Consulting Chemist to Quebec Government)
JAMES G. ROSS
Consulting Mining Engineer
HEAD OFFICE: 171 St. James St., MONTREAL

Phone M. 1889 Cable address "Heys"
Established 1873.
HEYS, THOS. & SON,
Technical Chemists and Assayers,
Rooms M and N, Toronto Arcade
Yonge Street, Toronto, Ont.
Sampling Ore Deposits a Specialty.

LEDOUX & CO.
ASSAYERS AND SAMPLERS
Office and Laboratory,
99 John St., New York.
Weigh and Sample Shipments at Buyers' Works, representing the Interests of Sellers in all Transactions.
We are not Dealers or Refiners.

SMITH & DURKEE
Diamond Drilling Co.
LIMITED
Contractors for all classes of diamond drill work.
We make a specialty of saving a large percentage of core in soft ground.
Plans showing location of holes and surveys of holes can be supplied.
SUDBURY - ONT.

CAMPBELL & DEYELL, Limited
Ore Samplers, Assayers and Chemists
Cobalt, Ont.
South Porcupine, Ont.
C. G. CAMPBELL,
General Manager.

CANADIAN LABORATORIES LIMITED
ASSAYERS AND CHEMISTS
ASSAY OF ORES
All commercial products tested and analyzed
OFFICES AND LABORATORIES.
24 ADELAIDE STREET WEST
TORONTO, ONT.

Laboratory of
DR. J. T. DONALD
(Official Analyst to Dominion Government)
ASSAYS OF ORES
Analyses and tests of all kinds of commercial products. Cement Testing, Coal, &c.
318, Lagauchetiere St. West, MONTREAL

HUGH BOYLE, SECY. JAS. E. BOYLE, MGR.
DOMINION DIAMOND DRILLING CO., Ltd.
SOUTH PORCUPINE, ONT.
Telephone 213 Box 506
CORE BORING SOUNDINGS CONTRACTORS

JOHNSON, MATTHEY & CO. LTD.
Buyers, Smelters, Refiners & Assayers of Gold, Silver, Platinum, Ores, Sweeps, Concentrates, Bullion, &c.
Offices—Hatton Garden, London, E.C.
Works—Patricroft, Manchester, England

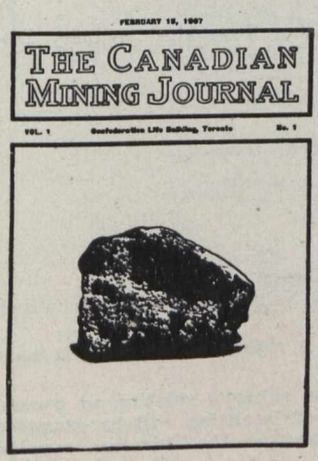
Smith & Travers Diamond Drill Company, Limited
Box 169, SUDBURY, ONT.
404 Lumsden Bldg., TORONTO.
All classes of Diamond Drill Contracting and Manufacture of Diamond Drill Parts.

Belleville Assay Office
Assays and Analyses of Ores and Minerals.
OFFICE AND LABORATORY,
185 Pinnacle St. Belleville, Ont.

STEEL SALESMAN WANTED
to represent a well known manufacturer of Hollow and Solid Drill Steel. Must be a first class man with thorough knowledge of the mining trade in the western territory. Apply with full particulars. Box I, Canadian Mining Journal.

POSITION WANTED
Want position as engineer erecting steam plants and electric equipments of different types, used to Westinghouse, G. E. and Allis-Chalmers apparatus.
A. J. E. CATTO,
41 7th Ave., Ville St. Pierre, MONTREAL

CAPITAL introduced for sound enterprises of all kinds. 5% commission. Bond and Stock issues placed. Underwriting procured. References exchanged.
Address, COOKE & BYRNE,
Harcourt Street, Dublin, Ireland



The Canadian Mining Journal

WITH WHICH IS INCORPORATED "THE CANADIAN MINING REVIEW"
A JOURNAL DEVOTED TO MINING AND METALLURGY
SUBSCRIPTION IN CANADA, $2.00
TO OTHER COUNTRIES, $3.00
PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH
TWENTY-FOUR ISSUES IN A YEAR

The Canadian Mining Journal,
Toronto, Ontario, Canada.

Send me the Canadian Mining Journal for one year and until countermanded, beginning with the month of.....for which I agree to pay the sum of.....Dollars per year.

Name .....

Address .....

.....

DEPARTMENT OF MINES GEOLOGICAL SURVEY.

PUBLICATIONS

The Geological Survey has published maps and reports dealing with a large part of Canada, with many local areas and special subjects.

A catalogue of publications will be sent free to any applicant. A single copy of a map or report that is specially desired will be sent to a Canadian applicant free of cost and to others at a nominal price. The applicant should state definitely the precise area concerning which information is desired, and it is often of assistance in filling an order for a map or report if he states the use for which it is required.

Most of the older reports are out of print, but they may usually be found in public libraries, libraries of the Canadian Mining Institute, etc.

REPORTS RECENTLY ISSUED:

CANADA
Summary Report of the Geological Survey for the year 1913.
NEW BRUNSWICK and NOVA SCOTIA
Memoir 20. Gold fields of Nova Scotia, by W. Malcolm.
Memoir 60. Arisaig-Antigonish District, Nova Scotia, by M. Y. Williams.
Memoir 41. The "Fern Ledges" Carboniferous flora of St. John, New Brunswick, by Marie C. Stopes.
QUEBEC
Museum Bulletin No. 3. The Anticosti Island faunas, by W. H. Twenhofel.
Memoir 39. Kewagama Lake Map-Area, Quebec, by M. E. Wilson.
ONTARIO
Museum Bulletin No. 5. A Beatricea-like Organism from the Middle Devonian, by Percy E. Raymond.
Memoir 40. The Archaean Geology of Rainy Lake Re-studied, by Andrew C. Lawson.
Museum Bulletin No. 8. The Huronian Formations of Timiskaming Region, Canada, by W. H. Collins.
NORTH-WEST PROVINCES
Memoir 47. Clay and Shale Deposits of the Western Provinces, Part 3, by Heinrich Ries.
Memoir 53. Coal Fields of Manitoba, Saskatchewan, Alberta and Eastern British Columbia (Revised Edition) by D. B. Dowling.
Museum Bulletin No. 4. The Crowsnest Volcanics, by J. D. MacKenzie.
Memoir 61. Moose Mountain District, Southern Alberta (Second Edition), by D. D. Cairnes.
BRITISH COLUMBIA
Memoir 32. Portions of Portland Canal and Skeena Mining Divisions, Skeena District, B.C., by R. G. McConnell.
Memoir 51. Geology of the Nanaimo Map-Area, by C. H. Clapp.
Memoir 55. Geology of Field Map-Area, B. C., and Alberta, by John A. Allan.
YUKON AND NORTH-WEST TERRITORIES
Memoir 31. Wheaton District, Yukon Territory, by D. D. Cairnes.

MAPS RECENTLY ISSUED:

CANADA
Map 91A. Geological map of the Dominion of Canada and Newfoundland. Scale 100 miles to 1 inch.
NEW BRUNSWICK AND NOVA SCOTIA
Map 27A. Bathurst and vicinity, Gloucester County, New Brunswick. Geology.
Map 39A. Geological Map of Nova Scotia.
Map 121A. Franey Mine and Vicinity, Victoria County, N.S.
QUEBEC
Map 95A. Broadback River, Mistassini territory, Quebec. Geology.
Map 100A. Bell River, Quebec. Geology.
ONTARIO
Map 124A. Wanapitei (Falconbridge, Street, Awrey, and Parts of Maclennan and Scadding Townships), Sudbury District, Ont. Geology.
Map 49A. Orillia sheet, Simcoe and Ontario counties, Ontario. Topography.
NORTH-WEST PROVINCES
Map 55A. Geological map of Alberta, Saskatchewan, and Manitoba.
BRITISH COLUMBIA
Map 43A. Sooke Sheet, Vancouver Island, British Columbia. Topography.
Map 136A. Hazelton-Aldermere, Cassiar and Coast Districts, British Columbia.
1321. Diagram Showing the Geology of Texada Island, British Columbia.
Map 106A. Groundhog coal field, British Columbia. Geology.
YUKON AND NORTH-WEST TERRITORIES.
Map 113A. Canadian routes to White River District. Yukon, and to Chisana District, Alaska.
Map 58A. Explored Routes in the Lower Parts of the Drainage Area of Churchill and Nelson Rivers, Manitoba and Saskatchewan. Geology.

NOTE.—Maps published within the last two years may be had, printed on linen, for field use. A charge of ten cents is made for maps on linen.

The Geological Survey will, under certain limitations, give information and advice upon subjects relating to general and economic geology. Mineral and rock specimens, when accompanied by definite statements of localities, will be examined and their nature reported upon. Letters and samples that are of a Departmental nature, addressed to the Director, may be Mailed O.H.M.S. free of postage.

Communications should be addressed to THE DIRECTOR, GEOLOGICAL SURVEY, OTTAWA.

BUYERS AND SELLERS OF METALS

ALPHABETICAL INDEX TO ADVERTISERS

The Canadian Miner's Buying Directory.

Air Hoists—
Canadian Ingersoll-Rand Co., Ltd.

Amalgamators—
Fraser & Chalmers of Canada, Limited.
Northern Canada Supply Co.

Assayers and Chemists—
Milton L. Hersey Co., Ltd.
Campbell & Deyell, Cobalt
Ledoux & Co., 99 John St., New York
Thos. Heys & Son.
C. L. Constant Co.

Assayers' and Chemists Supplies—
C. L. Berger & Sons, 37 William St., Boston, Mass.
Lymans, Ltd., Montreal, Que
Stanley, W. F. & Co., Ltd.
Peacock Bros.

Ball Mills—
Fraser & Chalmers of Canada, Limited.
Peacock Bros.
Mussens, Ltd.

Beams—Steel—
Dominion Bridge Co.
Mussens, Ltd.

Belt Tighteners and Clamps—
Dodge Mfg. Co., Ltd.

Belting—Leather, Rubber and Cotton—
Mussens, Ltd.
Northern Canada Supply Co.
Jones & Glassco
Federal Engineering Co.
Can. H. W. Johns-Manville Co.
Dodge Mfg. Co., Ltd.

Blasting Batteries and Supplies—
Thomas & William Smith
Can. Ingersoll-Rand Co., Ltd.
Curtis & Harvey (Canada), Ltd.
Mussens, Ltd.
Northern Canada Supply Co.

Blowers—
Fraser & Chalmers of Canada, Limited.
Mussens, Ltd.
Northern Canada Supply Co.

Boilers—
Mussens, Ltd.
Fraser & Chalmers of Canada, Limited.
Peacock Bros.
Northern Canada Supply Co.
Can. Ingersoll-Rand Co., Ltd

Boots—
Dodge Mfg. Co., Ltd.

Buckets—
Hendrick Mfg. Co.
M. Beatty & Sons, Ltd.
Mussens, Ltd.
Northern Canada Supply Co.

Buildings—Steel Frame—
Dominion Bridge Co.

Cable — Aerial and Underground—
Mussens, Ltd.
Fraser & Chalmers of Canada, Ltd.
Northern Canada Supply Co.

Cableways—
Fraser & Chalmers of Canada, Limited.
M. Beatty & Sons, Ltd.
Mussens, Ltd.

Cages—
Mussens, Ltd.
Fraser & Chalmers of Canada, Limited.
Jeffrey Mfg. Co.
Northern Canada Supply Co.

Cables—Wire—
Northern Electric Co., Ltd.
Standard Underground Cable Co. of Canada, Ltd.

Carbon (Black Diamonds and Bortz)—
Abe. Levine.

Cars—
Jeffrey Mfg. Co.
Mussens, Ltd.
Northern Canada Supply Co.

Car Pullers—
Dodge Mfg. Co., Ltd.

Cement Machinery—
Northern Canada Supply Co.
Peacock Bros.

Chains—
Jeffrey Mfg. Co.
Peacock Bros.
Jones & Glassco
Mussens, Ltd.
Northern Canada Supply Co.
Dodge Mfg. Co., Ltd.

Chain Blocks—
Mussens, Ltd.

Chemists
Canadian Laboratories.
Campbell & Deyell.
Thos Heys & Sons.
Milton Hersey Co.
Ledoux & Co.

Coal—
Dominion Coal Co.
Nova Scotia Steel & Coal Co.

Coal Cutters—
Jeffrey Mfg. Co.
Sullivan Machinery Co.
Can. Ingersoll-Rand Co., Ltd.
Peacock Bros.
Mussens, Ltd.

Coal Mining Exposives—
Curtis & Harvey (Can.), Ltd.

Coal Mining Machinery—
Mussens, Ltd.
Can. Ingersoll-Rand Co., Ltd.
Fraser & Chalmers of Canada, Limited.
Peacock Bros.
Jeffrey Mfg. Co.

Coal Punchers—
Sullivan Machinery Co.
Can. Ingersoll-Rand Co., Ltd.
Mussens, Ltd.

Coal Washeries—
Jeffrey Mfg. Co.
Mussens, Ltd.
Peacock Bros.

Collars—
Dodge Mfg. Co., Ltd.

Compressors—Air—
Fraser & Chalmers of Canada, Limited.
Sullivan Machinery Co.
Can. Ingersoll-Rand Co., Ltd.
Mussens, Ltd.
Peacock Bros.
Northern Canada Supply Co.

Concentrators and Jigs—
Fraser & Chalmers of Canada, Limited.
James Ore Concentrator Co.
Mussens, Ltd.

Concrete Mixers—
Mussens, Ltd.
Peacock Bros.
Northern Canada Supply Co.

Condensers—
Fraser & Chalmers of Canada, Limited.
Smart-Turner Machine Co.
Peacock Bros.
Northern Canada Supply Co.

Converters—
Fraser & Chalmers of Canada, Limited.
Jeffrey Mfg. Co.
Northern Canada Supply Co.
Peacock Bros.
Mussens, Ltd.

Conveyor—Trough—Belt—
Hendrick Mfg. Co.

Coupling—
Dodge Mfg. Co., Ltd.

Cranes—
Smart-Turner Machine Co.
Peacock Bros.
Mussens, Ltd.
M. Beatty & Sons, Ltd.

Cranes—Electric—
Mussens, Ltd.

Cranes—Overhead Traveling—
Mussens, Ltd.

Crane Ropes—
Mussens, Ltd.
Allan, Whyte & Co.
Thos. & Wm. Smith.

Crushers—
Fraser & Chalmers of Canada, Limited.
Peacock Bros.
Lymans, Ltd.
Mussens, Ltd.
Hadfields Steel Foundry Co.

Cyanide Plants—
Fraser & Chalmers of Canada, Limited.
Roessler & Hasslacher.
Thos. & Wm. Smith.
Peacock Bros.

Derricks—
Smart-Turner Machine Co.
S. Flory Mfg. Co.
M. Beatty & Sons, Ltd.
Mussens, Ltd.

Diamonds (for Diamond Drills)—
Abe. Levine.

Diamond Drill Contractors—
Diamond Drill Contracting Co.
Smith and Travers.

Dredging Machinery—
Peacock Bros.
M. Beatty & Sons.
Mussens, Ltd.

Dredging Ropes—
Allan, Whyte & Co.
Fraser & Chalmers of Canada, Limited.

Drills, Air and Hammer—
Can. Ingersoll-Rand Co., Ltd
Mussens, Ltd.
Jeffrey Mfg Co.
Sullivan Machinery Co.
Peacock Bros.
Northern Canada Supply Co.

Drills—Core—
Can. Ingersoll-Rand Co., Ltd
Standard Diamond Drill Co.

Drills—Diamond—
American Diamond Rock Drills.
Sullivan Machinery Co.
Northern Canada Supply Co.

Drill Steel Sharpeners—
Can. Ingersoll-Rand Co., Ltd
Northern Canada Supply Co.
Mussens, Ltd.

Dump Cars
Sullivan Machinery Co.
Mussens, Ltd.

Conveyors—Belt—
Mussens, Ltd.

Drills—Electric—
Mussens, Ltd.
Can. Ingersoll-Rand Co., Ltd.

Dynamite—
Curtis & Harvey (Canada), Ltd.
Canadian Explosives.
Northern Canada Supply Co.

Dynamos—
Northern Electric Co., Ltd.

Electric Cranes—
Mussens, Ltd.

Ejectors—
Mussens, Ltd.
Peacock Bros.
Can. Ingersoll-Rand Co., Ltd
Northern Canada Supply Co.

Elevators—
Jeffrey Mfg. Co.
M. Beatty & Sons.
Sullivan Machinery Co.
Northern Canada Supply Co.
Mussens, Ltd.
Peacock Bros.

Elevator Cups—
Dodge Mfg. Co., Ltd.

Engineering Instruments—
C. L. Berger & Sons.
Peacock Bros.

Engineers and Contractors—
Fraser & Chalmers of Canada, Limited.
Roberts & Schaefer Co.

Engines—Automatic—
Smart-Turner Machine Co.
Peacock Bros.

Engines—Gas and Gasoline
Fraser & Chalmers of Canada, Limited.
Mussens, Ltd.
Alex. Fleck.
Sullivan Machinery Co.
Smart-Turner Machine Co.
Peacock Bros.

Engines—Haulage—
Mussens, Ltd.
Fraser & Chalmers of Canada, Limited.
Peacock Bros.
Can. Ingersoll-Rand Co., Ltd

Engines—Marine—
Smart-Turner Machine Co.
Peacock Bros.

Engines—Oil—
Peacock Bros.

Engines—Steam—
Fraser & Chalmers of Canada, Limited.
Smart-Turner Machine Co.
S. Flory Mfg. Co.
Peacock Bros.
M. Beatty & Sons.
Mussens, Ltd.

Fans—Ventilating—
Fraser & Chalmers of Canada, Limited.
Sullivan Machinery Co.
Peacock Bros.
Mussens, Ltd.

Feeders—Ore—
Fraser & Chalmers of Canada, Limited.
Mussens, Ltd.

Fixtures—Counter Shaft—
Dodge Mfg. Co., Ltd.

Flights—
Hendrick Mfg. Co.

Floor Stands—
Dodge Mfg. Co., Ltd.

Friction Clutches—
Dodge Mfg. Co., Ltd.

Forges—
Mussens, Ltd.
Northern Canada Supply Co., Ltd.

Forging—
M. Beatty & Sons.
Smart-Turner Machine Co.
Peacock Bros.

Continued on page 30.

Canadian Miner's Buying Directory.—(Continued from page 28.)

Furnaces—Assay—
Lymans, Ltd.
Mussens, Ltd.

Fuse—
Peacock Bros.
Curtis & Harvey (Canada), Ltd.
Canadian Explosives.
Mussens, Ltd.
Northern Canada Supply Co.
Canadian H. W. Johns-Manville Co., Ltd.

Gears—
Smart-Turner Machine Co.
Northern Canada Supply Co.

Generators—
Northern Electric Co., Ltd.
Peacock Bros.

Grease Cups—
Dodge Mfg. Co., Ltd.

Hangers—Cable—
Northern Electric Co., Ltd.
Standard Underground Cable Co. of Canada, Ltd.
Dodge Mfg. Co., Ltd.

Hand Hoists—
Fraser & Chalmers of Canada, Limited

Heaters—Feed Water—
Mussens, Ltd.
Peacock Bros.

High Speed Steel Twist Drills—
Mussens, Ltd.
Northern Canada Supply Co.

Hoists—Air, Electric and Steam—
Can. Ingersoll-Rand Co., Ltd
Peacock Bros.
Mussens, Ltd.
S. Flory Mfg. Co.
Jones & Glassco.
M. Beatty & Sons
Fraser & Chalmers of Canada, Limited
Northern Canada Supply Co.

Hoisting Engines—
Peacock Bros.
Mussens, Ltd.
Sullivan Machinery Co.
Fraser & Chalmers of Canada, Limited
Can. Ingersoll-Rand Co.
M. Beatty & Sons.

Hoists—Gas and Gasoline—
Mussens, Ltd.

Hose—
Canadian H. W. Johns-Manville Co., Ltd.
Mussens, Ltd.
Northern Canada Supply Co.

Jacks—
Mussens, Ltd.
Can. Ingersoll-Rand Co., Ltd
Northern Canada Supply Co.

Jigs—
Mussens, Ltd.
Roberts & Schaefer Co.

Lamps—Acetylene—
Mussens, Ltd.
Northern Canada Supply Co.

Lamps—Safety—
Mussens, Ltd.
Canadian Explosives.
Peacock Bros.

Link Belt—
Northern Canada Supply Co.
Jones & Glassco.

Locomotives—Electric—
Mussens, Ltd.
Jeffrey Mfg. Co.

Locomotives—Steam—
Mussens, Ltd.

Metal Merchants—
Henry Bath & Son.
Geo. G. Blackwell, Sons & Co.
Consolidated Mining and Smelting Co. of Canada.
Canada Metal Co.
C. L. Constant Co.

Monel Metal—
Orford Copper Co.

Motors—
Mussens, Ltd.
Northern Electric Co., Ltd.
Peacock Bros.

Mule Stands—
Dodge Mfg. Co., Ltd.

Ore Sacks—
Northern Canada Supply Co.

Ore Testing Works
Ledoux & Co.
Can. Laboratories.
Milton Hersey Co., Ltd.
Campbell & Deyell.

Ores and Metals—Buyers and Sellers of—
C. L. Constant Co.
Geo. G. Blackwell.
Consolidated Mining and Smelting Co. of Canada.
Orford Copper Co.
Canada Metal Co.

Perforated Metals—
Fraser & Chalmers of Canada, Limited
Northern Canada Supply Co.
Hendrick Mfg. Co.

Pick Machines—
Sullivan Machinery Co.

Picks—Steel—
Mussens, Ltd.
Thos. & Wm. Smith.
Peacock Bros.

Pillow Blocks—
Dodge Mfg. Co., Ltd.

Pipes—
Consolidated M. & S. Co.
Peacock Bros.
Mussens, Ltd.
Northern Canada Supply Co.
Smart-Turner Machine Co.

Pipe Fittings—
Can. H. W. Johns-Manville
Mussens, Ltd.
Northern Canada Supply Co.

Pneumatic Tools—
Can. Ingersoll-Rand Co., Ltd
Jones & Glassco.

Producer—Gas—
Mussens, Ltd.

Prospecting Mills and Machinery—
Standard Diamond Drill Co.
Mussens, Ltd.
Fraser & Chalmers of Canada, Limited

Pulleys—Iron, Wood Spit, Iron Centre Wood Rim—
Dodge Mfg. Co., Ltd.

Pulleys, Shafting and Hangings—
Fraser & Chalmers of Canada, Limited
Northern Canada Supply Co.
Dodge Mfg. Co., Ltd.

Pumps—Boiler Feed—
Mussens, Ltd.
Northern Canada Supply Co.
Peacock Bros.
Canadian Ingersoll-Rand Co. Ltd.
Fraser & Chalmers of Canada, Limited

Pumps—Centrifugal—
Mussens, Ltd.
Smart-Turner Machine Co.
Peacock Bros.
Thos. & Wm. Smith.
M. Beatty & Sons.
Can. Ingersoll-Rand Co., Ltd
Fraser & Chalmers of Canada, Limited

Pumps—Electric—
Mussens, Ltd.
Canadian Ingersoll Rand Co., Ltd.
Fraser & Chalmers of Canada, Limited

Pumps—Pneumatic—
Mussens, Ltd.
Smart-Turner Machine Co.
Can. Ingersoll-Rand Co., Ltd

Pumps—Steam—
Can. Ingersoll-Rand Co., Ltd
Mussens, Ltd.
Thos. & Wm. Smith.
Northern Canada Supply Co.
Smart-Turner Machine Co.

Pumps—Turbine—
Mussens, Ltd.
Canadian Ingersoll-Rand Co., Ltd.
Fraser & Chalmers of Canada, Limited

Pumps—Vacuum—
Smart-Turner Machine Co.

Quarrying Machinery—
Mussens, Ltd.
Sullivan Machinery Co.
Can. Ingersoll-Rand Co., Ltd.

Roasting Plants—
Fraser & Chalmers of Canada, Limited

Rolls—Crushing—
Mussens, Ltd.
Fraser & Chalmers of Canada, Limited

Roofing—
Dominion Bridge Co.
Mussens, Ltd.
Northern Canada Supply Co.
Can. H. W. Johns-Manville

Rope Blocks—
Mussens, Ltd.

Rope Wheels—
Dodge Mfg. Co., Ltd.

Rope Dressing—
Dodge Mfg. Co., Ltd.

Rope—Manilla and Jute—
Jones & Glassco.
Mussens, Ltd.
Peacock Bros.
Northern Canada Supply Co.
Allan, Whyte & Co.
Thos. & Wm. Smith, Ltd.

Rope—Wire—
Allan, Whyte & Co.
Northern Canada Supply Co.
Thos. & Wm. Smith.
Fraser & Chalmers of Canada, Limited
Mussens, Ltd.

Samplers—
Canadian Laboratories.
C. L. Constant Co.
Ledoux & Co.
Milton Hersey Co.
Thos. Heys & Son.

Screens—
Mussens, Ltd.
Jeffrey Mfg. Co.
Northern Canada Supply Co.
Peacock Bros.
Fraser & Chalmers of Canada, Limited

Screens—Cross Patent Flanged Lip—
Hendrick Mfg Co.

Separators—
Smart-Turner Machine Co.
Peacock Bros.

Shafting—
Dodge Mfg. Co., Ltd.

Sheets—Gennine Manganese Bronze—
Hendrick Mfg. Co.

Shovels—Steam—
Mussens, Ltd.
M. Beatty & Sons.

Slime Tables—
James Ore Concentrator.

Smelting Machinery—
Mussens, Ltd.
Peacock Bros.
Fraser & Chalmers of Canada, Limited

Spiral Conveyors—
Dodge Mfg. Co., Ltd.

Sprockets—
Dodge Mfg. Co., Ltd.

Stacks—Smoke Stacks—
Canadian H. W. Johns-Manville Co., Ltd.
Hendrick Mfg. Co.

Stamp Mills—
Mussens, Ltd.
Peacock Bros.
Fraser & Chalmers of Canada, Limited

Steel Drills—
Sullivan Machinery Co.
Mussens, Ltd.
Northern Canada Supply Co.
Can. Ingersoll-Rand Co., Ltd
Peacock Bros.
Swedish Steel & Imp. Co., Ltd

Steel—Tool—
Mussens, Ltd.
Thos. & Wm. Smith.
N. S. Steel & Coal Co.
Swedish Steel & Imp. Co. Ltd

Surveying Instruments—
Peacock Bros.
W. F. Stanley.
C. L. Berger.

Switchboards—
Northern Electric Co., Ltd.

Take-ups—
Dodge Mfg. Co., Ltd.

Tanks—Cyanide, Etc.—
Mussens, Ltd.
Peacock Bros.
Fraser & Chalmers of Canada, Limited
Hendrick Mfg. Co.

Tramways—
Mussens, Ltd.

Transformers—
Northern Electric Co., Ltd.
Peacock Bros.

Transits—
C. L. Berger & Sons.
Peacock Bros.

Transmission Rope—
Dodge Mfg. Co., Ltd.

Trippers—
Dodge Mfg. Co., Ltd.

Tube Mills—
Mussens, Ltd.
Peacock Bros.
Fraser & Chalmers of Canada, Limited

Turbines—
Peacock Bros.
Fraser & Chalmers of Canada, Limited

Winding Engines—
Mussens, Ltd.
Peacock Bros.
Canadian Ingersoll-Rand Co., Ltd.

Wire Cloth—
Mussens, Ltd.
Northern Canada Supply Co.

Wire (Bare and Insulated)—
Northern Electric Co., Ltd.
Standard Underground Cable Co., of Canada, Ltd.

Zinc Dust—
Roessler & Hasslacher.

THOS. & WM. SMITH, LTD.,

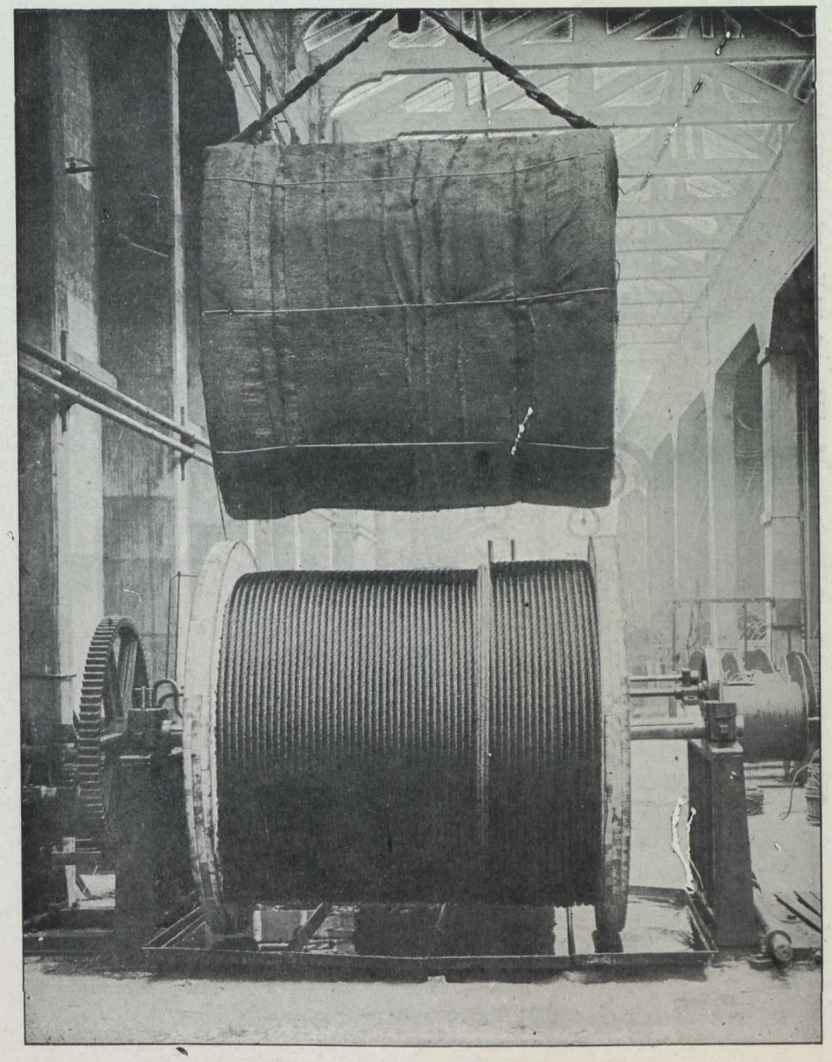
WIRE ROPE MANUFACTURERS,

NEWCASTLE-ON-TYNE, ENGLAND.

STEEL WIRE ROPES (RED THREAD BRAND.)

For MINING:—
Winding, Hauling, etc.

Also Aerial Cableways,
Cranes, Dredges, etc.

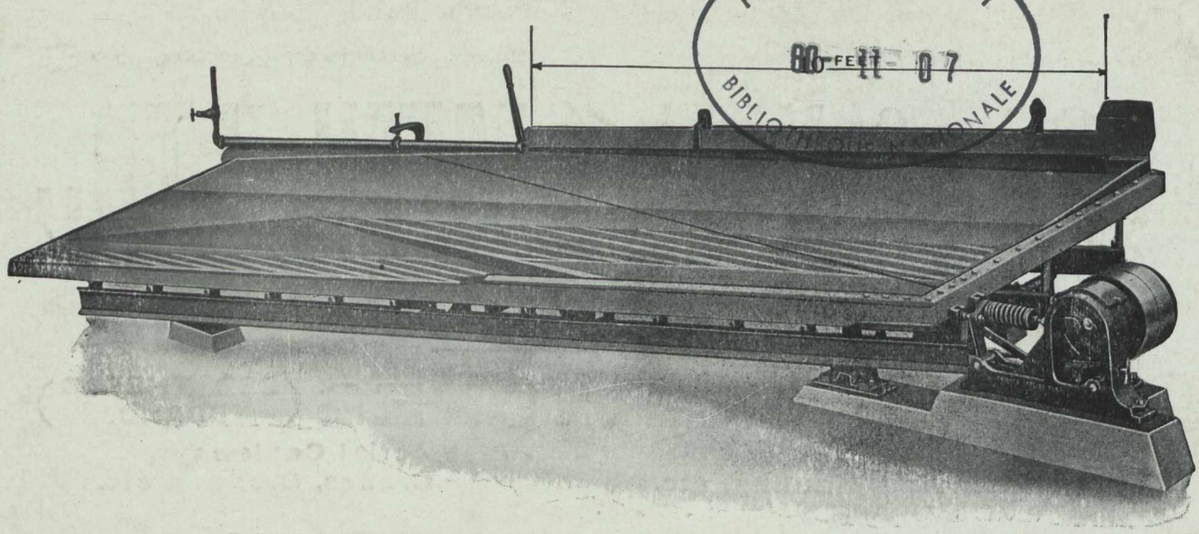


Two Reels of Wire Rope for a Colliery Company in Nova Scotia, each 10,000 feet long, 1⅛" diameter, and weighing ten tons each.

MODERN AND UP-TO-DATE APPLIANCES
for dealing rapidly and efficiently with Wire Ropes of any weight.

CANADIAN REPRESENTATIVE:
D. W. CLARK, 49 Common Street, Montreal, P.Q., CANADA.

AGENTS.
Evans, Coleman & Evans, Ltd., Vancouver B.C.
CANADIAN B. K. MORTON CO., LTD., TORONTO



The James Diagonal Plane Slimer, Patented

The James Diagonal Plane Slimer Has Proven Its Superiority Over Its Competitors In The Cobalt District. This table is manufactured in New Glasgow, Nova Scotia, for the Canadian Market, and Newark, N.J. for the United States and Mexican Markets.

The following are users of the JAMES TABLES in this district.

Nipissing Reduction Works. **Buffalo Mines.** **Temiskaming Mining Co., Ltd.**
Hudson Bay Mines, Ltd. **Trethewey Silver Cobalt Mining Co., Ltd.**
Beaver Consolidated Mines, Ltd. **The O'Brien Mines.**

James Ore Concentrator Company, 35 Runyon St. NEWARK, N.J.

CURTIS'S & HARVEY (CANADA) LIMITED
DRAGON BRAND

Best Quality Only

EXPLOSIVES

400 St. James Street
Montreal

Bank of Ottawa Bldg.
Cobalt

Also Magazines at
Timmins & Halifax