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CIRCULATION.

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CONTENTS.

GOLD DEPOSITS OF NORTHERN ONTARIO

In this issue we reprint from the transactions of the Institution of Mining and Metallurgy extracts from a paper by Mr. J. B. Tyrrell, entitled "The Occurrence of Gold in Ontario." With his paper are presented extracts from the discussion by Dr. J. M. Bell, Mr. A. G. Burrows, and Mr. S. J. Lett.

In view of the fact that Ontario has suddenly become a large producer of gold we may expect that much will be learned in the next few years concerning the nature of Ontario gold deposits. There are already in the literature many brief descriptions of deposits; but the recorded observations have, in many cases, not been satisfactory on account of the small amount of accurate information available. The development of profitable deposits which has been recently begun is being accompanied by systematic study which has not formerly been possible. In a few years it should be possible to write a reasonably thorough description of the Porcupine and Kirkland Lake deposits.

In the meantime, however, those who are interested in the development of the deposits can make good use of the information which has already been gathered by the many mining men who have visited the districts. The Ontario Bureau of Mines has published geological maps and reports which have been of much service. The work of Mr. A. G. Burrows, who has spent several seasons in the district for the Bureau, has been frequently favorably commented upon by those who have had to puzzle over the ores and rocks. Aside from the Government and mining company reports, however, there has been little of the vast amount of information gathered placed on record. Each investigator who has gone into the district with his eyes open has found many reasons for concluding that there is very little yet known concerning the deposits. Each learns a little; but hesitates to risk exposure of what he has learned.

In his paper Mr. Tyrrell has broken the ice. He has drawn some conclusions from his observations and stated them. Dr. J. M. Bell says politely that Mr. Tyrrell is wrong in asserting that the Kirkland Lake deposits are typical of Ontario gold deposits, and proceeds to prove it. Mr. Tyrrell replies that Dr. Bell is mistaken, and presents some information to substantiate his statements. Mr. Burrows gives some information from which one might conclude that his views and Mr. Tyrrell's concerning the relative age of the conglomerate and porphyry in the Kirkland Lake district are diametrically opposite.

It may seem surprising that such difference of opinion exists among those who have had frequent opportunity to study the geological characteristics of the deposits. Anyone who reads the paper and discussion must conclude that one or other is incorrect in his statements or illogical in his conclusions. Those who have made a special study of the geology of pre-Cambrian ore deposits will, however, not be as much surprised as others. It seems but another illustration of the danger of applying to a whole district conclusions drawn from the study of widely separated outcrops.

Mr. Tyrrell takes the Swastika district as a type to illustrate the occurrence of gold in Northern Ontario. To this we raise the objection that the Swastika district is not typical and that moreover there is considerable variety in the narrow limits of the Swastika district itself.

Compare the Tough-Oakes deposit with the Hollinger. Are they similar? In a few respects, yes; but in most respects, decidedly no.

At the Hollinger there is a system of large quartz veins standing nearly vertical and parallel to one another and enclosed partly in a massive rock whose chief constituents are quartz, carbonates, and sericite, and partly in greenstone containing these minerals. The veins are several feet in thickness and composed largely of white quartz with a little pyrite and small quantities of several secondary minerals. The gold is in the form of native gold. The ore is a remarkably simple, easily-treated, pyritic, gold quartz. The country rock of the main vein was probably originally a rather siliceous porphyry.

At the Tough-Oakes the ore and enclosing rock are of very different character. The vein matter exposed will average only a few inches in thickness. The enclosing rock is a conglomerate. The vein where opened up is but a few feet from the contact with a mass of feldspar-porphyry. The ore contains tellurides as well as native gold, and is frequently accompanied by a black substance which is known to be partly molybdenite. Minute crystals of pyrite are very abundant. The rock is much fractured, and there are numerous seams of distinctly secondary quartz. The conglomerate undelies the porphyry and the vein dips towards the contact.

Dr. J. M. Bell, in discussing Mr. Tyrrell's paper, suggests that the Porcupine gold deposits are more typical of others in Ontario. He goes on to say, however, that both at the Dome and Hollinger the gold occurs in the schist as well as in the quartz. There is some gold in the schist at both mines; but it has been distinctly pointed out by Mr. P. A. Robbins that most of the gold at the Hollinger occurs in the quartz and that the portions of the schist which contain much gold are characterized by quartz veinlets. Dr. Bell's statement is true enough; but it does not make clear the fact that most of the gold is in quartz.

Mr. Tyrrell and those who have discussed his paper do not give a very satisfactory account of the black substance which is so characteristic of the Tough-Oakes deposits. This is probably because of the fact that it occurs commonly as a thin film made of an aggregate of minute particles which cannot readily be separated for examination. Mr. C. A. Foster had some of this material analyzed and it was found to be partly molybdenite. Some of it contains no molybdenum. It would be interesting if those who have had analyses made would publish them. Apparently it is a mixture of minerals. In an article published in our July 15, 1913, issue we called the material graphite. Mr. Foster having found some of it to be molybdenite the interest in determining the nature of the substance seems to have dropped. It is to be hoped that some chemist will be induced to make an investigation of the substance. In the meantime we can only refer to it as molybdenite, knowing that to be one of the minerals present.

Another feature of the Kirkland Lake deposits which should prove interesting to the chemist is the presence of tellurides. A few qualitative and a very few quantitative tests have been made to determine the character of these minerals. The information so far available concerning the tellurides is anything but satisfactory.

Mr. S. J. Lett has asked whether the gold at the Tough-Oakes is commonly associated with secondary quartz, calcite and sericite. The answer is yes, so far as visible gold is concerned. The Tough-Oakes deposit shows much more evidence of secondary changes in the vein matter than do the Porcupine deposits. In places coarse gold is abundant on the fractured surfaces.

Mr. Lett asks what the sericite was derived from if the feldspars are soda-lime feldspars. The answer is that there is potash in the rocks and that sericite can be, and often is, formed in other ways than by the simple decomposition of feldspars. Moreover, it is a distinct characteristic of most Northern Ontario gold deposits that the gold quartz is enclosed by altered rock of which quartz, carbonates, and sericite are common constituents. This is the case whether the enclosed rock is siliceous or basic, igneous or sedimentary. The significance of this feature has already been pointed out in a paper on the origin of the Porcupine gold deposits.

Mr. Lett quotes Dr. Baelz as stating that the gold-bearing magma is directly connected with great granite intrusions. That is a remarkable discovery, but without any argument on which to base the statement, the conclusion doesn't seem to have any great value. What information did Dr. Baelz hope to convey by such a statement?

Mr. Tyrrell, in replying to Dr. Bell, states that the Kirkland Lake and Porcupine deposits are to be regarded as similar because they are "associated with porphyries rich in soda-lime feldspar." But is that conclusion justified by the facts, and is it an important characteristic even if true? Most porphyries are rich in soda-lime feldspars, and it is not remarkable that many of those associated with the gold deposits should be. Many of them are. Some, including those at the Tough-Oakes and Teck-Hughes, are rich in alkali feldspars. Possibly a continuation of the study which Mr. Tyrrell has undertaken will show that a narrower limit may be set on the variety of rocks which are to be considered as favorable formations for gold in Ontario. At present there is no very good reason for discriminating between the porphyries in conducting explorations. Gray feldspar porphyries of several varieties are common in the gold fields. Any of them, and the rocks around them, are worthy of close examination for gold quartz veins.

Mr. Burrows seems to be of the opinion that the porphyries are intrusive into the conglomerate. Mr. Tyrrell's description leaves the impression that he thinks the porphyries older. It would be well if a more definite statement were made as to the particular rocks being described and as to the evidence from which conclusions as to relative age were derived.

THE CLASSIFICATION OF IGNEOUS ROCKS

The publication of the very interesting volume on The Igneous Rocks, by Dr. R. A. Daly, brings up again the question of classification. For a number of years the readers of American descriptions of rocks, especially descriptions written by members of the U. S. Geological Survey, have been annoyed by the persistent use of a classification based on chemical analyses rather than on the more easily determined characteristics of rocks.

In the American quantitative classification, as it is called, the most easily determined features are made subordinate to chemical analyses and certain assumptions deduced from the chemical analyses. A great list of new names was invented and students in the colleges were required to learn the new system.

For some time evidently it has been considered quite the proper thing to avoid the use of the time-honored classification based on mineral composition. Even some of our Canadian geologists seem to consider their descriptions of rocks incomplete without the use of a few of the new terms, a table of chemical analyses of some other rocks, and a few mathematical calculations based upon more or less unfounded assumptions.

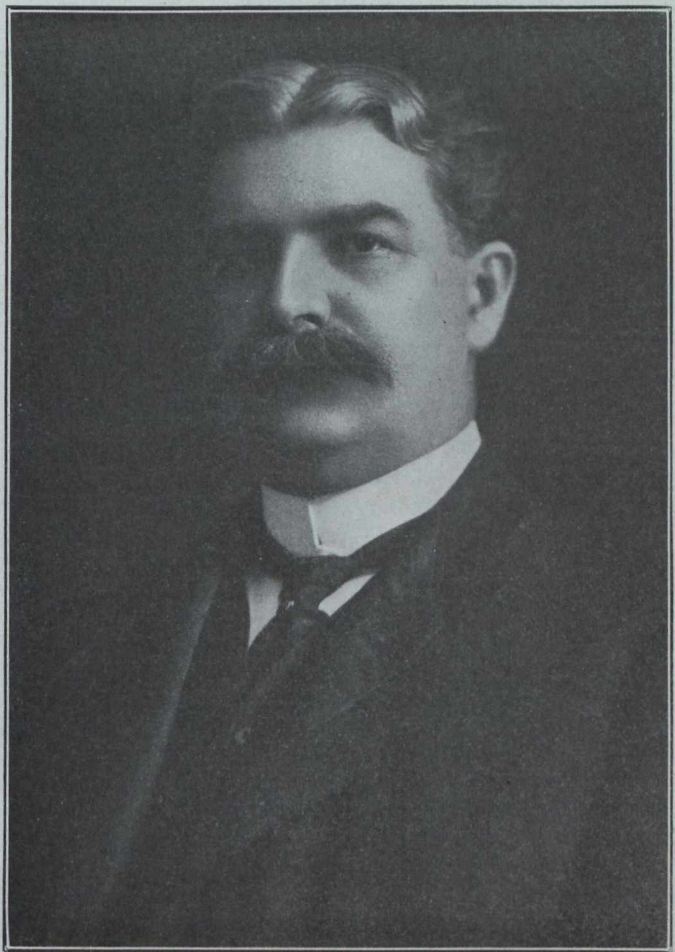
It is very refreshing to find, therefore, that Dr. Daly makes a stand in favor of the simpler classification and shows a fondness for such old terms as granite, diorite and gabbro, and a lack of enthusiasm over norms and rangs.

CANADIAN MINING INSTITUTE

The new officers are planning a campaign to increase the membership of the Canadian Mining Institute. As pointed out by President Lindsey, a larger membership would make it possible to publish a bulletin at regular intervals, possibly monthly, instead of a few times a year, as at present. The regular publication would give those who find it impossible to attend the meetings of the Institute a more substantial return for their fees and keep them better posted as to what the Institute is accomplishing. It is, therefore, in the interest of every member that the membership should be larger.

THE LATE MINISTER OF COLONIZATION AND MINES OF THE PROVINCE OF QUEBEC.

On the first of March, the Honourable Charles Ramsay Devlin passed away at his father's residence, in Aylmer East, P.Q., at the age of 55. He succumbed after a long, strenuous fight of eighteen months against a well-nigh inexorable malady, Bright's disease. That the fight was courageous, and that the spirit never flinched, will be



The late C. R. DEVLIN

realized by the members of the International Geological Congress who were present at the banquet in the Armouries of Toronto on August 13th, 1913. At the time that he made his address, answering on behalf of the Province of Quebec, to the toast of "The Dominion and the Provinces," Mr. Devlin was practically a doomed man, and he knew it. Yet there was no inkling of this in his brilliant allocation, given in a perfect, faultless French, eloquently delivered, with the slight suspicion of foreign accent, which gave to his speech an added charm. His attendance at this banquet, to which he had come against his doctor's orders, was his last appearance at a public function.

Charles Ramsay Devlin was born in Aylmer in 1858. After sound classical studies at the Ottawa College and at Laval University of Quebec, he first entered business, which he soon forsook to take up journalism and politics. He was eminently fitted for this. His education, his surroundings, had given him an additional French individuality, and he was equally liked by Irish, French and English-Canadians. From the start he won brilliant successes in his newly chosen field. His command of language, his warm, eloquent delivery, and his personality made Devlin one of the most popular speakers of the Liberal party. In 1891, he was elected to the House of Commons, as member for Wright County, which seat he retained until 1897, when he was appointed Canadian representative in Ireland. He resigned this position in 1903 to contest the County of Galway for the British House of Commons. He represented this constituency until 1906, when he returned to Canada, and, soon afterwards, in 1907, was called to the Gouin Cabinet, as Minister of Colonization, Mines and Fisheries, which portfolio he retained until his death.

His demise leaves a great void in the Provincial Cabinet. He had proved himself a good administrator. The remodelling of the Quebec Mining Laws has been one of his chief works, he always took a keen interest in the mining industry and its development. He was a good friend of the Canadian Mining Institute.

His personality was of the most lovable and estimable nature. Warm-hearted, of strong convictions, of an integrity and honesty of purpose above the shadow of suspicion, Charles Devlin had adversaries, as all strong characters must have, but it may truly be said that he had no enemies.

THE COBALT COMBINE.

London, March 11.—Official details of the proposed amalgamation of four of the Cobalt mining companies, regarding which we were able to give some advance information in yesterday's issue, are now published and will doubtless be studied with interest by the British shareholders concerned. The scheme is a complicated one. The mining properties are held by Canadian companies, in three of which English companies with similar titles hold a controlling interest. These three are the Cobalt Townsite, the Cobalt Lake, and the Townsite Extension. The fourth property included in the deal is the City of Cobalt Mining Company, a Canadian concern, the controlling interest in which is held by the Cossack Exploration Company, another Canadian enterprise. A new Canadian company is to be formed with a capital of $2,075,000 in shares of $1 each to purchase the mining properties from the companies in which they are now vested, and a new English company—which will control the Canadian amalgamated company—is to be incorporated with a capital of approximately £1,600,000 in £1 shares. The Cobalt Townsite and Cobalt Lake (English companies) will receive respectively 600,000 and 509,580 shares in the new English company, 60,000 will go to the Canadian Extension Company and 359,538 will be allotted to the Cossack Company. The valuations adopted as a basis of the scheme are set out in the circular as follows:—

Cobalt Lake	£600,000
Cobalt Townsite	600,000
City of Cobalt	400,000
Townsite Extension Property	60,000

It is not clear why the Cobalt Lake should be valued on the same basis as the Cobalt Townsite, nor why the City of Cobalt should be considered worth two-thirds the valuation of those two undertakings. Evidently the market valuations have not been taken into account, for at current prices that of the Cobalt Lake works out at approximately £446,000 and that of the Townsite at £537,000. The last price we heard of for City of Cobalt shares was 32½ cents, which would make the market capitalization of this concern just about £136,000. Apparently this divergence accounts for the criticism of the scheme we have already heard, to the effect that the terms favor the holders of City of Cobalt and Lake shares, as against those interested in the Townsite, although the last-named concern will evidently be expected to provide the largest proportion of the amalgamated concern's earnings, at any rate so far as the early future is concerned. On the face of it the scheme looks rather like an attempt to work off the City of Cobalt, for which a market has not yet been found in London; anyway, the proposals need careful consideration, and it would, we think, have been better if more time had been given for the purpose than is indicated by the calling of the Townsite meeting for the 18th instant.—Financial Times.

HOLLINGER.

The statement of the Hollinger Mines for the second four-week period of 1914 shows gross profits amounting to $111,679.60, with current assets of $358,980.42, and estimated gold reserves of $228,757.38. The surplus at February 25 stood at $721,805.68, a net increase of $33,342.88 since the beginning of the year. Capital expenditures during the period amounted to $13,317.12, less $2,777.70 received for dwellings sold to employes.

Working costs were unusually high during the period, as, according to the assistant manager's report, an accident to the plant of the power company supplying the mine reduced the running time 25 per cent. in the mill, and 15 per cent. in the mine. The costs totalled $5,518 per ton of ore milled, including $2,373 for mining, and $1,513 for milling. A total of 9,681 tons of ore was hoisted, of an average value of $17.50 a ton, and 1,672 tons were hoisted of waste rock. In the mill, which ran 72 per cent. of the possible running time, 10,042 tons were treated, including 239 tons on account of the Acme Gold Mines. Approximate extraction was 97.4 per cent.

During the period No. 8 vein was cut by a crosscut on the 300-foot level, and No. 4 vein was located by diamond drill on the 425-foot level. The main shaft was sunk to 425 feet, and equipment commenced. Development work amounted to 635 feet, and diamond drill exploration to 522 feet.

JUPITER.

Toronto, March 24.—A special meeting of the Jupiter shareholders has been called for Wednesday, April 8, in Montreal, to confirm the deal with the McKinley-Darragh Mines for the financing of the Jupiter. An official circular giving the details of the deal differs in some respects from previous summaries:

The deal as officially explained will be as follows:

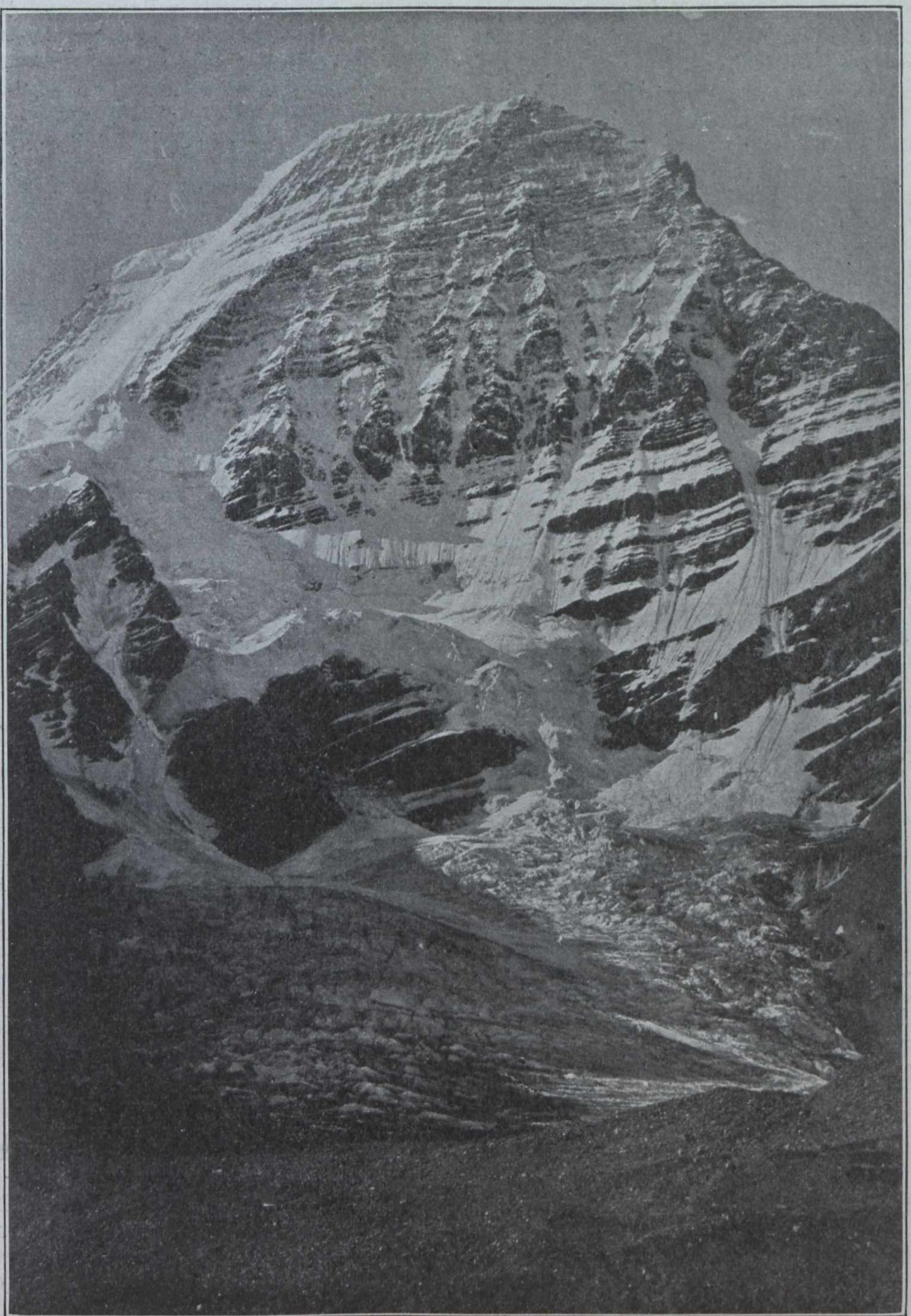
A six months' option to buy a half interest in the Jupiter, in exchange for which the McKinley-Darragh agrees to spend $30,000 in developing the Jupiter during that period. If the McKinley-Darragh exercises its option, it agrees in addition to pay off the bonded debt of the Jupiter, $50,000, and to pay into a new company to be formed to take over the Jupiter a further sum of $40,000 for further development. The McKinley-Darragh will also supply further funds should they be deemed necessary.

Subsequently a $2,500,000 corporation is to be formed, to which the Jupiter mine is to be conveyed. Of the issued shares of the new company, the McKinley is to receive an amount equal to 50 per cent. of the outstanding shares of the Jupiter, and a similar amount is to go to Jupiter mines shareholders. The remaining shares will be left in the treasury of the new company. It will thus be seen that one of the features of the deal is that the new company's capitalization will be $2,500,000, an increase of $500,000 over Jupiter's present capitalization.

RAILWAYS AND MINERAL PRODUCTION*

By E. Jacobs.

At a meeting of the Western Branch of the Canadian Mining Institute, Mr. Alexander Sharp (in by-gone years a coal mine superintendent on Vancouver Island, but for several recent years mining engineer to Mr. P. Burns, who has extensive mining interests), directed attention to the very striking effect the construction of railways in Canada has had upon the mineral production of the Dominion. Going back to the days of construction of the Canadian Pacific Transcontinental Railway, he quoted from Dominion official statistics the value of the mineral production for the calendar year 1886, namely, $10,221,235, and with that relatively small amount he compared the total for 1912—$135,048,296.



Mount Robson, the monarch of the Canadian Rockies. On the line of the Grand Trunk Pacific.

The total value of the mineral production of Canada for the period of twenty-seven years, 1886-1912, is on official record as having been $1,371,502,110; official fig-

*Written for the Daily Colonist.

ures for 1913 are not yet available, but estimating last year's production at only $140,000,000—a very low estimate, I believe—this will give a total for all years appearing in the official statistical tables of approximately $1,511,502,000.

At Mr. Sharp's suggestion I gave the meeting above mentioned some comparative figures showing the large increase in British Columbia's mineral production since its present producing districts were made accessible by the construction of railways. For all years up to 1893, inclusive, the total value on record was $84,678,482; for ten years, 1894-1903, it was $122,546,010; for ten years, 1904-1913 (allowing $30,000,000 as the value of last year's production it was $252,913,030.

Incidentally it may be mentioned that the total value of the production of Rossland mines in 1894 was $75,510; during twenty years to the end of 1913 the grand total has attained to between $55,000,000 and $60,000,000. Figures printed by the Consolidated Mining and Smelting Company, Ltd., in its last annual report—to September 30, 1913—show the gross value of ore produced from the Centre Star group of mines, at Rossland, as $26,489,615, and from the Le Roi, $22,462,640, together $48,952255; figures of value for East Kootenay mines are: St. Eugene, $10,626,608, and Sullivan group, $4,364,805.

Last month is was announced in the press that the output of ore from the Granby Company's mines at Phoenix had just passed the 10,000,000 ton mark; that quantity represents a gross value that may be approximated at $40,000,000 and still leave a margin not included. Then there are the big mines of the British Columbia Copper Co. and the New Dominion Copper Co., the value of the output of which, added to that of the Granby Co., and others, brings the total for Boundary district up to about $60,000,000. And practically none of this vast natural wealth was available for utilization until after the completion of the Columbia & Western Railway in 1900, although the ore deposits had been prospected, more or less, for ten years previously.

The coal mines of the Crowsnest country, South-east Kootenay, might also be cited, but for still more striking evidence of the great transformation made in the utilization of natural resources let us look at Ontario, which has of late years wrested from British Columbia its previously enjoyed pride of place as the "Mineral Province of Canada." In 1904, the year Cobalt mines commenced to produce silver, which metal was discovered there as a result of making a rock-cut in the course of construction of the Government-owned T. & N. O. Ry., the value of the silver output was $118,376; in 1912, official figures show it to have been $17,772,352, while the quantity of silver produced in 1913 was larger than in 1912. Again, take Ontario's gold output. In 1911, it was $42,625; in 1912, after the T. &. N. O. Railway had been extended to the Porcupine district, it was $1,788,596; for 1913, the estimate of the Deputy Minister of Mines for Ontario is $4,300,000, practically all from the country opened by the T. & N. O. Railway, Ontario's total mineral production in 1904, the year production was commenced at Cobalt, was valued at $12,582,843; for 1912, it was $51,985,876; for 1913, an estimate of $55,000,000 does not seem too high—a fourfold increase in less than ten years, due largely, if not altogether, to railway construction.

The late Dr. George M. Dawson, then assistant director of the Geological Survey of Canada, more than twenty years ago read before the Royal Colonial Institute a paper on "The Mineral Wealth of British Columbia," in the course of which he observed: "I wish to draw attention to one or two ruling features of the actual situation which are too important to be left without mention: The Cordilleran belt, or Rocky Mountain region, of North America, has, whenever it has been adequately examined, proved to be rich in the precious metals as well as in other ores. This has been the case in Mexico and in the Western States of the American Union. . . . . Placer gold mining has often been continued for years and then abandoned, long before the gold and silver-bearing veins in the same tract of country have been discovered and developed. This later and more permanent phase of mining has followed the construction of roads and railways, and the series of conditions thus outlined are repeating themselves in British Columbia to-day. The Province includes a length of more than 700 miles of the Cordilleran region."

Earlier in his paper, Dr. Dawson had remarked: "Although British Columbia possesses valuable fisheries and remarkable resources in its forests, besides important tracts of arable and pasture land, much of its prosperity must depend on the development of its mineral wealth, which is the compensation afforded by Nature for the generally rugged character of a large part of its surface."

Just a few more figures in conclusion. Eleven years ago, Mr. Bernard MacDonald, widely known as a leading mining engineer, read before the Canadian Mining Institute a paper entitled, "Mining Possibilities of the Canadian Rockies." In that he showed that in Mexico the Rocky Mountains had yielded of the precious metals alone a production of $5,500,000,000 over a length of 1,700 miles, or an average of $3,235,300 a mile; in the United States, $4,500,000,000, or $3,460,000 per mile along a length of 1,300 miles, while in Canada the total had reached only $166,000,000," of course with a correspondingly small amount per mile. Later, Mr. MacDonald added: "It is fair to assume that the Rockies in Canada will yield a quantity of the precious metals equal to that produced by them in American or Mexican territory—mile for mile of their length—when equally developed." Corresponding figures brought up to date would, of course, be much more impressive, but let us take the United States amount per mile as it stood in 1902 and apply it to British Columbia's 800 miles of the Cordilleras—$3,460,000 per mile for 800 miles would equal $2,768,000,000. Why, only one-tenth of the production up to 1902 (which leaves out of account the very large total for the eleven years that have since elapsed) would be $276,800,000, or considerably more than one-half of the total value of the mineral production of British Columbia in all years since Hudson Bay men commenced to mine coal more than sixty years ago. And then there is the big country north and north-east of British Columbia to keep in mind as well. But all this potential wealth will lie dormant until it shall be made accessible by the construction of railways.

ALASKA-YUKON RAILWAY.

"I believe the time has now come for the building of a railroad through Northern British Columbia to the Yukon and Alaska, and I may say that the authorities at Washington and Ottawa have both gone so far as to heartily endorse some project of co-operation in the building of this line."

In these words, according to the Daily Colonist, Sir Richard McBride, at a session of the Legislature discussed the possibilities of the early evolution of a scheme which he is known to have had closely at heart for many months and opened up a vista of possibilities for the extension of the railroad policy of the Province that is bound to excite a widespread interest on this continent and in Europe.

THE ELECTRICAL DRIVING OF WINDING ENGINES AND ROLLING MILLS*

By C. Antony Ablett, A.M.Inst.C.E., and H.M. Lyons, A.M.I.E.E .

The use of electrical machinery for driving hoisting engines in mines and reversing rolling mill plants in steel works is comparatively recent, the first winders of importance having been introduced in 1902, and the first electrically driven reversing rolling mill being installed in 1906, though non-reversing rolling mills were driven electrically some eight or ten years earlier.

The developments along these lines have been extremely rapid, as is shown by the fact that at the present time about one thousand large winding engines and nearly sixty reversing rolling mills are being driven electrically, and still greater developments may be expected in the future.

Under these circumstances a paper dealing with the modern aspects of the subject and giving the results of the experience obtained in the past would appear desirable.

The earlier winding engines were extravagant in power and had the disadvantage of drawing very heavily upon the source of electrical supply at the moment of starting. It was, therefore, impossible to use them on systems where the supply of current was limited, and even on comparatively large plants their use resulted in serious interference with other machinery. These disadvantages were, however, practically done away with

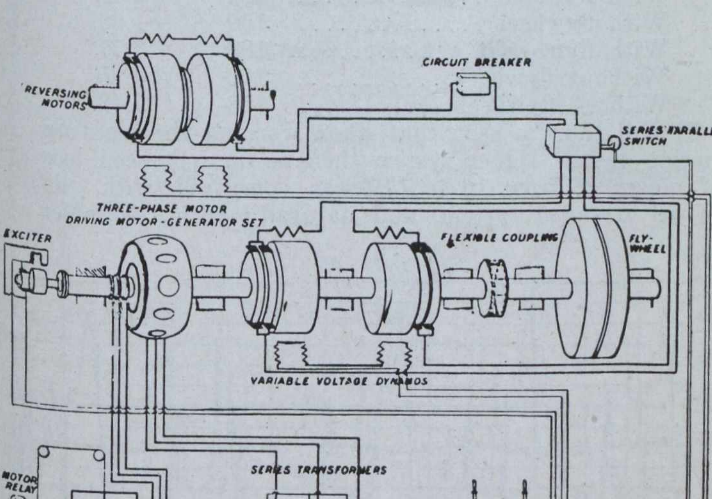


Fig. 1.—Diagrammatic view of Ilgner system of driving winding engines or reversing rolling mills.

when the Ward Leonard system and Ilgner's adoption of the flywheel to this system were introduced, but the last few years have seen greater improvements in the Ward Leonard and the Ilgner system.

The present paper will deal chiefly with the developments of these systems by the various Siemens Companies, who have installed about half the total plants in existence, and with whom the authors have the honor to be associated.

Ward Leonard System.

A short description of the so-called Ward Leonard System, illustrated in Fig. 1, is desirable as an introduction.

In this system a direct current motor is used to drive the winding engine or rolling mill, the motor being supplied with power from a direct current dynamo, and the essential feature of this system is that the voltage supplied to the motor, and consequently the speed of the motor, is controlled by controlling the field current of the generator, instead of by varying the resistance in the armature circuit of the motor.

Thus, as the field current of the generator is increased from nothing to a maximum, the motor speeds up from standstill to full speed, and if the field current of the generator is reversed, the motor reverses its direction of rotation.

This system enables a very exact control of the speed to be obtained, because the speed of the motor is practically proportional to the strength of the generator field, whatever the load on the motor may be, while with any control system where resistances are inserted into the armature circuit of the motor, the speed would vary within very wide limits with a change of load, rendering the exact speed control quite impossible.

The control of the dynamo field involves scarcely any waste of electrical power, but where resistances are inserted into the armature circuit the loss of power may be, and usually is, very great.

The field currents of the generator are small, so that the control mechanism is small, compact and very easy to handle, the armature currents are perhaps fifty times as great, so that any control mechanism which varies the resistance of the armature circuits is large, clumsy and difficult to handle, in fact a complicated relay system is often necessary to enable it to be handled at all.

The dynamo used to supply the motor in the Ward Leonard system is usually driven by a motor supplied from the available power circuit, forming a motor generator set, and this motor may be either direct current or three-phase, according to the power available. The dynamo may be and sometimes is driven by an engine, water turbine or other prime mover, if this happens to be more convenient.

Application of Ward Leonard System to Winding Engines and Hoists.

Speed Control.—The main control lever for operating the winding engine is coupled to the regulating resistance in the field circuit of the generator, so that when this lever is in the mid position there is no current in the generator field. As the lever is moved in one direction the generator field current increases, and as it is moved in the other direction, the generator field current is also increased, but in opposite sense.

From what has been said in the introductory remarks it will be seen that when the lever is in the mid position, the winding engine is at a standstill, and that it starts and speeds up as the lever is moved from the mid position in one direction, while if the lever is moved from the mid position the other way the winding engine

*Authors' abstract of a paper read at a mining section meeting of the Canadian Society of Civil Engineers, March 12, 1914, and at the annual meeting of the Canadian Mining Institute, March 4-6, 1914.

increases in speed in the other direction, and that the speed of the winding engine is practically proportional to the displacement of the lever from the mid position, and is not affected by the weight of material being hoisted.

The driver has not absolute control over the speed, for two cams are provided on the depth indicator, one for each cage, which operates levers coupled to the control lever in such a way as to prevent the cages being accelerated at too rapid a rate, and to slow up the winding engine at the proper point so that the bank is approached at a crawling speed.

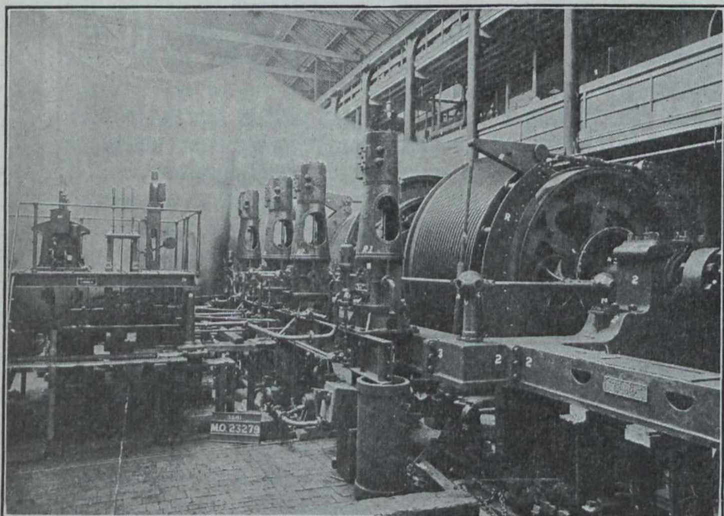


Fig. 5.—Conical Drum Ward Leonard winder, at the Canadian Collieries Company's Cumberland Colliery, showing brake gear and control levers. Depth, 1,000 ft.; nett load per wind, 3½ tons.

Provided that these limits set by the cams are not exceeded the speed of the wind is entirely within the driver's control.

The depth indicator and the cams are positively driven from the drum of the winding engine and the cams are so geared that they make less than one revolution per wind.

Use of Flywheel.—Fig. 6 shows the typical horse power diagram for a winding engine. The inertia of the drums, cages, head sheaves, material wound and the ropes, which altogether weigh about 60 tons in this particular case, necessitates a horse power at the end of the acceleration period of each wind of 1865, which is about three and a half times the average power demand of the winding engine, in this case 524 horse power, and it is found that the maximum acceleration peak is usually between three and four times greater than the average demand.

The consumption of energy for this Ward Leonard control rises gradually during the starting period, and the maximum is only reached at the end of the time of acceleration, i. e. from ten to fifteen seconds after the start, because the speed of the winding motor is increased while it is giving the requisite turning moment by increasing the field of the generator, and consequently there is no loss of power in starting.

Since this acceleration peak is of short duration and only comes on gradually, it is possible to supply Ward Leonard winders from power stations of comparatively small total output, provided that the machines in the power station have a sufficient overload capacity to maintain their speed during peak loads, as is usually the case with steam turbo generators where the generators are provided with modern voltage regulators.

Where, however, this is not the case, and the acceleration peaks of the winding engine are large compared with the average demand on the power station, or where the winder is supplied through a long transmission line from a distant power station, it is sometimes necessary to couple a flywheel to the motor generator set.

This is the Ilgner system, so-called after the engineer who first used it in practice.

Fig. 7. illustrates the effect of the flywheel in equalizing the load taken by the winder, where it will be seen that the current taken by the winding motor varies between + 1900, and — 1000 amperes, while the current taken from the supply system is maintained practically constant at 400 amperes, the maximum voltage supplied to the winding engine and the supply voltage being the same.

The following example will give an idea of the power taken by the Ilgner system under practical working conditions with a winding engine arranged to wind 240 tons per hour from a depth of 1,960 feet, making as a maximum 44½ winds per hour, where the flywheel is used whenever the full output is being wound at the full speed but where a lesser output is being wound at reduced speed, so that the acceleration peaks become less serious, the flywheel is uncoupled to save power.

These results are conveniently expressed in terms of the kilowatts taken by the electric winding engine plant per shaft horse power.

	Output in tons per hour.	Kilowatt per Shaft horse power.
With flywheel	240	1.49
With flywheel	160	1.60
With flywheel	108	1.77
Without flywheel	160	1.35
Without flywheel	108	1.48

It will thus be seen that when working the winding engine on the Ilgner system there is an increased loss of power of from 16 to 17%, as compared with the Ward Leonard system, and naturally with the latter where the flywheel is uncoupled the resistances are cut out of the rotor circuit of the three-phase motor to avoid loss of power.

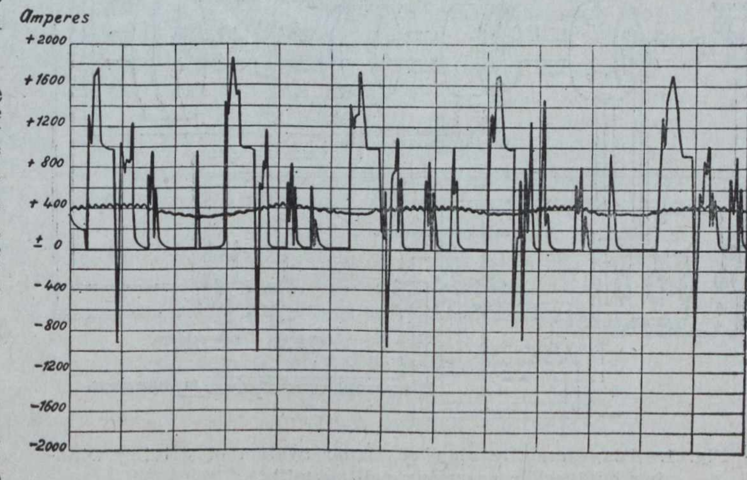


Fig. 7.—Diagram showing the equalizing effect of the flywheel on Ilgner's adaption of the Ward Leonard system. The wavey line at about 400 amperes is the current taken from the supply system. The curve which shows the great variations represents the current taken by the winding engine.

To avoid misunderstanding of the above results, it should be specially pointed out that shaft horse power is taken to mean the actual work done in raising the load, i.e., if the actual weight of coal or ore, expressed in lbs., which is raised per minute is multiplied by the depth of the shaft in feet, and divided by 33,000, the shaft horse power is obtained. The shaft horse power thus does not include the mechanical friction of the winding engine, the sheaves, the guides or the rope losses, and the figure of the kilowatts divided by the shaft horse power brings in the mechanical efficiency, as well as the electrical.

Details of Ilgner System.—Of recent years the capital cost of Ilgner plants has been greatly reduced, owing to the adoption of higher speed for the motor generator sets and to the improvements in the manufacture of such flywheels, which enable them to run at very high peripheral speeds compared with those used in the earlier winding engines.

For example, the provision of flywheel capacity to equalize peak loads of 60,000 horse power seconds, in the early days of Ilgner winding, where peripheral speeds of 15,000 feet per minute were used, would require two flywheels of a total weight of about 80 tons, the friction and windage loss of which would be abou' 150 horse power. Under modern conditions where the regular peripheral speeds are 27,000 and 30,000 feet per minute a single flywheel of 22 tons weight would be used, instead of the two flywheels having a total weight of 80 tons, and the friction and windage losses would not exceed 100 horse power.

The Ilgner system was used on practically all the early European winding engines, but as at the present

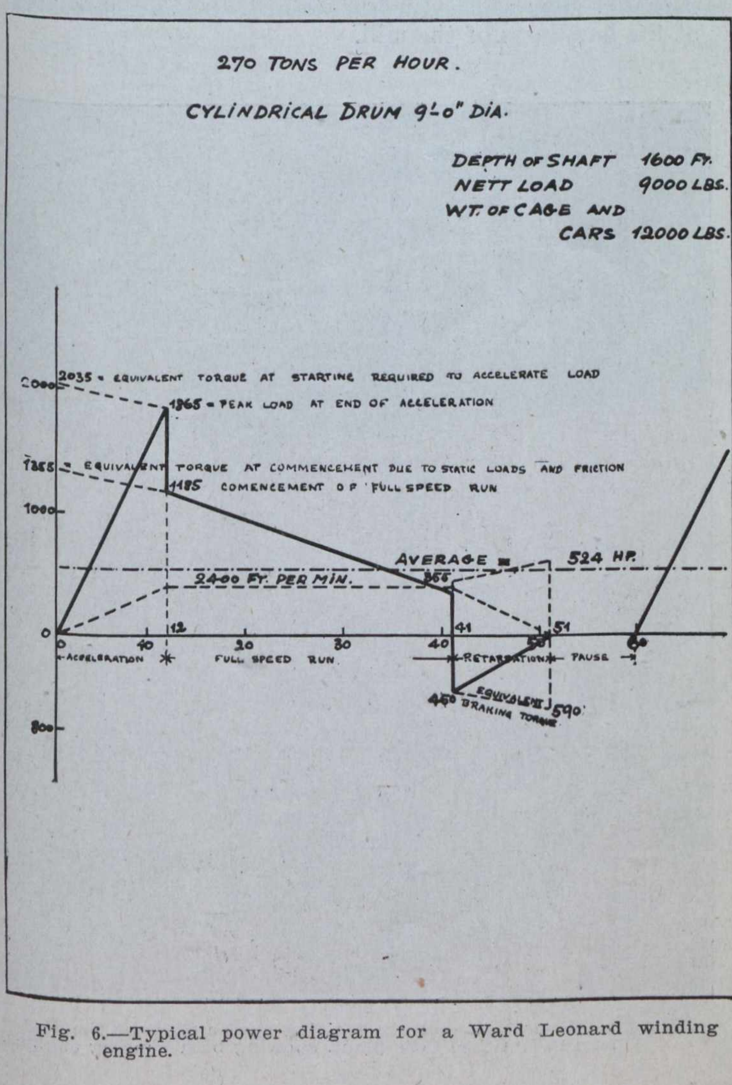


Fig. 6.—Typical power diagram for a Ward Leonard winding engine.

day power stations are being installed of much greater capacity than those of a few years ago, and high speed

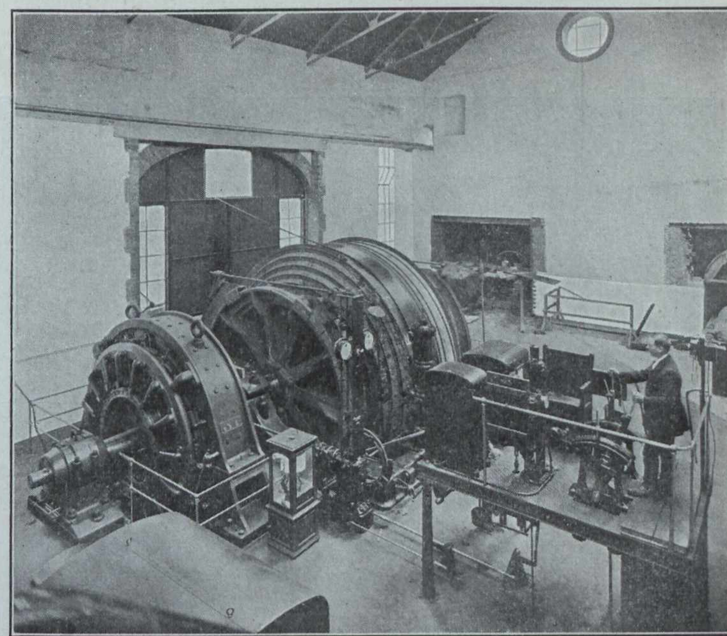


Fig. 9.—Scroll Drum Ilgner winder at Markham Steam Coal Co.'s Holly Bush Colliery, showing control gear, brake gear, depth indicator, and cams.

turbo generators of large overload capacity are being adopted, the Ward Leonard system at the present time is being used to a much greater extent than the Ilgner system for winding engine work.

Generally speaking, the Ilgner system of winding may be preferable to the Ward Leonard system in the following cases:

(1) When the time occupied by the wind is short.
(2) For vertical shafts.
(3) For large outputs.
(4) Where the winding speed is very high.

The above conclusions may be considerably modified by the nature of the electrical supply. Where the power station is small or the winder is supplied through a transmission line of considerable length, the Ilgner system will be more suitable, but where the power station is large and near the winder, the Ward Leonard system is the better.

Brake Gear.—The mechanical brake is so arranged that when it is required to bring it into action it is actuated by a weight at the end of a lever, but it is normally held off the drum by an air cylinder.

Under normal conditions the cams on the depth indicator actuate the control lever, so that the cages approach the bank at a very slow speed. When they reach the bank the driver brings them to rest by means of his control lever, and then puts on the mechanical brake to hold the cages in position by means of the brake lever. The brake lever is interlocked with the control lever, so that the driver cannot put on the brake by means of the brake lever until the control lever is at about its middle position, i.e., unless the cages are moving at a comparatively slow speed.

To enable the driver to stop the winder in case of any emergency arising, a third lever, the emergency lever, is placed on the driver's platform, and if this is operated it puts on the mechanical brake through the emergency gear and at the same time cuts off the excitation from the dynamo of the motor generator set.

Safety Devices.—As mentioned above, cams are provided on the depth indicator which keep the acceleration within safe limits, and the cage is brought gradually to a slow speed by the time it reaches the bank. An overwind device is provided, usually both on the depth indicator and in the shaft, which puts on the mechanical brake through the emergency gear and cuts off the excitation should the cage overwind the bank, thereby bringing the winding engine instantly to a stop. Should the air pressure or the excitation fail, the mechanical brake is put on by means of the emergency gear.

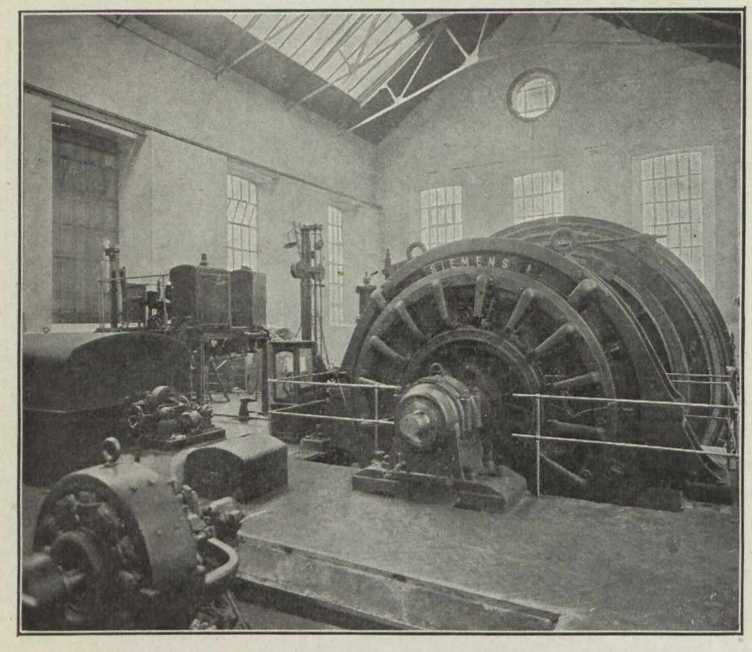


Fig. 10.—Direct current winding motor at the Markham Steam Coal Co. Depth of wind, 1,800 ft. Nett load per wind, 3½ tons. Maximum winding speed, 2,900 ft. per minute. Motor, 1,400 horse-power, at 51 r.p.m.

When men are being hoisted the throw of the main control lever is limited by means of a switch on the bank, so that the winding engine cannot be run above a certain speed.

Where electrical driving is adopted it is very easy to provide safety devices, and all those mentioned are designed to protect the plant against careless handling, but if the majority of safety devices were dispensed with, the Ilgner and the Ward Leonard winder would still be better protected against careless handling than the steam winder. The fact that it is impossible for an Ilgner or a Ward Leonard winder to race or run away makes it inherently safer than the steam winder.

Application of Ward Leonard System to Reversing and Three High Rolling Mills.

Nearly 60 large reversing mills are being driven electrically in different parts of the world and a modification of the Ward Leonard system has been installed in almost every case to meet these special requirements.

The power requirements of a reversing rolling mill impose much more severe conditions on the electrical plant than those of a large electrically driven hoist. With a large 36-in. or 45-in. blooming mill, ten to twelve passes are often made in a minute, and the power during individual passes may rise to 12,000 h. p. or more, while the total time of the passes, i.e., the total time that the ingot is between the rolls, is very short compared with total time taken to roll an ingot down to a bloom or billet. It is thus easily seen that the average power required from the power station is very much less than the maximum power which the mill motor has to give.

For example, in many electrically driven blooming mills, the average power is only one-sixth or one-seventh of the maximum power.

In the case of an electrically driven hoist, the duration of a wind would be perhaps one minute, followed by a pause of 20 seconds or so, and the maximum power required seldom exceeds 3,000 to 4,000 horse power, so that the average power is of the order of one-third of the maximum power. While, as has already been pointed out, it is frequently necessary to employ flywheels with winding engines it is always necessary to couple a flywheel to the motor generator set which supplies a reversing rolling mill motor.

A reversing rolling mill motor, on account of the rapidity with which it has to reverse, must be so designed that its moment of inertia is kept down to a minimum, and special precautions must be taken to see that the field of the generator supplying this reversing motor should build up as rapidly as possible. This has been accomplished so successfully that it has been found possible to reverse a large reversing mill motor having rotating parts weighing over 70 tons, 30 or 40 times per minute between a speed of 60 revolutions in one direction and 60 revolutions in the other, when no steel is being rolled. Such tests naturally cannot be made while steel is being rolled, because it would be quite impossible with the present type of live roller tables to return the ingots to the mill quickly enough, but such tests are useful in showing the very high rate of acceleration of the mill motor which can be obtained, and as a measure of the handiness of the mill.

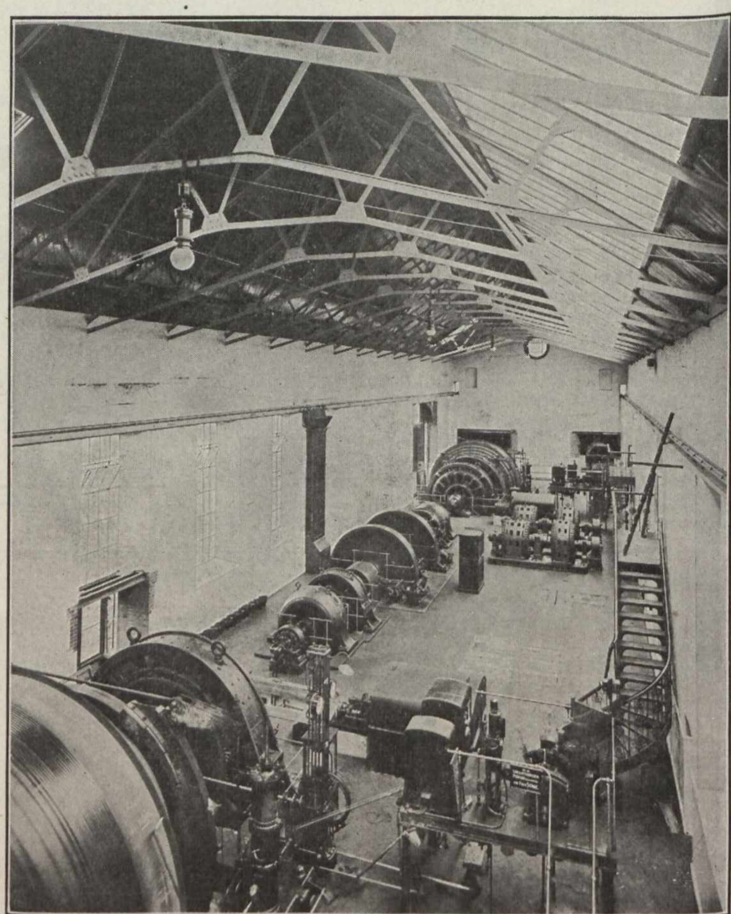


Fig. 13.—General view of the winding engine plant at the Markham Steam Coal Co.'s plant, showing both winding engines.

Power Diagram for Reversing Blooming Mill.—Under ordinary conditions the power diagrams for each wind of a hoist are identical and can be calculated with considerable exactitude from the conditions of working, but with a rolling mill the power diagrams for each pass vary very greatly from one another, and cannot be calculated with any accuracy, for the following reasons:

During the earlier passes heavy drafts are taken, but the ingot is quite short, consequently large powers are required for very short times; but as the ingot is gradually rolled out to a bloom of considerable length and reduced in section the drafts are diminished, as the reduction in area must be kept moderate, otherwise the bloom is damaged by the formation of surface cracks, etc., so that during the last passes the necessary power is not very great, but it is required for a considerable time.

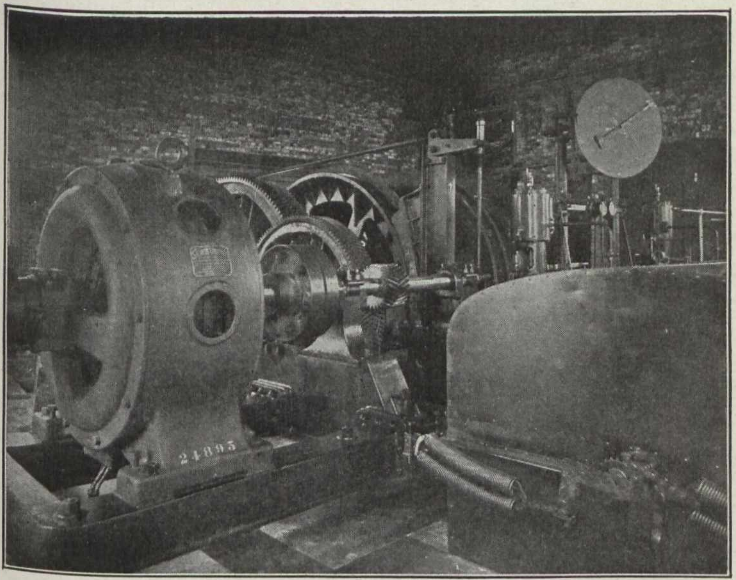


Fig. 23.—Cylindrical drum three-phase winder at the Acadia Coal Co., Stellarton, N.S., showing motor and double reduction gearing. Total length of slope, 4,921 ft. Nett load per wind, 11 tons.

During the first two or three passes the ingot still has its tapered shape and the metal is very spongy in character, so that the powers required are not very heavy and are very irregular. By the time that the last passes are taken the bloom has cooled down considerably, and while this cooling increases the specific power required, such drafts are taken that the power required for these passes remains much less than that for the first passes.

Action of Flywheel.—There is a great difference between the behavior of the flywheel coupled to the motor generator set used for driving a hoist, and that used for driving a rolling mill. In the case of a hoist where the power diagrams for each successive wind are almost indentical, and about an equal period elapses between each wind, the flywheel gives up power during a wind and regains it during the interval, thus serving to equalize the power between individual winds and intervals. In the case of a rolling mill, and particularly a blooming mill, the flywheel has to do a double duty, because during the first passes made on an ingot the mill motor has to give a large power for a very short time as the ingot is short, so that the energy consumption during the earlier passes is much less than the energy consumption during the later passes, where, although the power given by the motor is not so great, the ingot has been rolled out to a considerable length, so that a very considerable energy is required per pass. The flywheel, therefore, has to give up energy during the passes and regain it during the interval between passes, and also the flywheel gains energy during the first passes of an ingot and loses energy during the later passes, so that its speed variation has a double period, namely, a short period of about 5 to 10 seconds, corresponding to the partial equalization of power between the pass and interval, and a long period of about 3 minutes, corresponding to the equalization of power over the whole time of rolling an ingot.

As the flywheel used in connection with a rolling mill has to equalize the power over a period of three minutes or so, it is usually found that these flywheels are much heavier than those applied to winding engines. The motor generator set for a blooming mill is usually supplied with a flywheel weighing about 40 tons, while a motor generator set provided for a plate mill, or a finishing mill, is generally supplied with a flywheel weighing anything from 60 to 100 tons, depending on the work which has to be done. The motor generator set for supplying hoists or winding engines is generally provided with a flywheel of not more than from 20 to 30 tons. Such flywheels would run at a peripheral speed of about 20,000 per minute, though in some cases this peripheral speed has been considerably increased.

Such a 100-ton wheel running at this speed would have a stored energy of about 300,000,000 foot lbs. or 545,000 horse power seconds, and in falling 20% in speed would give up 108,000,000 foot lbs. or 195,000 horse power seconds.

The total work required to roll a $1\frac{1}{2}$ ton ingot to a $4\frac{3}{4}$ x $4\frac{3}{4}$ billet is 59,000,000 foot lbs. or 108,000 horse power seconds.

Safety Devices.—The safety devices provided for an electrically driven rolling mill are of a much simpler character than those provided for a hoist, because it is not necessary to provide against the possibility of an overwind or the loaded cage falling to the bottom of the shaft due to the failure of the electric power. It is only necessary to protect the electrical plant and the mill itself against careless handling.

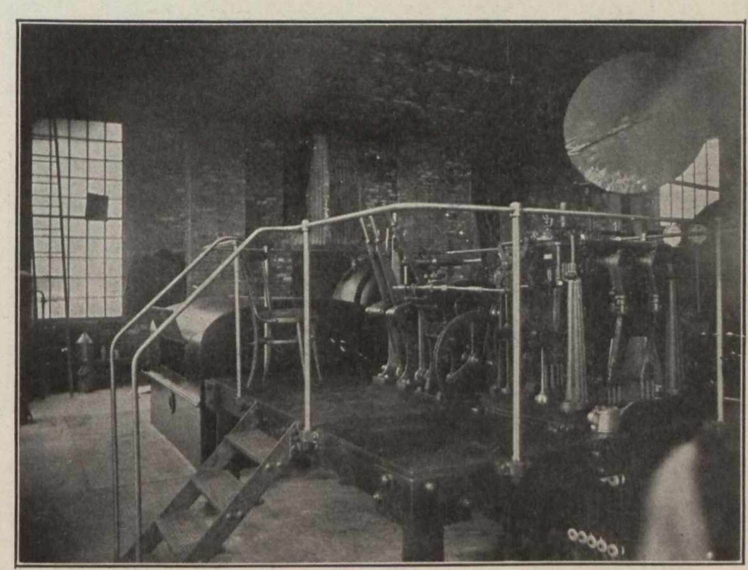


Fig. 24.—Control gear of three-phase winder shown in Fig. 22, showing main control lever, emergency lever and clutch levers. The reversing oil switch is on the right hand side and the liquid controller on the left hand side.

A circuit breaker is provided in the main circuit between the generator of the motor generator set and the mill motor to cut off the power from the motor in case, through carelessness, an attempt is made to roll a cold ingot, or too great a draft is taken on an ingot, imposing a greater strain on the motor and mill than they were designed for.

The circuit breaker is a protection against broken rolls as well as against damaging the motor, and it must be remembered that many rolls, especially the bottom roll, have a very small factor of safety. (Dr. Puppe, Iron and Steel Institute, Carnegie Scholarship Memoirs, Vol. II., page 300.) Such a circuit breaker would be most objectionable if used with a hoist, as only the prompt application of the brakes would prevent the cage falling in the shaft when the breaker opened, but with a mill, when the circuit breaker acts the motor merely comes promptly to a standstill, and if there is an ingot between the rolls, the mill can be reversed, the circuit breaker put in, the ingot run out of the mill again, and no damage is done.

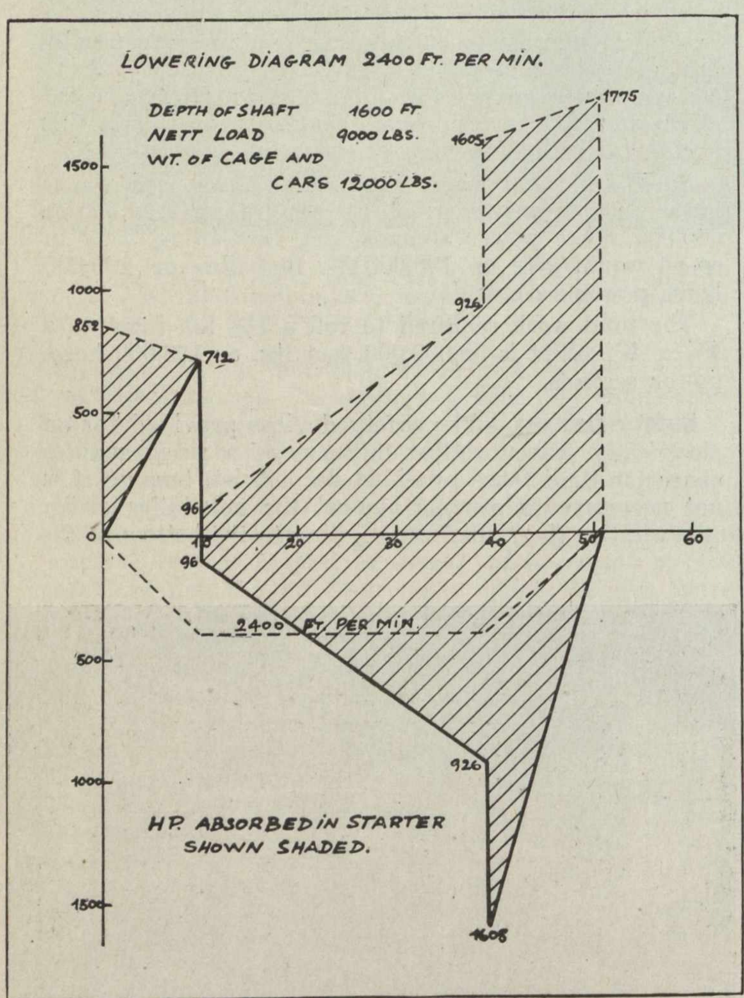


Fig. 28.—Typical power diagram for three-phase winder, lowering with reverse current, showing excessive power which is taken from the supply system and wasted.

A good deal of space in this paper has been devoted to description of safety devices, but it should not be considered on this account that there is any inherent risk in using such electrical plant, as the safety devices are to protect the plant against damage due to careless handling. The devices applied to steam hoisting engines, and particularly to steam reversing rolling mill engines, are of a much more rudimentary description, and the safety of such steam plants really depends on the skill and experience of the driver.

It should be particularly pointed out that the electrically driven reversing mill does not increase in speed as the ingot passes out of the rolls, while the steam engine, unless carefully handled, will race and run away.

Three-Phase System.

Application of Three-Phase Motors to Winding Engines and Hoists.

A three-phase motor cannot be built for a very low speed without its power factor being bad, which tends to upset the regulation of the supply system, and for this reason where three-phase motors are driving winding engines they nearly always run at higher speeds than the drums, and are geared to them. In the Ward Leonard or Ilgner system, however, where a direct current motor is used, this is almost invariably direct coupled to the drum.

Control.—The speed of a three-phase motor is controlled by varying the resistance in the rotor circuit so that all three-phase winding engine motors are naturally slipring motors, while the direction of rotation is reversed by interchanging two of the connections to the stator, so that a reversing switch must be provided for this purpose.

In order to explain the differences between the control of a three-phase winder and that of a Ward Leonard winder, it is necessary to refer briefly to the behavior of a three-phase induction motor when resistances are connected in the rotor circuit.

If the proper resistances in the rotor circuit of a three-phase induction motor are connected to reduce the speed by a given amount for a definite turning moment, the speed of the motor will increase if the turning moment which it has to give decreases, and it will decrease if the turning moment increases.

It will thus be seen that while with a Ward Leonard or Ilgner winder, the winder runs at a definite speed for each position of the control lever, and the speed of the winder is independent of the load in the cages, with a three-phase winder the speed does not solely depend on the position of the control lever, but also depends on the turning moment which the motor has to give, so that for a definite position of the control lever the speed may vary according to the position of the cages in the shaft and according to the load that is being hoisted, for as the loaded cage is being hoisted, its weight becomes more and more balanced by the weight of the rope attached to the empty cage.

With the three-phase winder, therefore, the manipulation of the levers would be different as different loads are being hoisted, and it is therefore impossible to employ cams on the depth indicator to limit the acceleration and to bring the loaded cage to a slow speed by the time it reaches the bank.

In the three-phase winder, therefore, we come back to the case of a steam engine where the wind is entirely in the hands of the driver and reliance must be placed in his skill for the safe handling of the plant.

Power Diagram of Three-Phase Winder.—Where the speed of a three-phase induction motor is controlled by placing resistances in the rotor circuit, and the motor is giving a definite turning moment, the same amount of power will be taken from the supply system whatever the speed of the motor may be. The turning moment multiplied by the speed gives the amount of power which the motor uses and the remainder of the power is wasted in the resistances. Thus, the three-phase motor involves great waste of power.

Fig. 27 is a power diagram for a three-phase winder with a cylindrical drum winding at the rate of 270 tons per hour from a shaft 1,600 feet deep, the maximum speed being 40 feet per second. The shaded portions of this diagram represent the power which is wasted in the resistances of the starter in starting and stopping the motor, and in this particular case the useful work done by the winder is 524 horse power minutes per wind. The amount of energy wasted in the starter is 325 horse power minutes per wind. Taking into account the efficiency of the three-phase motor the energy taken by the winder from the supply system is 910 horse power minutes per wind. The average efficiency of the electrical plant, therefore, is only 57,5%.

Comparison of Three-Phase Winder with Ward Leonard and Ilgner Winders.—Fig. 27 shows how large the power losses are in starting and stopping a three-phase winder. It also illustrates a case that is much more suitable for a Ward Leonard or Ilgner winder than a three-phase winder, and as the loss in starting and stopping a three-phase winder is very great, it will be seen that it is most advantageous to employ a three-phase winder where the starting and stopping is infrequent, and where there is a long run at full speed, when the three-phase winder is economical, or where there is a considerable interval between winds. These are practically the conditions of a long slope haulage.

Under such conditions a three-phase winder can easily prove more economical in power than the Ilgner or the Ward Leonard winder, because, with the latter, the motor generator set would have to be kept running continuously and this involves an unceasing though small expenditure of power, so that the energy taken to run the motor generator set can easily be more than the energy wasted in starting and stopping the three-phase winder.

The three-phase winder is advantageous:

(1) Where the capital cost of the plant is a prime consideration, as the total cost of the three-phase winder is from 20% to 35% lower than that of a Ward Leonard winder.

(2) Where the starting and stopping is infrequent and long runs at full speed are required, as is particularly the case with slope haulage.

Lowering Load.—There are three methods by which the load can be lowered with a three-phase winder:

(1) By controlling the speed with the mechanical brakes.

(2) By lowering at such a speed that the motor is run above its synchronous speed and so acts as a generator and returns power to the supply system.

(3) By reversing the connections to the motor so that it is giving its turning moment in the reverse direction to the rotation, and controlling the speed by the use of the ordinary control lever with reverse current.

(To be Continued.)

DUNSMUIR COLLIERIES.

Bondholders of Canadian Collieries (Dunsmuir), the great British Columbia mining corporation, are to meet on the 30th to consider a proposal that the company postpone its sinking-fund payments for five years. The Canadian Gazette considers that the proposal is "reasonable and should be cheerfully complied with." The circular of the directors says in part:

"A prolonged strike has continued for many months on the properties of the Canadian Collieries. The strike broke out in September, 1912, and speedily involved the whole of the company's mines both in the Comox and the Wellington fields. Subsequently towards the latter half of 1913 the strike extended to all of the colliery companies on Vancouver Island, and was accompanied by great violence and rioting. During the last few months the men have been returning to work, but conditions still continue difficult and labor scarce. The output of the Comox field has for some time been approximately what it was before the strike, but in the southern —Ladysmith—field the output is still small. In both areas disturbed conditions are still reflected in high working costs. It is expected that some time will elapse before normal conditions can be established in both the Comox and Wellington fields.

"This strike extending over nearly 18 months has caused serious loss of profit to the company, necessitating the standing charges for the past year being met to a large extent out of working capital. It has also caused serious delay in carrying through the scheme of new construction and development entered upon when the company was formed. At that time a sum of about £600,000 was provided to pay for the extensions then contemplated, and to provide the additional working capital required to carry on the increased business. This sum was estimated by the company's manager as amply sufficient for the purpose, but a further sum of about £300,000 will probably be required to carry out and complete all the necessary works.

"This sum certain large holders of preference and ordinary shares are willing to find as and when required, on certain conditions, one being that the holders of the first mortgage bonds agree to the postponement for a period of five years, i.e. until March 31, 1919, of the sinking fund, the first payment of which, in terms of the trust deed, is due on March 31, 1914, the minimum payment being £40,000.

"Power will be reserved to the company should circumstances make it desirable to commence payment of the sinking fund at an earlier date than March 31, 1919, and the resolution for the postponement of the sinking fund will provide that no dividend shall be paid on any share capital of the company until the company has commenced to make the sinking fund payments."—Financial Times.

McKINLEY-DARRAGH.

Net profits of the McKinley-Darragh Savage Mines for 1913 were $771,487, a decrease of $382,361 from 1912. A decrease in ore reserves is also shown. At the end of 1912 these were placed at 5,368,500 ounces and have now dropped to 3,210,000 ounces.

The cost per ounce of mining silver increased from 18½ cents to about 22 cents. Total silver recovered during the year was 2,214,026 ounces, compared with 2,717,383 ounces in 1912.

Dividends aggregating $584,400 were paid in 1913, and $134,862 was paid January 1, 1914.

ALBERTA OIL.

London, March 20.—At a statutory meeting of the British Alberta Oil Company, held at Birmingham yesterday, Mr. John Lee, chairman, announced that the company had contracted for drilling two wells in the Alberta oilfields, located in accordance with Mr. Cunningham Craig's instructions. Drilling, it was stated, would begin early in April.

Mr. Craig who attended the meeting, will leave shortly for Alberta, with an assistant, to complete a survey on 10,000 acres controlled by a company which considers it the most promising area yet taken up.—Montreal Star.

THE OCCURRENCE OF GOLD IN ONTARIO*

By J. B. Tyrrell

Up to the present time the Dominion of Canada has contributed £63,700,000 to the world's gold supply, and of this total the great placer or alluvial camps of Klondike in the Yukon territory, and Cariboo, etc., in British Columbia, have contributed respectively £30,000,000 and £14,400,000, leaving £19,300,000 as the contribution of both the placer and quartz mining camps of the rest of the Dominion. Of this latter amount the quartz or vein mines of Ontario have contributed, to December 31, 1912, £900,000, all of which came from localities in the latter province underlain by rocks of pre-Cambrian age. (The total production of Canada for the year 1913 was $16,216,131. The production of Ontario was $4,558,518.)

The question at once arises why, if Ontario is rich in gold-bearing lodes or veins, these have not been discovered or developed as they have been in other countries where similar rocks prevail.

The answer to this question is involved in a knowledge of the history of the country from the Pliocene period down to the present.

Pre-Cambrian rocks, similar to those of Northern Ontario, are known in many other parts of the world, and among them may be mentioned Minas Geraes in Brazil, Kalgoorlie in Western Australia, Rhodesia and India. In all these places gold-bearing lodes have been worked extensively, and have yielded enormous returns to those who have been fortunate enough to own them.

But in these countries, as well as in that far northwestern portion of our own country, the Klondike, rock decomposition went on continuously throughout all later geological periods. Rain descended on the loose decomposed rock, dissolved parts of it, and carried the insoluble portions down into the streams, and these streams in their turn carried the lighter portions down into the sea, while the streams themselves concentrated the gold and other heavy minerals contained in the decomposed rock into the more protected parts of their channels, forming placer deposits. Compared with gold-bearing quartz veins or lodes in undecomposed rock these placers are readily discovered, and when discovered, yield up their riches quickly and easily to the miner. In addition to which, 5 dwt. of gold to the ton of gravel constitutes a rich placer in almost any country, while a similar quantity of gold, in quartz, is impossible to extract at a profit except under the most favorable conditions. Placers, when discovered, cause a rush or stampede of prospectors and miners into the country; these men quickly scatter about and greatly extend the knowledge gained by the original discoverers.

With the confidence engendered by abundance of gold at various places in these placer deposits, and with the necessary experience and capital supplied directly or indirectly from the same sources, search is then instituted for quartz veins or lode deposits, often successfully, so that great quartz veins have been opened up in the same countries, and in others in the vicinity of them. But for the placer mines of Brazil, California, Colorado, Australia, etc., it is doubtful whether the rich gold quartz veins of these countries would have even yet been discovered or developed.

In Ontario gold-bearing quartz veins occur in many places, and in the very long period which intervened between that time in some of the later Palæozoic Epochs when the Pre-Cambrian rocks were raised above the Palæozoic seas, and the close of the Pliocene, rock decomposition on a tremendous scale undoubtedly took place, for during all this immeasurably vast interval of time these rocks were above the level of the ocean, and were constantly subjected to the corroding influence of atmospheric and meteoric agencies. This decomposed rock was then carried away by streams which assorted the undissolved portions and left the heavy gold in the valleys, while they carried much of the lighter material down into the sea.

In this way alluvial deposits, rich in gold, were undoubtedly formed in many parts of Ontario, where they must have existed during the Pliocene and earlier periods. The rich alluvial gold-fields of the Klondike, where, in an area underlain by Pre-Cambrian rocks, sedimentation has been continuous from Miocene times down to the present, give us some indication of what must have been the extent and character of those alluvial deposits in Pliocene times.

But in the Province of Ontario, and in those portions of Canada to the west and north-west of it, rock decomposition, and concentration through the agency of running water, have not been continuous down to the present, but on the contrary these processes were suddenly interrupted in Post-Pliocene times by the invasion of vast fields of ice, which moved with irresistible force over the country, and swept all the disintegrated rock, gravel, sand and other loose material along with it, even planed off and carried away some of the underlying hard undecomposed rock itself. All this rotten and broken rock material was kneaded together by the flowing and crushing of the ice, which at the same time moved it southward, and deposited much of it over the southern parts of Ontario, and adjoining portions of the United States.

In this way the gold-bearing alluvial deposits which undoubtedly existed in many parts of Ontario during the Pliocene Epoch were removed and destroyed by glacial agencies.

Since the close of the Glacial Period, when the last of the ice invasions took place, there has not been a sufficient lapse of time to allow for any extensive decomposition of the hard Pre-Cambrian rocks, or of the included gold-bearing lodes when such are present. Consequently the present streams have been unable to form any important gold placers on account of a lack of supply of proper gold-bearing material from which the metal could be concentrated.

The few low-grade placers which are known to exist in the province have undoubtedly been derived from a re-concentration of glacial debris containing a little gold, and not from a concentration of material worn directly from the rock itself.

In consequence therefore of the erosive action of the ice during the Glacial Period, and of the comparative recency of that period, there are no rich and extensive gold-bearing placer deposits in Ontario such as are found in most other gold-producing countries.

As these gravel or placer deposits have in most cases contained the gold first discovered in other countries, and as this gold was quickly and easily extracted from them, they were the means of drawing together the

*Extracts from a paper presented at the Nov. 20, 1913 meeting of the Institution of Mining and Metallurgy.

first great throngs of prospectors, and their absence from the Province of Ontario, and the consequent lack of this powerful attractive agent, has militated strongly against the discovery and development of its gold resources.

Gold was discovered in Ontario in the summer of 1866, in a quartz ledge on the property of Mr. J. Richardson in the Township of Madoc, north of Lake Ontario, but so little was known about gold by the men living in the vicinity who discovered it, that the identity of the metal was not determined until it was seen by H. G. Vennor, then in the employ of the Geological Survey of Canada, who immediately recognized it.

Five years later, in 1871, gold was discovered in quartz veins in the country west of Lake Superior, and from that time onwards up to the present it has been found in many places, but until recently very few, if any, of these discoveries resulted in the opening up of productive and profitable mines.

Such mines have now unquestionably been found in the Porcupine District. The characters and conditions of occurrence of these payable gold-bearing veins are much the same as many, if not all, of those which had previously been exploited in other parts of the province. The occurrence of an ounce of gold more or less in a ton of vein matter can scarcely be regarded as of sufficient importance from a geological point of view to place these richer veins in a class by themselves, although the additional ounce may make a vast difference in their commercial value, and in the interest which may be attached to them in the promotion of the general welfare of the community.

In all places where gold has been found it has occurred more or less closely associated with quartz veins in Pre-Cambrian rocks, usually near the contact of acid intrusions with some basic rocks of either igneous or sedimentary origin.

The Porcupine District mentioned above has several profitable gold mines producing gold from veins of great regularity and continuity. Another district in which gold-bearing veins of very similar character also occur is situated in the vicinity of Swastika Station, on the T. & N. O. Railway. As the rocks with which the veins are here associated are proving to be sufficiently widespread to include many other areas both in Ontario and Quebec where gold is known to occur, and as the conditions of occurrence of these rocks are rather clearly defined at Swastika and in its vicinity, a brief description of this district will be of interest.

Swastika District.

The Swastika district* is fairly typical of the Archæan peneplane of Northern Canada.

Its surface configuration is characterized by low rounded hills and shallow valleys in which lie beautiful clear lakes with very irregular outline, connected by smaller or larger streams.

The country has all been severely glaciated from a northerly direction, and the rocks which underlie it have been planed down until all the weathered and softer portions have been removed, and that which remains is the hard rock, unaltered by surface or atmospheric agencies.

These rocks, however, are not now generally exposed over large tracts, but are usually covered with a coating of clay or sand of glacial or post-glacial age, and these surface deposits support a dense forest of spruce and other timber which, with the overburden of soil, makes the work of prospecting slow and difficult.

The rocks which underlie the country, and in, or in connection with which the gold-bearing quartz veins occur, are as follows, arranged in increasing age from above downwards:

- Glacial and Post-Glacial
  - Till, sand, clay and boulders.
- Pre-Cambrian
  - Diabase
  - Minette and lamprophyre
  - Albite diorite
  - Felsite
  - Conglomerate
  - Diorite-porphyry
  - Greenstone=highly altered diabase, amygdaloidal basalts, etc.

Beginning with the oldest, the basement rock of the district is a fine-grained greenstone of Keewatin age, which in many places is hard and massive, while in other places it may be slatey or schistose. The more massive phases often exhibit the ellipsoidal or pillow structure so common in basic rock of this age.

Intruded into the greenstone is a batholitic mass of diorite or feldspar-porphyry, which on the surface weathers to a dirty white color, but on fresh exposure varies in color from light green to red. It is usually distinguished by the presence of light-colored phenocrysts of plagioclase, often altered to saussurite, with occasional crystals of biotite, imbedded in a finer grained matrix of plagioclase, hornblende and chlorite. Quartz is also often present, and in some places to such an extent that the rock becomes a quartz-mica-diorite. In other places the ferro-magnesian constituents may be absent and the rock then partakes of the character of aplite.

Overlying the greenstone and diorite-porphyry are conglomerates, greywackes, etc. They consist of a green fine-grained groundmass, the particles of which are in places rounded and water-worn, while in other places they are sharp, crystalline and angular, suggesting a volcanic or tufaceous origin. Some of the beds are fine-grained throughout, while others are packed with well-rounded, water-worn pebbles or boulders of the older rocks, such as greenstone, diorite-porphyry, red jaspilite, etc. In the finer varieties of these sediments it is often difficult to distinguish them from altered igneous rocks, but the presence of particles of jasper usually furnishes a distinguishing characteristic.

All have been deposited in water in horizontal or approximately horizontal attitude, but since their deposition they have been squeezed and upturned, so that the beds are often highly inclined. Many of the pebbles are shattered and broken, and in some cases the green matrix has been squeezed in between separated portions of pebbles of such distinctive rock as red jasper.

In many places the relative ages of the diorite-porphyry and conglomerate are difficult to determine with certainty, for, in the immediate vicinity of Swastika, the contact is obscured by superficial deposits, and near Kirkland Lake, a few miles further north-east, it is almost everywhere marked by a strong well-defined fault. However, in both places the conglomerate contains a plentiful supply of pebbles of the diorite-porphyry, and at one place near Kirkland Lake, on Claim No. 2566, the unfaulted contact was clearly seen. The pebbles are there rolled and well rounded, and, immediately above the contact, are composed entirely of diorite-porphyry packed together almost as closely as they can lie. This occurrence, together with the char-

*See also a report on "The Swastika Gold Area," by E. L. Bruce, in the 21st Annual Report of the Bureau of Mines (for Ontario), 1912, pp. 256-265, with map.

Note.—In the examination and determination of a large number of microscopical sections of the rocks of the district, I was assisted by Prof. T. L. Walker and Mr. G. S. Scott.

acter of the pebbles in many other places, shows clearly that the conglomerate is later in age than the diorite-porphyry.

The greenstone, diorite-porphyry and conglomerate are the three most abundant rocks of the country, but, in addition, there are several varieties of igneous rocks which have been intruded into or through those above enumerated in the form of dikes or sills.

Dikes of minette or "lamprophyre" from a few inches up to many feet in width cut both the porphyry and conglomerate at the Tough-Oakes mine, and on other mining claims in the vicinity of Kirkland Lake. They are approximately vertical, and follow the general strike of the conglomerate, but they are all later in age than the conglomerate, for they have not participated in the folding to which the latter rock was subjected, and which had therefore assumed its present conditions and attitude before the minette was injected into and through it.

Quartz Veins.—Quartz veins occur in the greenstone, diorite-porphyry and conglomerate or greywacke, and some veins have been also observed in the albite-diorite. Since, wherever gold occurs, it is more or less closely associated with these quartz veins, a knowledge of their character and mode of occurrence is highly important from an economic standpoint.

Most of the veins dip at a high angle, usually not more than a few degrees from vertical, though the dip may vary to some extent at different depths. Thus, at one place a vein may dip at an angle of 70°, while above or below it may be vertical, or even dip in the opposite direction.

In the greenstone and porphyry the veins are of quartz of a white or light bluish color, often enclosing irregular masses of country rock. Very often the vein matter is distinctly banded, and in such cases the bands may be of green chloritic material, or they may contain a considerable percentage of dark tourmaline.

In the conglomerate the veins may contain a considerable proportion of specular iron ore, or, as in the case of the Tough-Oakes vein, they may contain a very large quantity of molybdenite. In almost every vein in which gold is found pyrite is more or less freely disseminated through the quartz, and also through the country rock adjoining the vein. Some of the gold is intimately associated with this pyrite, while other portions of it are scattered through the quartz quite independently of the pyrite, so that in milling it is possible to catch from 50 to 80% of it on amalgamated plates.

Faults.—In the tremendous disturbances to which these old rocks have been subjected, numerous slips have occurred, and faults have been formed of greater or less displacement. The fault planes may be simple or composite, and the slickensided surfaces show movement varying all the way from the vertical to the horizontal. Most of the faults are reverse.

In the northern portion of the Township of Teck the main fault zone runs roughly east and west parallel to the contact of the diorite-porphyry and conglomerate and to strike of the folding which has affected the rocks in the Tough-Oakes and adjoining claims, and also to a rather prominent lamprophyre dike which crosses the country near the above contact.

Farther south most of the faults observed are near the contact of the diorite-porphyry and greenstone, and are much more irregular in their direction and distribution, often crossing and intersecting each other at various angles. The main direction in any particular locality is probably determined by the direction of the line of the porphyry-greenstone contact. They appear to have begun to form shortly after the intrusion of the diorite-porphyry and to have continued to form until the close of the period of disturbance in which the amprophyre dikes were injected into the adjoining rock.

The veins in this district, though not everywhere throughout the Pre-Cambrian rocks of Ontario, are usually associated with these fault planes, so that one or other or perhaps both of the walls may be smooth and well-defined. In one case a vein was seen to follow a fault plane for a certain distance to the intersection of another fault plane almost at right angles to it, when the vein turned sharply and followed the cross fault, the dark bands (of growth) in the vein turning sharply with the change in direction.

In other cases cross faults may pull or tear apart original fissures in which veins were being formed, permitting widening of the veins at and near the intersections, or the fissures may have been pulled back on one side of the cross fissures and not on the other, thus forming wedge-shaped enlargements of the veins on one side of the intersections.

Many of the quartz veins are at or near the contact of the diorite-porphyry and greenstone or conglomerate. The contact zone is not usually very sharply defined, for the rocks were very much disturbed, crushed and faulted by dynamic agencies as they assumed their present condition after the intrusion of the feldspar porphyry. The veins may run parallel to the general trend of the contact, or they may branch off at angles from it along subsidiary fissures which have extended out into one rock or the other.

As stated above, the main veins usually approximate to a vertical attitude, while apophyses may branch off from them in all directions. Some of them were large, while others might be quite minute. Where such minute veinlets carry gold, they may convert a considerable extent of country rock adjoining the veins into payable ore.

In the northern portion of the Township of Teck, the gold is to a very large extent closely associated with molybdenite, which chiefly occurs along the walls of the veins, and is later in age than most of the quartz.

In the porphyry-greenstone contact zone the fault fissures, when first formed, seem to have been usually accompanied by intrusions of felsite, which, as already stated, is composed of the same minerals as the diorite-porphyry, after which quartz was introduced, often in definitely banded form, and as this quartz was fractured by continued movement, gold and other minerals associated with it, including tellurium in some form, were also introduced. In some cases the movement in the fault was continued until the quartz was broken down into an irregular fault-breccia.

Near the porphyry-conglomerate contact the veins run in very definite courses, and occupy fissures which cut indifferently across from one rock to the other.

The distinguishing feature of all these gold-bearing veins is their close association with intrusive masses of diorite or feldspar porphyry rich in soda or soda-lime feldspar. While these veins were not derived directly from this rock, for it had consolidated, had been fractured, quartz veins had been formed in it, and these again had been fractured, before the gold was introduced into them, it is probable that the later intrusions of felsite, albite-diorite and possibly also of lamprophyre were all phases of the same rock, were derived from the same original magma, and that the gold has also been exuded from this same magma.

In an undeveloped country, such as the northern parts of the Province of Ontario, in which gold mining is in its infancy, but in which it may be expected to have a much more extensive development, a knowledge of the way in which the gold occurs, and of the rocks with which it is associated, is of the first importance.

The Swastika district has been merely taken as a type to illustrate its occurrence in the Pre-Cambrian rocks of Northern Ontario. From the Harricanaw country of Northern Quebec in the east, westward through Northern and Western Ontario, as far as Lake of the Woods, similar conditions appear to prevail, and it would seem not improbable that in the association of gold with certain definite types of rocks, the whole of this vast country may be one metallogenetic province similar in general character to that small portion of it here briefly described.

Contributed Remarks.

Dr. J. M. Bell: As a geologist who has traveled widely throughout the Canadian Hinterland both in Northern Ontario, and the region still farther North underlain by Pre-Cambrian rocks, Mr. Tyrrell is well qualified to address us on the subject with which his paper deals.

He has briefly mentioned several localities at which gold has been found in Ontario, and has given a more elaborate description of the rocks in the new gold field of Kirkland Lake, which he has taken as a type. While public attention is being riveted to some extent on this locality, it is interesting to learn of the various rocks of the district—greenstone schists, diorite porphyry, conglomerate, felsite, albite-diorite, minette, lamprophyre and diabase.

I do not agree with Mr. Tyrrell that the Kirkland Lake veins are typical of most of the Ontario veins. The gold deposits of this field consist generally of very narrow quartz veins, characterized by the mineral molybdenite and in places exhibiting specular showings of gold.

The country rocks are diorite-porphyry and a conglomerate in which occur brilliant pebbles of jasper. Though in places the country adjoining the narrow veins is highly silicified and gold-bearing, it is not characterized by much visible vein quartz. The veins of Kirkland Lake are on the whole well-defined, and the fissures appear to be persistent.

The gold veins of Porcupine are to my mind much more typical of others in Ontario than are those of Kirkland Lake. In that camp the deposits are of two more or less general types, (1st) the Dome type, consisting of large irregular lenses of white quartz, with, in some places wonderful showings of free gold, but of a generally low tenor, and (2nd) the Hollinger type, consisting of generally strong and fairly persistent quartz veins, with inclusions of schist. Gold occurs in both types in the quartz and in the schist. The walls of neither type are generally well-defined, and quartz stringers commonly ramify from the main veins into the country.

Deposits of quartz, very similar in character to those of Porcupine, occur at Swastika, Sturgeon Lake, Michipicoten, the Lake of the Woods, and in many other parts of the Ontario wilderness. They differ, however, in one important respect. They have not yet been proved to be sufficiently rich to be profitable to work.

The Porcupine Field, as is well-known, was only discovered in 1909 and in 1911 was devastated by fire. It is highly creditable that in so short a time as the two years that have passed since then, so many mines in the camp should already have become productive. The monthly output of the Hollinger is about $140,000, that of the Crown Porcupine about $50,000 or $60,000, and that of the Dome a somewhat greater amount than the latter.

Mr. Tyrrell has mentioned the difficulty of prospecting in Ontario, and has said that the great glaciers which in the past covered Ontario carried away the gold found prior to the invasion of the country by ice, so that there is no wash to lead the prospector to locate gold-bearing veins. This is quite true, and in addition he has to cope with the difficulties of a very dense vegetation, and in many places a covering of moss. He soon learns to know that in a certain formation or formations in any locality he may expect to find quartz veins which he hopes to prove valuable, and may locate a likely area, but even here he may search indefinitely, and miss in his stripping a valuable deposit within a few feet, as there is no detrital gold, in the overburden, to give the scent.

Mr. Stephen J. Lett: The author informed me, in answer to my inquiries before the meeting, that the earlier writers had been mistaken about the identity of the "graphitic material," which they had said was such a marked feature of the deposits, there being no graphite present as a matter of fact, and what had hitherto been mistaken for graphite has proved to be molybdenite. I mention this for the benefit of those who did not hear question or answer, as the matter is of great interest. But this is not the only matter upon which the author and the earlier writers differ one from another, and as he did not criticize the papers and reports referred to in his footnotes, perhaps he will deal with a few points which have occurred to me in reading his papers and the papers, etc., in question.

Is it a fact that, as stated by one writer, the gold is commonly associated with "much secondary quartz calcite and sericite," and if so, from what is the sericite derived if the feldspars are soda-lime feldspars?

Spearman writes "the common variety of porphyry is a reddish alkali porphyry with predominating orthoclase phenocrysts"; he also says that the acid porphyries are genetically associated with the deposits; but another writer says that their favorable influence cannot be of a genetic nature, for they are much older than the deposits. Which is correct?

Again, Walter Baelz states that the gold-bearing magma is directly connected with great granite intrusions, but the granites mentioned by the author are of Laurentian age, and the deposits are much younger; besides, the author apparently does not associate the granites with the deposits, though the minerals mentioned by him as associated with the gold are such as are usually associated with acid magmas. On p. 9, when mentioning together the veins in the greenstone and porphyry, the author fails to take advantage of the favorable opportunity for referring to the influence of the "country" on the gold contents. This being an important matter from an economic standpoint, it would be useful to have the author's experience on this point, particularly as one writer has clearly stated that the greenstone is decidedly unfavorable.

It has been stated that the proportion of silver to gold has increased with depth; any information on this point cannot fail to be of interest.

Mr. J. B. Tyrrell: Dr. J. M. Bell does not agree with me "that the Kirkland Lake veins are typical of most of the Ontario veins," but that "the gold veins of Por-

See also the following papers:—"The Goldfields of New Ontario," by Walter Baelz. Translated by T. L. Walker. Can. Min. Journal, May 1, 1912, pp. 299-304; "Kirkland Lake Gold Deposits," by R. E. Hore. Ibid., July 15, 1913, pp. 424-31; "Ore Deposits of Kirkland Lake District," by Charles Spearman, Ibid., October 1, 1913, pp. 599-601.

cupine are. . . . much more typical of others in Ontario than are those of Kirkland Lake." He divides the Porcupine veins into two types, "(1st), the Dome type, consisting of large irregular lenses of white quartz," and "(2nd), the Hollinger type, consisting of generally strong and fairly persistent quartz veins, with inclusions of schist."

The Porcupine gold-bearing veins, though sub-divided by Dr. Bell into two classes, on what would appear to be physical characteristics may, on a little consideration, be recognized as agreeing very closely with those described at Kirkland Lake. In the Porcupine area, both at the Hollinger and at the Dome mines, the veins, though differing somewhat in shape, occur near the contact of acid porphyritic igneous rocks and basic greenstones or conglomerates, the veins sometimes occurring in the porphyries themselves, but much more often in the contiguous rocks. Both rocks are usually somewhat foliated and have evidently been subjected to considerable pressure or strain. It was doubtless the physical conditions which prevailed in those rocks at the time when the veins were formed, providing channels for the passage of the solutions bearing quartz, gold and other associated minerals, that controlled the general shape of these veins. For instance, the veins on the Hollinger are nearly vertical, and the rocks containing them appear to have been bent around a boss of basic greenstones which lies to the south of them. Their general appearance strongly suggests the saddle veins of Nova Scotia, with this difference, that in this case the saddle is lying on its side. The horizontal bending of the strata has probably given rise to larger ore channels at or near the apex of the bend than elsewhere, and may account for the greater richness of this property than those adjoining it.

The acid porphyry which is found associated with the gold in the Porcupine country has generally been spoken of as a squeezed quartz porphyry. That on the McIntyre property, south of Pearl Lake and east of the Hollinger mine, was found to contain large phenocrysts of orthoclase and plagioclase in about equal proportions, imbedded in a fine grained ground-mass of feldspar, quartz and sericite. A very few phenocrysts of quartz were also observed in it. The plagioclase is a soda-lime feldspar with a preponderance of lime. In this particular instance the porphyry had been much crushed; but a little further west, on the opposite side of the Hollinger mine, it was found in some drill-holes in a less altered condition, consisting of a holocrystalline rock with large phenocrysts of feldspar in a coarse matrix of feldspar, chlorite and sericite. A few of the phenocrysts are orthoclase, but most of them are plagioclase, in which the lime preponderates over the soda.

In the vicinity of the Dome, the porphyry examined has a much larger percentage of quartz, though some of the phenocrysts are of soda-lime feldspar.

Thus it will be seen that in their mode of occurrence, associated with porphyries rich in soda-lime feldspar, the gold-bearing veins of the Porcupine district fall in line with those described from Swastika and Kirkland Lake.

As stated in my paper, similar porphyries occur associated with the gold-bearing veins throughout the Pre-Cambrian areas of Canada. Among these Mr. A. L. Parsons has drawn attention to the fact that several of the gold-bearing veins on Lake of the Woods are definitely associated with dykes rich in plagioclase.

In answer to Mr. Lett's first question, whether it is true that the gold is commonly associated with "much secondary quartz, calcite and sericite," it is undoubtedly true that most of the primary quartz in the veins had been much fractured before the gold was introduced into it. In some places these quartz veins have numerous cross-veins of secondary quartz in them, but as far as I am aware this secondary quartz is not usually rich in gold.

Calcite is not a common constituent in the richer veins, though it is very common in the adjoining rocks, being probably derived in part from the decomposition of the plagioclase. Sericite is also often present near the walls of the veins, having probably been derived from the decomposition of some of the orthoclase present in the porphyry.

In regard to the character of the porphyry, I must take issue with Mr. Spearman's statement that orthoclase phenocrysts predominate. I have myself examined or have had examined for me a large number of microscopic slides of this porphyry from a number of localities, and I find that, while orthoclase is usually present, and is sometimes abundant, plagioclase greatly predominates in this rock which I have designated "diorite-porphyry," and which Mr. Bruce in his official report published by the Bureau of Mines of the Province of Ontario, calls "feldspar-porphyry."

Since this paper was presented to the Institution, the Bureau of Mines of Ontario has also published a very valuable "Map of the Kirkland Lake and Swastika Gold Areas," by A. G. Burrows, with marginal notes. On this map Mr. Burrows also uses the term "feldspar-porphyry" for these rocks. He regards them as later in age than the conglomerates (of the Timiskaming series), but the evidence which I presented in my paper shows clearly that they are earlier. I consider that, though the porphyries are older than the gold-bearing veins, the latter are genetically associated with them to this extent, that they have been derived from the same deep-seated magma.

With regard to Mr. Baelz's statement that the gold-bearing veins are connected with great granite intrusions of Laurentian age, I have no exact evidence as to the relative ages of the porphyry and the Laurentian granites, except that stated for the Harricanaw district where Laurentian granites are intruded by porphyry similar to that at Kirkland Lake, and gold-bearing quartz veins are found in the granite adjoining the porphyry.

As to the influence of the country rock on the gold contents of the veins, I have but little evidence to offer. At the Hollinger property some of the richest veins are in an old greenstone, which is a highly altered diabase or basalt. In the Pearl Lake section of the Porcupine country the porphyry extends northeastward as a tongue into the adjoining country, with basic greenstones, such as those above mentioned, on both sides of it, and the gold-bearing veins have an undoubted tendency to form in this greenstone. Some of the veins, however, are in the porphyry, which is then often altered into a calc schist.

In many other places in the Pre-Cambrian areas of Northern Ontario quartz veins are scattered irregularly through the contact zone between porphyry and greenstone. In most of such cases they are short, and where gold is present in them it is also likely to be in short irregular shoots.

I would consider that the extent and value of the gold-bearing veins in the greenstone was much more fully controlled by the proximity and size of a mass of intrusive porphyry, and by the length and width of the fissures through which the gold-bearing solutions were able to circulate, than by minute difference in the character of these old basic Pre-Cambrian rocks.

In the Porcupine district I believe that the percentage of silver as an alloy of gold is practically constant at any depths yet reached, but in the Kirkland Lake district, where tellurides of gold, silver and lead are present in appreciable quantities, the silver in the ore undoubtedly varies with the quantities of tellurides present. It is hardly likely, however, that the grade of the gold itself, and the quantity of silver which is alloyed with it, have suffered any change at any depth to which the shafts have yet reached in the Kirkland Lake district.

I can only repeat what I said in an earlier part of this paper, that my object in bringing the occurrence of gold in Ontario before members was to point out the association of gold-bearing veins in our Pre-Cambrian areas with diorite-porphyries, or intrusives rich in soda-lime feldspar.

Dr. Malcolm Maclaren, in a recent paper in the Mining and Scientific Press, has clearly pointed out a similar association in the Pre-Cambrian rocks of Kalgoorlie in Western Australia.

In summing up the value of a knowledge of the association of the gold-bearing veins in Western Australia with the intrusive dykes, Dr. Maclaren* says: "It is not too much to say that had a geological map, showing all the porphyry and porphyrite dykes of the region, been available in 1893, every deposit now known, and some still unknown, would have been discovered within three months, and thousands of pounds' worth of useless work and misspent energy avoided."

Mr. Stephen J. Lett: I have received the following communication from Mr. A. G. Burrows, Assistant Provincial Geologist, Toronto. As the information embodied in the communication may be of interest to the members I send it as a contribution to the discussion on Mr. J. B. Tyrrell's paper.

Mr. A. G. Burrows: My attention has been called to the paper appearing in Bulletin 110 of the Institution of Mining and Metallurgy entitled "The Occurrence of Gold in Ontario," by J. B. Tyrrell, and also to the subsequent discussion of this paper by yourself and Dr. J. M. Bell.

I think that Dr. Bell is correct in stating that the occurrence of gold at Kirkland Lake is not typical of Ontario gold deposits.

The quartz veins in the best deposits so far discovered at Kirkland Lake are extremely narrow, usually only a few inches in width, but there is a considerable portion of replaced or impregnated wall rock along these veins which sometimes carries gold in economic quantities. There are other veins or lenses of quartz roughly parallel to a main vein, and also cross stringers of quartz which have allowed an extensive circulation in the adjacent wall rock. The ore deposit, consisting of quartz, calcite, country rock, etc., has been greatly disturbed and brecciated. A sample of ore has a dark grey appearance, and, unless wet, is sometimes difficult to distinguish from ordinary rock. This ore is quite different from most of the gold ore from other parts of the Province, which consists so largely of white glistening quartz. The richness of the high-grade ore in gold and silver, as shown by shipments, and the presence of so much telluride (altaite) are noteworthy features.

For some time it was thought that the ore carried graphite, but Mr. C. A. Foster, of the Tough-Oakes mine, had the mineral, which usually occurs as a film on fracture planes, determined as molybdenite, which was confirmed by further tests at the Provincial Assay Office of Ontario. Graphite, if present, occurs only in minute quantity. Molybdenite has also been observed in ore from the Swastika area, a few miles to the south-west of the Kirkland Lake area.

As to the query: "Is it a fact that, as stated by one writer, the gold is commonly associated with much secondary quartz, calcite and sericite, and if so from what is the sericite derived if the feldspars are soda-lime feldspars?" Original and secondary quartz in a vein can be distinguished with difficulty, particularly when a great portion of the quartz has been finely fractured. It is very likely that secondary quartz does exist in the veins. Secondary calcite is observed in all the thin sections examined. Sericite is present in some of the ore, but only to a small extent. Sericite, like calcite, is found in almost all the altered rocks of northern Ontario and may apparently be a migratory mineral.

The prominent phenocryst of the porphyry is a plagioclase near the albite end of the series, but there is some replacement by $KAlSi_3O_8$ (orthoclase). Blades of sericite, sometimes in zonal arrangement, occur in the plagioclase phenocrysts.

An analysis of porphyry from the Teck-Hughes property gave—Silica, 66.48%, Al_2O_3 15.42%, Fe_2O_3 1.05%, FeO 1.18%, CaO 3.15%, MgO 1.67%, Na_2O 5.92%, K_2O 2.56%, H_2O 0.30%, CO_2 2.65%.

The gold deposits of the Kirkland Lake area occur in sedimentary rocks of the Timiskaming series, and also in the reddish feldspar-porphyry which intrudes the older series. Veins have been found which cut both the sedimentary and igneous rocks. In the Swastika area the productive veins are in the greenstone near the contact with the feldspar-porphyry. The occurrence of these veins in the proximity of the contact of the older sedimentary or igneous rocks with an intrusive dyke rock (porphyry) is very suggestive of some genetic relationship between the veins and the intrusive rock.

The intrusion of the porphyry would shatter the older rocks along the contact, while the cooling, shrinkage and readjustment of the intrusive would result in the formation of the narrow fissures, later filled with quartz, which are so numerous in the porphyry itself. The vein filling could have ascended through channels in the porphyry, possibly being derived from the same source as a differentiation product. The term "Laurentian" has been used during the past to include many rocks such as gneiss, granite, etc., the age relationships of which were not always known. The granite, syenite, etc., of the Swastika area were first grouped as Laurentian, but field work during the past year has proved some of these rocks later in age than the Timiskaming series and older than the Cobalt series. The gold-bearing veins occur in the Keewatin, Timiskaming, and a later intrusive (feldspar-porphyry), but not in the Cobalt series. The light-colored intrusives are probably of the same age as the Lorrain granite in the Cobalt area, while the syenite, granite and feldspar-porphyry may be facies of a plutonic rock underlying the whole area.

The International Coal and Coke Co., operating at Coleman, Alberta, in March paid a dividend of one per cent.; total amount $30,000.

The Standard Silver-Lead Mining Co., with a silver-lead-zinc mine situated near Silverton, Slocan Lake, British Columbia, on March 10 paid its customary dividend of 2½ cents a share on its 2,000,000 shares, or $50,000. The total paid since the first dividend was declared in April, 1912, was $1,225,000 on a capitalization of $2,000,000.

*"Geology of the Kalgoorlie Goldfields," by Malcolm Maclaren and J. Allan Thomson. Mining and Scientific Press, 9th August, 1913, p. 232.

THE KIRKLAND LAKE EXPLORATION, LIMITED.

This company is organized with a share capital of £150,000, divided into 150,000 shares of £1 each. 50,000 shares were advertised for issue at par on January 28, 1914.

The following is taken from the prospectus published by the company:

"This company has been formed with the objects mentioned in the memorandum of association and in particular to carry on exploration work in the Kirkland Lake area, Ontario, in the Dominion of Canada. The company will obtain the opinions and reports of experts and others as to the mineral deposits, with the view of acquiring a limited or absolute interest in lands or claims suitable for mining development, of forming subsidiary companies to work the same, and also of acquiring interests in companies operating in the Kirkland Lake area.

"The Kirkland Lake area is in the district of Timiskaming, Province of Ontario, Canada, and is about 400 miles north of Toronto, the cobalt silver district being about 60 miles south, and the Porcupine gold district about 60 miles northwest.

"The Kirkland Lake area is a comparatively new mining field. About eighteen months ago the discovery of rich gold on certain claims in this area attracted considerable attention amongst men interested in mining in Northern Ontario, and since then many veins have been disclosed. Shafts have been sunk on a number of these claims, and several properties are now being actively developed.

"As evidence of what is believed to be the value of this new gold-mining area, it may be mentioned that the £1 shares of the Kirkland Lake Proprietary, Limited, are quoted in the market at a considerable premium.

"This company will be one of the earliest in the field, and it is anticipated that by prospecting, obtaining options on likely claims, proving them, and forming subsidiary companies to develop and work the same, substantial profits should be earned.

"The selection of claims will be undertaken upon the advice of a mining engineer who is already in the district. The company are also fortunate in having as a director Dr. F. H. Hatch, who has for many years been consulting engineer to an important group in the Transvaal.

"The Kirkland Lake Proprietary, Limited, has the right to nominate a director to the board of this company.

"Under the contract below mentioned the Anglo-Spanish Trust, Limited, has agreed with this company to pay, discharge, and indemnify this company against all expenses whatever in relation to this company down to the first general allotment of shares other than brokerage, and to advertise and circulate this prospectus, and in consideration therefor the Anglo-Spanish Trust, Limited, is to receive from this company £5,250 in cash and a call option on 100,000 of the unissued shares at par up to the 31st December, 1914, and in the event of such option being exercised to the extent of at least 50,000 shares within such period then an option up to the 31st December, 1915, at par on the balance of the 100,000 shares. None of the shares of this issue have been underwritten and, therefore, with the exception of the sum of £5,250 payable to the Anglo-Spanish Trust, Limited, in respect of the preliminary expenses, the whole of the moneys subscribed will be available for working capital and the general purposes of the company.

"The directors of the company are: Lieut.-Col. Chas. Hyde Villiers, Roydon Hall, Tonbridge, Kent, Director, Magadi Soda Company, Limited; George Cornwallis-West, J.P., Pinners Hall, London, E.C., Director, Cordoba Copper Company, Limited; Dr. Frederick Henry Hatch, M. Inst. Min. Met. and M. Inst. C.E., 34, Bishopsgate, London, E.C., Consulting Mining Engineer."

BURNSIDE CLAIMS.

Mr. H. H. Johnson, in a report, made for the Kirkland Lake Proprietary Co., on the Burnside claims, Kirkland Lake, says, in part:

"The property consists of three claims, Nos. L. 1821, 1822, and 1823, in extent about 90 acres, the first-named being situated in the Lebel Township and the two last in the Teck Township in the Kirkland Lake Goldfield, Ontario, Canada. The elevation is about 950 feet above sea level; the claims are bounded on the north by the Tough-Oakes mines, and Gull lake approaches near to the eastern and southern boundaries. The main line of the Timiskaming and Northern Ontario Railway runs within five miles of the property, the nearest station being Swastika, distant some six miles by good wagon road. Telephone communication is also established. Trains run daily between Swastika and Toronto, the capital of the Province of Ontario, connecting also with the main lines of the Grand Trunk Pacific and Canadian Pacific Railways; the time occupied between the capital and Swastika being about 20 hours. The claims are situated in the Timiskaming series, consisting of conglomerates, quartzites, and greywackes, which are generally greatly uptilted, and which are underlain by the Keewatin greenstones. Post-Timiskaming intrusions of feldspar porphyry are prominent, from which quartz veins appear to have been derived, these latter tending to follow the bedding planes or schistose partings in the sedimentaries. The quartz veins are in general the principal gold-carriers and are usually well mineralized. Several veins have been opened up on the surface by trenching, and at the northeast corner of Claim No. L. 1823 a vertical shaft (No. 1) has been sunk to a depth of 88 ft., from the bottom of which a crosscut has been driven 120 ft. across alternating conglomerates and greywacke, in a direction N. 35 deg. W., and at a distance of 80 ft. from the shaft the crosscut has intersected a quartz vein striking nearly N. 80 deg. W. and dipping 46 deg. south.

"Samples of this vein gave the following results:—

Location of sample.	Width, in.	Assay Gold, dwts.
*In back of crosscut	4	75.4
†3 ft. down on west side of crosscut	7	181.0
5 ft. down on west side of crosscut	2.5	306.0
In foot of crosscut, west side	3	170
Average	4.1	172.5

*3 or 4 inches of porphyry on either side.

†Includes 4½ in. of porphyry.

"Bulk samples from this vein, of 841 lb. quartered down, assayed 218 dwt. A further sample taken across 36 in. of vein-stuff and foot-wall and hanging-wall conglomerates assayed 137.6 dwt. Owing to a small inflow of water and the absence of any facilities for handling it at the moment, no driving has been done on this vein, and the water has been allowed to rise halfway up the shaft, while the labor force available has been concentrated in trenching on other veins before the winter snow prevented further surface operations. Some 800 ft. south of No. 1 shaft, No. 9 vein has been exposed for a distance of 220 ft. in an east and west direction; the values on the surface averaging 22 dwt. across 7.3 in. This vein is in identical schistose conglomerates to the Tough-Oakes, and it may reasonably be expected that further work below the surface will open up good values. Further west and near the western boundary of No. 1822 claim are two parallel veins numbered 6 and 7; the former has been exposed for 40 ft., samples averaging 30.9 dwt. over 8 in. of quartz; the vein looks strong and carries visible gold right up to the boundary of the Sylvanite claims adjoining on the west. No. 7 vein, which is found some 60 ft. south of No. 6, is also small, but contains coarse gold, the average value being 10.6 dwt. over 17 in. A bulk sample of 490 lb. of ore from this vein, quartered down to 20 lb., assayed 9 oz. 12 dwt. per ton. The situation of the property renders it specially suitable for efficient working, being on the Government road to the Tough-Oakes mine; labor generally is of good quality and plentiful, and plentiful supplies of timber are at hand. Work can readily be carried on underground the whole year round, and the conditions are healthy in the extreme.

"I beg to place before you the following recommendations:

Recommendations.

"1. The sinking of No. 1 shaft to the 200 ft. level, at which point it should cut the vein already encountered on the first level. 2. Driving both ways on the above-mentioned vein from the first level crosscut in No. 1 shaft. 3. Raising from the first level crosscut on the vein to surface to assist ventilation. 4. Sinking of a shaft on No. 9 vein to a depth of 100 ft. and drifting along the vein at that level. 5. Sinking of a shaft on either No. 6 or 7 vein to a depth of 100 ft., connecting both veins at that level by a crosscut and simultaneous drifting on both. 6. Further exploratory work on the surface in the spring, which will probably be the means of locating further veins in this region.

Conclusions.

"1. The situation of the Burnside claims in the Kirkland Lake district renders them of great value owing to their adjoining the Tough-Oakes mine on the one side and the Sylvanite on the other, and being in the same identical geological formation. 2. Several veins have been opened up on the surface carrying good values in gold. 3. The deepest work, in No. 1 shaft, has disclosed the richest ore, thus pointing to the advisability of continuing work in depth. 4. The conditions for working are good, the claims being readily accessible, and mining can be carried on throughout the whole year without trouble due to climatic changes. 5. There is every indication of the continuity of the veins in depth, and development should be rapidly pushed forward. 6. Indications at present point to the likelihood of the Burnside developing into a mine of similar importance to the Tough-Oakes."

THE COPPER HANDBOOK.

The new Copper Handbook describes 159 active Canadian copper mining companies, the descriptions being included in the first part of the volume with those of the United States and Mexico. Most of the Canadian properties are naturally in British Columbia, but the geographic index shows that Manitoba has one, New Brunswick two, Quebec eight, Nova Scotia nine, Yukon eight and Ontario 37, while Newfoundland has 12.

This seems a small number considering the very many known copper prospects of British Columbia, but it must be remembered that the 94 companies described as British Columbia concerns embrace only the active mines of the Province, and that many owners of dormant mines and lesser prospects have not responded to Mr. Weed's request to send information to the Copper Handbook. It is hoped the next edition will be more generously supported, to the end that capital may be attracted to the development of the undoubtedly great copper resources of the Province.

It is of local interest to note that a very full description of the Granby Consolidated covers five pages and has a full but concise account of the new holdings of the company, its finances, geology, smelting practice, costs, etc., and that a favorable future is prophesied for this corporation. As Mr. Weed has personally visited practically all the mines of the Sudbury, Rossland, Boundary, Kamloops, Howe Sound and Vancouver Island districts in the course of his professional work, the descriptive matter concerning Canadian properties is authentic and not merely a compilation as in former editions of the work.

An interesting feature of the book is the section devoted to Copper Statistics and covering every feature of the industry in 47 pages of tables and charts. A list of the 325 leading copper mines of the world, tabulated according to their 1912 and 1913 production, is headed by the Anaconda Copper Co., with Rio Tinto fourth, Cerro de Pasco eighth, and Canada's largest producer, the Granby, in the twenty-third place.

NIPISSING.

As anticipated by many Nipissing Mine directors dropped the extra 2½ per cent. dividend paid since 1909, only declaring the regular quarterly 5 per cent., payable April 20. The financial statement as of March 16 shows cash, $737,670; bullion in transit, $168,832; bullion and ore at mine, $193,621; total, $1,100,123.

The course of the company's production, together with the falling cash surplus in recent months, has indicated that a cut in the dividend was inevitable.

The movement of Nipissing's cash and bullion surplus during the last nine months of 1913 was as follows:

Date.	Cash surplus
March 16, 1914	$1,100,124
Dec. 31, 1913	1,244,000
Sept. 30, 1913	1,384,000
June 30, 1913	1,484,000

The Hedley Gold Mining Co., operating the Nickel Plate group of gold mines in Similkameen district, British Columbia, has declared a quarterly dividend of 3 per cent. and a bonus of 2 per cent. on its issued capital of $1,200,000, making a total distribution of $60,000.

The Granby Consolidated Mining, Smelting and Power Co.'s first quarterly dividend in 1914 was of 1½ per cent., or a total of $224,977.73 for that period. Granby Co. has now paid about $5,000,000 in dividends, or about one-third of the par value of its issued stock.

The Consolidated Mining and Smelting Co. of Canada, Ltd., with mines and smeltery in British Columbia, has declared Dividend No. 12, of 2 per cent., for the quarter ended March 31. The total of this distribution is $116,088. This is the fourth consecutive quarterly dividend payment of a similar total amount.

THE MILL AND METALLURGICAL PRACTICE OF THE NIPISSING MINING COMPANY, LIMITED*

By James Johnston, Cobalt, Ont.

(Continued from March 15 issue)

Battery.

The mortar block foundations, consisting of 846 cu. yds., are of concrete 81 ft. long and 6 ft. wide on top, with the anchor bolts set in on an incline; and facilities are provided for dropping the bolts so that a mortar may be easily removed. The battery posts are 12″ x 26″ and 24″ x 26″ set in cast iron shoes, rubber ¼″ thick being placed between shoes and concrete. The mortars are Fraser & Chalmers, No. 161 type for rapid discharge, weigh, with steel liners 12,410 lb. each, and have rubber ¼″ thick placed between them and the concrete.

There are forty 1,500 lb. stamps, five to each camshaft, and the order of drop is 1, 3, 5, 2, 4 with a set height of 8″ at 96 drops per minute. The camshaft is of 7″ diameter, of the Blanton fluted type, and the stems are 4″ in diameter. The height of discharge is maintained at 1″ above the level of the dies.

The different parts of the stamps weigh when new as follows:

Swedish iron stem, 4″ dia. x 16 ft. long	681 lb.
Cast steel tappet, 10⅛″ x 14″, key and gib...	190 lb.
Cast steel head, 9½″ dia. x 24″ long	41 lb.
Forged chrome steel shoe, 9¼″ x 12″........	254 lb.
	1,537 lb.

Each battery of ten stamps is driven by a 40 h.p. motor running at 575 revolutions per minute. The motor is placed directly under the ore bin and drives with a 12″ wide rubber belt to the countershaft placed below the feeder and mortar floor. This countershaft runs at 113 revolutions per minute and is placed at 11′ 7″ centres from the motor. Drive from countershaft to camshaft is by a 12″ wide x 8 ply belt to a 6 ft. diameter camshaft pulley. The operation of the various battery motors is controlled by individual switchboards arranged side by side, under the battery ore bins.

The ores from the Cobalt district are very hard and tough as may be seen by the figures given in the following table:

Battery Screens and Crushing Duty.

Stamps operation.	Mesh per in.	Size of Wire in.	Aperture in.	Stamp duty per 24 hr.
Early Practice.				
20	8 x 8	0.048	0.077	5.7 tons
20	2 x 4	0.072	0.178	
Present Practice.				
20	3 x 3	0.072	0.261	6.7 tons
20	2 x 2	0.092	0.408	

Screen Pulp Grading Mesh.

+8	+20	+60	+100	+150	+200	—200 Sands	—200 Slimes
25.1%	29.8%	17.89%	5.93%	1.93%	1.65%	4.28%	12.43%

The battery screens are 18″ deep and are made of high carbon crucible cast steel, double crimped, wire cloth. This quality of screen has been in operation now for three months, and shows practically no signs of wear.

The chilled cast iron liners, 1″ thick, of the mortars last but 30 days, while Manganese steel liners last as long as 165 days. The life of the shoes is 105 days, equal to 703.5 ton days.

The power necessary to drive each 10 stamps is 23 k.w.

A dilution of about seven of solution to one of ore gives the best results in the mortars whilst crushing.

The battery feed tank is 20 ft. in diameter and 15 ft. deep; it contains 147 tons of solution, and the bottom of the tank is 8′ 6″ above the top of the mortar. The main pipe between tank and batteries is 6″ diameter, with flanged connections for pipes, fittings and valves, to enable the easy cleaning of pipes.

On account of the preliminary desulphurizing treatment which is given to the ore before it is cyanided, it is necessary to crush in the battery with a 0.25% caustic soda solution, having no cyanide in it; 5 lbs. of lime are added to each ton of ore, as it is placed in the battery ore bin; this is necessary for the settlement of the slime in the collecting tanks, enabling a clean solution to be returned for recrushing and classification purposes.

Classification and Fine Grinding.

The importance of extremely fine grinding was clearly demonstrated in the early experiments, and further experimental work confirmed this. The grinding was then considered on the basis, that all the ore (metallic silver included) had to be ground to pass a 200 mesh screen; that this product had to be classified to take out the —200 mesh sands for regrinding and further classification, until there remained only about 15 to 20% sand, much finer than —200 mesh, in the product delivered to the cyanide plant.

The need for an accurate method to determine the percentage and grading of these sands and slimes was soon apparent and resulted in the use of a small system of cone classification to replace the earlier practice of hand panning. Three tin cones, respectively 5½″ diameter, 7″ diameter and 10½″ diameter at the top, were arranged in series for these tests with a water dilution tank, 8″ diameter by 8½″ deep, so placed as to give a 6″ head. The pulp to be tested is slowly fed into the first and smallest of this series of cones and the different grades of sands and slimes are recovered from each cone. As this device worked fairly accurately, two of them were installed, so that a constant check could be kept on this work, as the final residues from the cyanide plant almost invariably rise or fall according to the efficiency of the grinding.

As an instance of this, when the mill pulp is delivered to the cyanide plant it shows a grading test as follows:

3% to 4%....................+200 mesh
30% to 35% sands in ....—200 mesh

The final residue after cyanide treatment assays about 3.50 oz. to 5.00 oz. silver per ton.

When the pulp shows grading test as follows:

0.5% to 1.0% ....+200 mesh
15.0% to 20.0% sands in..........—200 mesh

the final residue after cyanide treatment assays under 2.00 oz. silver per ton of ore.

The necessity of such fine grinding of the ore accounts for the large tube mill and classifier capacity as compared with the number of stamps operating. The classification is obtained with one Drag classifier and 6 Dorr duplex classifiers, the slime overflow lips of which were raised 5″ to give greater opportunity for the settlement of the —200 mesh sands, and to prevent them from being carried over with the fine slimes as they overflow to the cyanide plant.

*Extracts from paper presented at Annual Meeting, C. M. I., Montreal, March 4, 1914.

Tube Mills.

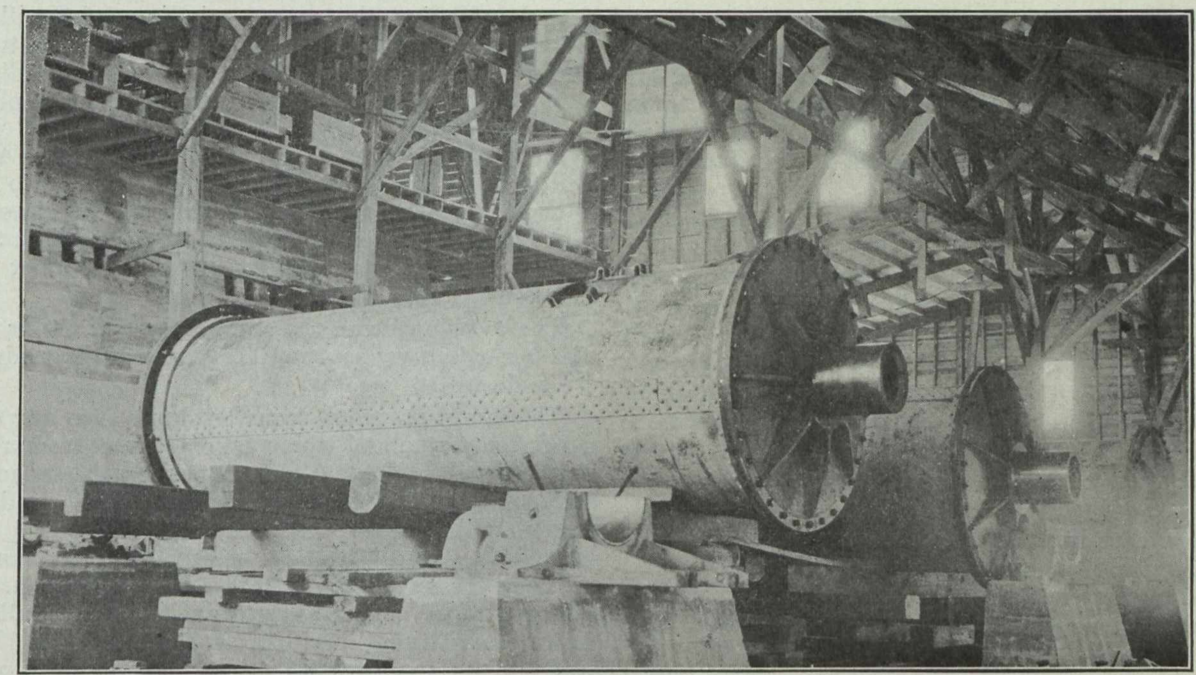
The four tube mills are 6 ft. in diameter x 20 ft. long with end bearings 20″ diameter x 18″ long. The feed end bearing or gudgeon is fitted with a removable, hard iron, spiral grooved liner, 9″ inside diameter, to the outside of which is fastened the feeding device, consisting of a cast iron spiral scoop, inside dimensions of which are 6″ x 6″. This scoop picks up from a wooden box the pulp which is to be fed into the mill. The discharge and gudgeon has a chilled cast iron screen with ½″ diameter holes in it to retain the pebbles inside the mill. The shell of the mill is 9-16″ thick and Silex bricks 4″ thick are used for inside lining. There are two 18″ x 18″ manholes. The mills run at 25 revolutions per minute and are driven by pinion and spur gears of 15 and 100 teeth with 3½″ pitch and 12″ face, from a countershaft to which the 96″ diameter x 19″ face driving pulley is connected through a quill and friction clutch. The weight of the 2 cast steel heads, 1⅝″, is 12,000 lb. The total weight of each mill is 45,375 lb.

The mills are arranged parallel to each other and at right angles to the battery, the driving, shafting and gears being arranged at the feed end of the mill. Each mill is driven by a 125 h.p. motor running at 580 revolutions per minute, the motor pulley is 28″ diameter and 19″ face, and is belted to the 96″ diameter pulley on the countershaft. Two of the mills, with their motors, are placed with 19′ 4″ between centre lines the other two with 24′ 4″ centres, the drive being transmitted through 8-ply endless, stitched, rubber belting, 18″ wide.

This system of driving has proved very satisfactory; none of the belts after 12 months' continuous service having yet been cut or spliced. The power necessary to drive each mill, when they are carrying a pebble load which is about 2″ to 3″ above the centre line of the tube mill, is 85 k.w. The mills operate in a closed circuit, two of them taking the classified pulp from the battery and the other two taking the classified fine sands for regrinding. The two coarse grinding tube mills are charged with flint pebbles and a hard ore pebble, selected from the hardest portion of the run of mine ore; the average consumption of pebbles in these two mills, per ton of ore crushed, is about 1.8 lb. of flint pebbles and 2.0 lb. of ore pebbles. The two fine grinding tube mills are charged with flint pebbles only and the average consumption per ton of ore crushed is about 4.3 lb., thus giving a total consumption of 6.1 lb. of flint pebbles and 2 lb. of ore pebbles.

The best grinding efficiency is obtained in all mills when the pulp carries about 40% of solution.

The following data afford the particulars of the feed and discharge of the mills when operating on the basis of 244 tons per day:



Tube Mills and Stamp Mill Foundations, Nipissing Mill.

Tube Milling Data.

	Two Tube Mills on coarse grinder, fed by Duplex Classifiers, each Classifier handling about 61 tons in 24 hours.				Two Tube Mills on regrinding, fed by 2 Duplex Dorr Classifiers and 1 drag Classifier.			
	No. 3 Mill.		No. 2 Mill.		No. 1 Mill.		No. 4 Mill.	
Mesh	Head Sample or Feed to Mill.	Tail Sample or Discharge.	Head Sample.	Tail Sample.	Head Sample.	Tail Sample.	Head Sample.	Tail Sample.
+20	57.02%	5.8	58.89%	2.90	2.12	0.4	4.46	1.44
40	14.7	5.58	14.74	4.96	1.90	0.92	3.86	0.70
60	5.17	6.04	6.82	7.6	2.44	1.00	5.38	1.56
80	4.26	6.24	4.19	8.96	5.06	7.77	6.60	3.80
100	4.73	9.2	4.10	11.32	12.06	2.74	11.34	10.40
120	3.48	7.6	2.47	6.96	11.14	6.46	2.40	9.80
150	0.30	0.40	0.27	5.0	1.42	0.4	3.92	0.62
+200	3.44	6.86	1.43	8.9	18.40	12.90	18.0	4.38
—200 Sand	5.21	19.30	5.28	18.11	41.19	38.27	39.94	38.44
—200 Slime	1.67	32.18	1.58	24.73	3.11	28.23	3.02	28.16
Totals	99.98	99.20	99.77	99.44	98.84	99.09	98.92	99.30

The battery pulp is conveyed to and classified in the first set of four classifiers; the slimes overflow direct to the slime collecting tanks in the cyanide plant and the oversize from all four is delivered into the two coarse grinding tube mills.

The above table shows the grading of the product fed into these mills.

The discharge from the coarse grinding tube mills then flows into the second set of two Dorr classifiers, where it is again separated into slimes and sands, the slimes overflowing into the same slime collecting tanks and the sands are elevated to the two fine grinding tube mills. The above table shows the grading tests of these mills.

The discharge from the fine grinding tube mills flows into the drag classifier and the above set of two Dorr classifiers; the slimes overflow to collecting tanks and the sands are returned for further fine grinding.

In this system all sands and metallic silver are kept in a closed circuit until they have been ground fine enough to overflow the weirs of the classifiers; and, on account of the fine product desired, the weirs were raised and the capacity of these standard classifiers was very much reduced so as to give more opportunity for settlement.

The best classification is obtained when working with a dilution of about 8% solution to 1 of ore, and frequent sampling of the slime overflow is necessary to ensure that too many fine sands are not passed over to the collecting tanks.

Tonnage and Values.

All the ore is weighed into the mill over a Fairbanks registering scale, a simple and effective method of recording the tonnage. These weights are then checked against the usual method of specific gravity tonnage determination, made in the slime plant, and after a seven months' mill run there was only a variation of one-eighth of 1% between the two methods.

Many moisture determinations have been made on a large scale on the ore entering the mill, and the average shows 1.5% moisture during the summer months and 2.0% during the winter months.

The head assay value is taken by an automatic sampler, the slotted pipe of which cuts vertically through the mill pulp as it enters the cyanide plant, about every six minutes. The ore in the pulp at this stage has all been crushed to finer than 200 mesh in a caustic soda solution, with no cyanide; hence this ensures as correct a sample as it is possible to get. The residue sample is taken while the filter box is discharging, a number of cuts of the pulp being taken from each discharge opening and then all mixed together. On the basis of the above determinations a check has been kept on the silver bullion produced, and, although a final cleanup will not be taken until the end of the year, more silver is already being produced than the commercial assay of the ore calls for, which warrants the consideration of the difference between the commercial, and the corrected, assay value of the ore.

The pulp as it flows from the classifiers, that are in the crushing department, into the cyanide plant has a dilution of 11 solution to 1 of dry slime.

The launders around the mill are all built of 2″ dressed dry white pine. The one from the battery to the Dorr classifier carries a pulp ground to pass two meshes to the inch with a water ratio of 7 to 1; this is 9″ wide by 7½″ deep and is placed on a 15% grade; the bottom of this launder is lined with a chilled, cast iron liner which is ⅝ of an inch in thickness, the wear and tear on this plate, which has been in operation for twelve months, has amounted to ⅛ of an inch.

The launder carrying the oversize from the classifiers to the tube mill has a pulp diluted to 40% for tube mill grinding; this launder is 4″ wide by 8″ deep and the bottom is lined with 3-16 of an inch sheet iron. The launder feeding the coarse grinding tube mills has a 30% grade; the one feeding the fine grinding tube mill has a 23% grade. The launder carrying the discharge from the tube mills to the lower classifiers is placed on a 6½% grade, is 6″ wide by 12″ deep, and is lined with 3/16 of an inch sheet iron on the bottom; the tube mill pulp is diluted with a ratio of about 10 to 1. The launder carrying the overflow over all the classifiers to the slime collecting tanks has a 4.7% grade, is 9″ wide by 8″ deep, and carries an all-slime product diluted to about 11 to 1.

The overflow from the slime collecting tanks runs to the lower battery solution tank on a 5.5% grade and is 9″ wide by 12″ deep.

The launders which transfer slimes into any cyanide treatment tank, and which take delivery from a 7″ centrifugal pump of 1,000 gallons per minute capacity, are 22″ wide by 18″ deep and have a 3.1% grade; they carry a thickened liquid with 1 of slime to 1½ of solution. The other launders which transfer slimes into cyanide treatment tanks take delivery from a 4″ centrifugal pump which has a capacity of 230 gallons per minute, and these launders are 11″ wide by 12″ deep and have a grade of 3.1; they transfer a pulp of the same ratio, namely, 1½ of solution to 1 of slime. The launders which take the decanted solution from the cyanide treatment tanks are 19″ wide by 15″ deep and have a 1% grade.

Cyanide Plant.

The description of the cyanide plant was reprinted in the Feb. 1 issue of the Canadian Mining Journal, pp. 99-101.

Electrical Power.

In a mill where the average power costs represent about $4,000 of a total working cost of about $28,000 per month, it was advisable to arrange the installation so that as high an efficiency as possible might be obtained. The installation was so planned that each machine should be of the correct size to carry its load, and thus, obtain the highest efficiency and power factor. As a measure of the success obtained in this respect it may be stated that the power factor of the mill averages 82.5%.

Cost of Electrical Installation.

Motors, switchboards, wiring, etc. and labor	$26,532.86	
Electric lighting of mill	1,635.61	
		$28,168.47
Extra wiring, poles, etc. for the Peterson Lake pumping plant located about 1,560 feet from the main buildings		250.00
		$28,418.47

Power is received at a pressure of 11,000 volts and is transformed to the working pressure of 550 volts in a sub-station situated 150 ft. from the main building. A 3-phase overhead line from this sub-station feeds the main switchboard, which is placed on the tube mill floor, this position being about the centre of power consumption. From the main switchboard, feeders are carried, through suitable links and disconnecting switches, to the various motor control boards.

The motors are all 3-phase, 550 volts, 60-cycle, Canadian Westinghouse type G.M. machines. The "squirrel cage" rotor was selected on account of its ruggedness and simplicity. The average full load efficiency and power factor for each class of these machines was found after careful testing to be:

Original Motor Power Distribution.

Washing Plant—Operates 6 Days of 9 Hours Each, per Week.				
1	40 h.p. Motor	850 Revs. per min.	Main drive	
1	15 h.p. Motor	565 Revs. per min.	Aerial tramline	
1	30 h.p. Motor	720 Revs. per min.	Surface hoist	
1	10 h.p. Motor	900 Revs. per min.	Elevator hoist	= 95 h.p.
Battery—				
4	40 h.p. Motors	575 Revs. per min.	Battery drive	
1	40 h.p. Motor	575 Revs. per min.	Return solution pump	
1	10 h.p. Motor	1120 Revs. per min.	Elevator ore bin	
1	5 h.p. Motor	1800 Revs. per min.	Conveyor belt	=215 h.p.
Tube Mills—				
4	125 h.p. Motors	580 Revs. per min.	Mill drive	
1	5 h.p. Motor	1120 Revs. per min.	Lower classifiers	=505 h.p.
Treatment—				
1	125 h.p. Motor	485 Revs. per min.	Agitating tanks	
1	35 h.p. Motor	855 Revs. per min.	Circulating slime	
1	20 h.p. Motor	690 Revs. per min.	Circulating desulphurizing	
1	20 h.p. Motor	690 Revs. per min.	Alkali pump to cyanide tanks	
1	2 h.p. Motor	1800 Revs. per min.	Experimental plant	=202 h.p.
2 Filters—				
1	80 h.p. Motor	870 Revs. per min.	Filter Box—Cyanide	
1	35 h.p. Motor	855 Revs. per min.	Filter Box—Alkali	
1	10 h.p. Motor	570 Revs. per min.	Vacuum pump cyanide	
1	1 h.p. Motor	1200 Revs. per min.	Hydraulic valves	=126 h.p.
Precipitation—				
1	10 h.p. Motor	570 Revs. per min.		= 10 h.p.
Water Service—				
1	25 h.p. Motor	1800 Revs. per min.	Centrifugal pump	= 25 h.p.
				28 Motors=1178 h.p.

Cost of installation $24.15 per h.p. of Motors.

Efficiency of Motors.

For 125 H.P. Class.	Efficiency=91%	Power factor 89.6%
For 80 H.P. Class.	Efficiency=89%	Power factor 88 %
For 40 H.P. Class.	Efficiency=88.3%	Power factor 86.9%
For 35 H.P. Class.	Efficiency=87.5%	Power factor 83.6%
For 15 H.P. Class.	Efficiency=85.8%	Power factor 85.5%

Each motor is provided with a control panel upon which are mounted a 3-pole, automatic, oil circuit breaker and auto starter, fitted with no-voltage release, ammeter, and a serviceable inverse, time-limit relay, in the form of fuses, and a double pole, spring tumbler switch, inserted across the circuit breaker, tripping coil terminals. This relay is used for starting duty only, and, in conjunction with the no-voltage release on the auto-starter, renders the gear practically "fool-proof." The motor control panels, 1′ 6″ wide x 6′ 0″ high, are grouped to make switchboards of convenient size, and are so placed that the machines which they control may be easily seen from them. The main switchboard is equipped with an automatic, 3-pole oil circuit-breaker, controlling the entire mill supply, a volt-meter, ammeter, integrating wattmeter, and a graphic recording wattmeter. The wiring of the graphic wattmeter is so arranged that a record of either the total mill load, or the load of any individual motor, may be obtained. All wiring within the mill is carried in steel conduits. The average total load on the mill amounts to 690 k.w. The recording wattmeter registers a variation of less than 5% from this figure from day to day, on the day load.

Much credit is due to Mr. W. H. R. Burrows, the company's resident engineer, for the excellent installation and high efficiency obtained in this power service.

In conclusion, the writer wishes to acknowledge the encouragement and assistance of Mr. R. B. Watson in the many difficulties that developed before all the details of the system and installation were satisfactorily worked out. Thanks are also owing to Mr. Watson for permission to publish the data in this paper. The writer also desires to pay tribute to the good wo done by Mr. Hamilton and Mr. Denny, in the course both of the experimental work and of the starting of the mill.

ELECTRICAL TRAINING FOR MINING ENGINEERS*

By Alexander Anderson.

In common with many other industries the science of coal mining is advancing, and the mining electrical engineer must extend his knowledge to cope with the new conditions which are constantly arising. Indeed, were it not for this fact, there would be no necessity for this Association and no occasion for this address. Experience has taught us, however, that the necessity exists and is every day becoming more apparent and more real. I have said on former occasions before members of this association that no man can rely on his own experience, however wide. It must be leavened by the experience of others if steady progress is to be made and maintained. I admit progress may sometimes be made single-handed, so to speak, but it is too slow for this age. Conditions have altered, and we must be prepared to meet them. To do so, I am prepared to give of what time and energy I may have at my disposal in trying to further an organization which has for its object the promotion of the study of electrical engineering in its relation to mining. As a matter of fact, the need for study is advancing, not by degrees, but by leaps and bounds. If the modern colliery electrical equipment is to be run and maintained in not only a safe condition, which is the first essential, but a condition that will satisfy the owner and justify its existence as an economical aid to mining, the day for the engineer who has only a little elementary knowledge of electrical machinery is gone, and the sooner he realizes the fact the better, not only for himself, but for all those associated with its use.

Our late president (Mr. Maurice) said in one of his addresses that "English working people on the whole are not much given to self-improvement." I say so much the worse for the people and so much more the need for those who see the necessity for it to bestir themselves to try to cultivate that something which is wanting in the people to whom he refers. If we are to keep our place amongst the nations which our good fortune and energy have given us, it will be done only by every individual realizing his responsibility, not only to himself, but to the country of his birth. This association has found there is a great deal of truth in Mr. Maurice's remarks, and I would ask you now to give them the attention they deserve and try to find out ways and means of arriving at the solution of the problem, because it is a problem and must be treated as such. Some of our branches, in the last two years, realizing the necessity of facing this question, have met with some success. They have organized lectures in colliery centres, enlisted the sympathy of resident colliery officials, and secured lecturers from within and without their own membership. These meetings have been made very popular and interesting with the aid of lantern slides, illustrating electrical mining appliances. When I tell you I have myself seen an audience of over 300 people—some travelling by train distances of over 20 miles—I think you will agree there is a great field open and quite ready to be tapped if proper enthusiasm is shown and the sympathies of the people enlisted. I commend this method as a stimulus to the ambition which is in every man, latent, perhaps, but requiring only to be stimulated in order to be awakened. There must be other ways of encouraging the progress of this great work, and I feel convinced that, given the attention which is both due and imperative, we may look forward to this association filling up the "fault," if I may so speak, in the path of progress.

The average engineer has not a great deal of time during the day to think or study. It is work that is expected of him, but the man who gives up some of his spare time to study the science of his profession will find that he gets back the time spent with compound interest. Nearly everything he does will have added interest. Knowledge is not only power, it means also personal respect. For instance, what can a man know about the power factor of a three-phase line unless he has studied the theory of alternating currents? How many men there are in charge of "plants" who have never given a thought to what happens to a line that is left in circuit when an "earth" develops on the other! A very little knowledge of theory makes both those questions interesting, but without the theory they may mean little or nothing until something happens. Electrical plant has now become so complicated that, to run it successfully, complete knowledge of its construction and characteristics has become not merely desirable, but essential.

As I have already said, things are moving by leaps and bounds, and it is very difficult to get really first-class men. Why? Many young men who enter the profession do not seem to realize the necessity for beginning their theoretical education at once, but rely solely on what years of practical experience may teach them. They do not seem to grasp the fact that a smaller number of years combined with some hard study would make them the competent and efficient professional men that all should aspire to become. If the latter course were adopted, I feel certain we would not have the same difficulty which to-day we meet with in finding reliable engineers amongst the younger men. Unreliable plant is very often the outcome of unreliable attention, not due to carelessness or laziness as some might think, but to the absence of technical knowledge in the matter of particular apparatus.

Everybody in or out of this association will agree there should be no room for anybody in the electrical world who does not know his work, but unfortunately, owing to the scarcity of the type of man we would all like to find, it is necessary sometimes to employ men who require a good deal of guidance where none should be required. What happens? High maintenance costs and sometimes irreparable injury to some apparatus or other. Unless a man is capable of "detecting" trouble in its early stages, or of seeing that his apparatus is kept in a condition calculated to avoid trouble, high maintenance charges may be expected. Indeed, this is common to all plant, but more particularly to electrical plant. A man who does not know his work is not only a menace to his employer, but a source of great trouble to the manufacturer. A man who understands his work can state his case, and by doing so at the proper time things can be straightened out; but the other type of man cannot, and because he cannot, saddles the blame on some other shoulders, prefacing his note, of course, by saying "It never was right." What we want is not

*Extracts from Presidential address, Association of Mining Electrical Engineers, Birmingham, October, 1913.

merely that "plant" should be "right" when it is placed, but that men who receive the "plant" are capable of knowing that it is "right."

I do not want, however, to lay the blame every time on the man in this unfortunate position, because in many cases, if he had had the opportunity of improving himself he would have done so, and this is our opportunity. Let this association, in the first place, show him the need, and then the way to improve himself in matters electrical. We are all accustomed to hearing an expression of opinion regarding the large number of rules and regulations that are laid down for our guidance, but I would ask—can we not do something ourselves to prevent the necessity for them? I think we can, and the elimination of the unreliable for the reliable engineer is the first step in this direction. The Rules and Regulations which exist to-day for our guidance require the latter type of engineer, and if we do not wish to court the necessity for further regulations we must do all we can to see those already existing efficiently executed. In doing so we are doing no more than may be expected of us. I think an engineer who values his reputation as such will see that they are carried out, and avoid getting himself and other people associated with him into trouble. To carry them out he must be energetic, and willing to spend a little of his time in order to become quite conversant with the class of practice permissible in mining. The present Electrical Rules are short and easily grasped by the alert enginer. To be alert in the true sense of the word the engineer must be a student, and the encouragement of studentship has always been the aim of this association. This encouragement has been shown by members of the different branches of the association, in the giving of prizes for papers of merit on electrical subjects which have been read from time to time.

As years go on we will see a steady development in the use of electricity as an aid to mining. Already we have collieries equipped which from the winding engine to the undercutting of the coal rely solely on electricity as the motive power, and this class of colliery is rapidly extending. What does all this mean? Electrical plant generating units of thousands of h.p. running at thousands of revolutions per minute, with their attendant condensers, and so on. Anyone will agree that to give machinery of this class the supervision it deserves requires no apprentice hand; the head and hands of the engineer are required. His work does not end here, however; units of this class are not controlled by means of the simple switchgear one can still see at the present time. We now find our engineer should understand the latest and best in switchgear, and all that goes to make up that extraordinary piece of apparatus. He must also be competent to select and calculate the size of his transmission lines, and it is just here that a great weakness is often shown. It is not uncommon to find 400 volts where one is entitled to expect 450.

Having selected his lines the engineer must turn his attention to his distribution gear. The tendency at the present time is to have this completely enclosed in cast iron with all interconnections made inside the casing. This is very effective and very safe. One is frequently struck, however, with the primitive housing given to underground switchgear. Nothing lends itself so readily to badly-kept apparatus as badly-designed housing. The average underground distributing station of the present day will compare badly with that of the future, when we may expect to see well-made walls and clean and even floors. The housing will be well lighted, as our successors will have learned what many of to-day evidently do not know, that plenty of light is essential to that degree of cleanliness which is demanded by either open or enclosed gear. Cables will enter and leave the station in a manner calculated to give one the impression that the engineer has an intelligent idea of where he means the cables to go, and not as we find too often now, the "bunching" process so rigidly adhered to as to suggest that this method is indispensable to well-installed lines. The engineer will have such a grasp of the necessity for complete and regular inspection of his lines, that he will see they are erected in such a manner as to make inspection not only as easy as possible, but also of some value when completed. He will realize that the leaving of road cables exposed to dripping water or buried in debris does not tend to economy, and that it is worth his while to adopt measures to give them that protection which the circumstances demand. Positions for sub-distribution gear will be chosen with due regard to accessibility, and a piece of apparatus hidden in the waste will not be tolerated. These appliances will get the place to which they are entitled, although one does not expect their housing to be of such a permanent nature as that of the main station. Although they are not of a permanent character it will be clearly recognized, however, that the first and last consideration in erecting electrical apparatus is safety. In damp workings especially, the importance of properly finishing off the ends of the cable will be recognized and all joint boxes will be well filled or made waterproof. Pumping and haulage stations will be well built and as well lighted as the circumstances demand. It will be recognized that this is not only essential for safety but is true economy. The motor attendant will not be expected to be the first to report signs of failure. This will be the duty of the engineer, who will keep a proper record of all motors under his charge, not only with regard to electrical tests but also in the matter of their condition mechanically. We have not many men to-day who are capable of looking after both the electrical and the mechanical side, but our future requirements, in my opinion, will necessitate all engineers combining both qualifications.

We have a difficulty at the present time in finding sufficient men who are able to do this. The engineer who recognizes that the majority of electrical breakdowns are due to inattention and dirt, will see that oil, grease and dirt are kept in their proper place, and that bolts which perform a useful function when tight, fail to do so when slack. If the insulation resistance is gradually falling, he will not wait until a "fault" develops, but will take steps to remedy the defect before it is too late. In doing so he will not only save himself much unnecessary trouble, but he will also save his employers money. Numerous as electrically driven coal-cutters are to-day, they will be still more so in the future, as the time is surely coming when little coal will be mined by hand. This will increase the work of the electrical engineer. I think the engineer should take some pains in educating motor attendants as to how apparatus under their charge should be handled, as it seems to me there is something wrong in placing apparatus worth hundreds of pounds in the hands of men who have little or no previous experience in their proper use. If more attention were paid to the education of the motor attendant, less would be heard about the maintenance charges. One "shift" of incompetent handling may necessitate repairs the cost of which would pay the wages of an instructor for six months. In a colliery using a large number of coal-cutting machines, changes amongst those in charge will be of frequent occurrence, and a capable instructor employed for no other purpose than as a responsible party to see that every machine is being properly handled, would well repay the management that recognizes this necessity.

I may be accused of creating extra officials, but in mining, as well as in every other industry, circumstances have arisen which make competent supervision, if not absolutely essential at least desirable if we want the maximum of profit and the minimum of trouble. Everything is now being boiled down to either units of weight or units of time, making mathematical precision the golden rule to be learned and observed by all. To maintain this precision and keep everything working in harmony, our gear must be selected suitable for its work, and thus shall design and workmanship come to their own. With the growth of technical education this is now becoming more generally recognized, and I am optimistic enough to think the day is not far distant when this will be universal, at least in the electrical world. We will then see at our regular meetings those gentlemen whom we only meet to-day in a so-called commercial capacity, and I feel satisfied those meetings will prove of interest to them, a pleasure to us, and a profit to their employers.

THE ELECTRO-METALLURGY OF STEEL.

Mr. Woolsey Johnson in the March, 1914, issue of Metallurgical and Chemical Engineering says in part:

There are three roads along which future progress will be made in applying electricity to steel metallurgy. Fortunately, we can record some pronounced commercial success in each line, and have generally recognized facts of the past and present on which to base hopes of the future; we have the evidences of things seen for existence of things unseen.

The three present roads are as follows:

(1) Crucible cast steel or alloy steel making.

(2) Steel castings in foundry.

(3) Super-refining of hot steel for "tonnage" steel in a steel plant.

In the first, unquestionably is the largest margin of profit. But an examination of the process for making "tool" steel does not disclose any great lack of satisfaction among user and maker. Much bad steel is sold as tool steel, but a great amount of fine steel is made in crucible to satisfaction of maker, vendor and user.

Unquestionably there are innate points of superiority in the electric steel furnace over the crucible. These can be enumerated as follows:

(1) Decreased labor charge.

(2) Dispensing with crucibles.

(3) Increased thermal efficiency.

(4) Control of temperature and chemical conditions.

All these can be summed up in fact that size of unit could be increased at will. Under (4) we might point out that the reaction between oxygen and carbon dissolved in steel comes slowly to equilibrium and that so-called "dead-killing" done in crucible can be effected much more easily in the electric furnace, and that a dense ingot can be better obtained by electric furnace than by crucible.

If we consider the electric steel furnace for alloy steel we see that its control over reductivity profoundly affects the commercial conditions in dealing with easily oxidized elements, as manganese, chromium, etc.

If I were going into the electric stool steel business, I would choose some special new field like the production of steel for mine drills. Here the advent of small high-speed hammer drill has brought a necessity for a better grade of steel, selling, say, for 8 cents per lb. This would give the newcomer more of an even chance, especially as the purchasers would buy in large blocks and would be guided by technical advice.

In arguing pessimistically in all the above, I disclaim any intention of doing anything but pointing out the general great commercial inertia and friction that confronts this and every similar innovation. My conviction of the gradual commercial success of the electric tool steel furnace is no less strong even if I see clearly the forces opposing it.

Electric Steel Castings.

In the steel castings we have much greater chances for an immediate broad expansion of the electric steel furnace. The economic freedom is great. For instance, in every industrial centre there is a growing demand for steel castings from many consumers, and there is produced often by some people a large amount in the aggregate of steel drillings and turnings, "fins" from drop-forge bar plant, all of good chemical quality and all sold at a discount because of physical nature. Some of this contains oil enough to do all the pre-heating under which procedure the energy consumption would be reduced to 350 kilowatt hours per ton of product. Besides this there is often "off-peak" power that could be purchased from central stations for 7 mills to 9 mills.

Under such conditions it is perfectly possible to produce liquid steel suitable for castings for $26 per short ton; in fact this is an accomplished commercial fact. With a good-sized plant and especially favorable conditions it is quite probable that liquid steel could be made for $18 per short ton, and this is not the ultimate. The "baby" converter which uses a "high-silicon" low-phosphorus pig iron costing at an average of over $20 per ton has a serious rival in the electric furnace for production of smaller castings.

The quality of electric steel is high and its physical properties are such that with careful molding a higher percentage of merchantable finished castings can be expected. It must be realized that in any foundry careful planning of the molding work is a sine qua non, and the electric steel foundry should have ability equal to that of competing plant. Molding is at least 50 per cent. of the battle of the electric steel foundry.

We may even hazard the prediction that the open-hearth steel foundry has a potential competition in the electric furnace on large castings.

Tonnage Electric Steel.

In considering this subject we see that the legitimate hopes of the pioneers have been deferred. In apposition to this is the opposition to the electric furnace by the old-time steel men. This is a perfectly natural human feeling.

In the manufacture of tonnage steel it is natural to give this a first quick refining in the Bessemer or open-hearth furnace, pour the partially refined steel into the electric furnace, finish the refining there by use of a slag high in lime, allow reactions to come to equilibrium, the gases to pass off and the impurities to come to the top, and after this "dead-killing" is accomplished, to pour the metal into ladle. It was this accomplishment with the discovery of the "calcium-carbide" slag and the practicalization of the "series arc" furnace that was the second great contribution of Paul L. T. Heroult to electro-metallurgy.

This electric process has given new life to the Bessemer converter, and there are those that see a "triplex" process, bessemerizing basic open-hearth treatment with final electric furnacing, as the process of the future. This may well be for certain large installations.

Certain it is that when operating in a large way on "duplex" process, the electric furnace can make steel of a superior quality at a cost slightly, if any, above the cost of that made by fire in a single operation. With the demand as pressing as it is now for "high-duty" steel rails, it is likely that the first marked commercial expansion in tonnage electric steel will be in the way of making a quality steel rail.

BOOK REVIEW.

IGNEOUS ROCKS AND THEIR ORIGIN—By Reginald Aldworth Daly, Sturgis Hooper Professor of Geology, Harvard University—McGraw-Hill Book Co.—Feb., 1914—Price $4.00—For sale by Book Department Canadian Mining Journal.

This book gives the substance of a course of lectures prepared for students in Harvard University and in the Massachusetts Institute of Technology. It is planned to meet the needs of those who desire either a general explanation of igneous rocks, or the more significant facts about them. Part I. is a summary of these facts, with a number of contributions thereto, a large part of which can be described quantitatively. Part II. treats of these facts in the light of the earth problem as a whole. Part III. treats them in relation to the comprehensive theory outlined in Part II.

The treatment is planetary and radically departs from that followed in any other work on this subject. The idea of a stratified earth and the related idea that basalt is the only primary lava are here for the first time systematically tested by the facts of modern petrology.

The author shows ground for belief in the gigantic development of secondary eruptive rocks and lavas; describes the relation between magmatic movements and the building of mountains; and explains volcanic action as well as the modes of igneous intrusion.

The emphasis throughout is on the field relations and the book has been written principally for the practical geologist. Students of ore deposits will find it of assistance in formulating fundamental principles of their science.

As was to be expected, Dr. Daly has written a very interesting book. He is an enthusiastic student of the subject of which he writes. He has contributed in recent years many valuable papers on the natural history of igneous rocks. Fortunately he had used a classification that is founded upon mineral composition.

RECENT PUBLICATIONS OF THE GEOLOGICAL SURVEY, CANADA.

Memoir 23.—Geology of the Coast and Islands Between the Strait of Georgia and Queen Charlotte Sound, B.C., by J. Austen Bancroft, 152 pp., 17 pls., 5 figs., 1 diag., 1 map, 1913.

Some of the main geological problems treated in this memoir are: The petrography of the igneous rocks of the Coast range, the methods of igneous intrusion and the regional and contact metamorphism of the stratified rocks. The study of details was limited chiefly to the geological relation of those areas where prospects were located or where mining development had been carried on.

Memoir 26.—Geology and Mineral Deposits of the Tulameen District, B.C., by Charles Camsell, 188 pp., 23 pls., 2 figs., 4 maps, 1913.

This memoir describes a rectangular area of 169 square miles lying in the Similkameen mining division in the southwestern part of British Columbia. This area embraces the villages of Tulameen and Granite Creek, the placer mining district of the Tulameen river and its tributaries, the coal basin on Granite creek and Collins gulch, and the gold, silver and copper localities on Bear and Boulder creeks and at other points. Platinum is an important constituent of the placers, and within this district lies the mass of peridotite carrying chromite, with which diamonds of minute size were found to be associated.

Memoir 30.—The Basins of Nelson and Churchill Rivers, by William McInnes, 146 pp., 19 pls., 1 map, 1913. (The map has not yet been received from the press.)

This memoir gives the results of explorations carried on in a rectangular area of about 220,000 square miles, having Fort Churchill at the northwest corner and Prince Albert at the southwest. The geological boundaries are laid down on the map with accuracy only where they cross, or occur in the vicinity of lakes or rivers; elsewhere owing to the extent of the region covered, they are necessarily only approximate. The region forms part of the extensive Pre-Cambrian peneplain of northern Canada encroached upon to the northeast, south, and west by more recent, flat lying sedimentary rocks. It embraces the section of country traversed by the Hudson Bay Railway.

Memoir 37.—Portion of Atlin District, British Columbia, with special references to Lode Mining, by D. D. Cairnes, 129 pp., 32 pls., 5 figs., 4 diags., 1 map, 1913.

Atlin mining district lies in the northwest corner of British Columbia. The placers of this district having been reported on by J. C. Gwillim for the Geological Survey some years ago, this memoir treats more particularly of the lode deposits. The topographical features, general geology and economic geology are discussed. The deposits of economically important minerals that are described are classified as follows:

I. Ore deposits.
- (a) Gold-tellurium veins.
- (b) Gold-silver quartz veins.
- (c) Cupriferous silver-gold veins.
- (d) Silver-lead veins.
- (e) Copper veins.
- (f) Antimony veins.
- (g) Contact-metamorphic deposits.

II. Coal.

Guide Books.—The Geological Survey has published a series of annotated guides to excursions to many of the leading mining centres and points of geological interest throughout the country. They are well illustrated and are accompanied by numerous maps. The areas described embrace sections of country lying adjacent to nearly all the leading transportation lines. They are of convenient size and should be of interest to the geologist or mining engineer visiting these sections of the country for the first time. Applicants should name the part of the country concerning which information is desired.

PERSONAL AND GENERAL

Mr. D. A. Thomas, the British coal operator, is in Ottawa in connection with the proposed railway for development of the Peace River country, where there are large coal deposits.

Mr. W. P. Alderson, general manager for the Motherlode Sheep Creek Mining Co., has returned to British Columbia from a visit to Eastern Canada.

Mr. Chas. A. Banks, general manager for the Jewel-Denero Gold Mining Co., is back at the Jewel mine, in Boundary district, British Columbia, after an absence of between two and three months, during which he made a trip to England and return. Mr. H. D. Quimby, who was in charge of the Jewel gold mine and stamp mill during Mr. Banks' absence, will probably return to the United States.

Mr. Clarence Cunningham, of Seattle, Washington, formerly interested in coal lands in Alaska, recently visited the Wonderful silver-lead mine, near Sandon, B.C., on which he and associates have been doing development work.

Mr. J. K. Cram has succeeded Mr. Roy Wethered as local superintendent of the Consolidated Mining and Smelting Co.'s several mines in Ainsworth camp, B.C.

Mr. Henry S. Fleming, of New York City, who is acting general manager for the Canadian Collieries (Dunsmuir) Limited, has been on Vancouver island, British Columbia, looking into the company's affairs, he having recently succeeded Mr. W. L. Coulson, general manager, who resigned.

Mr. A. Gordon French, of Nelson, B.C., left that province for England a few weeks ago, probably on a visit.

Mr. Thos. Graham, chief inspector of mines for British Columbia, paid an official visit to the Crowsnest district, Southeast Kootenay, just about the time the Rocky Mountains branch of the Canadian Mining Institute was holding a meeting at Fernie, in that district.

Sir Richard McBride, premier and minister of mines for British Columbia, arranged to pay a visit to Ottawa during the latter part of March.

Mr. Gordon McKenzie, gold commissioner for Yukon, was in Vancouver, B.C., about the middle of March on his return to the North after having spent part of the winter in California.

Mr. J. J. Malone, of Nelson, B.C., has been appointed liquidator of the Kootenay Gold Mines, Ltd., in place of Mr. E. K. Beeston, who died lately. The company was organized a few years ago to operate the Granite-Poorman gold mines and stamp mill in Nelson mining division, but was handicapped by lack of money for development work.

Mr. G. Middleton, manager of the Dominion Assay Office, Vancouver, B.C., is away on a three months' vacation. During his absence Mr. J. B. Farquhar is in charge of the assay office.

OBITUARY.

Mr. Duncan Irvine, who died in Victoria, British Columbia, on March 16, had been resident in that Province for 25 years or more. He was born near Blair Atholl, Perthshire, Scotland, in 1853. After a college course in Edinburgh, he gave particular attention to the study of geology, and was for a number of years in the service of the Royal Scottish Geological Survey. He went to California in 1886, and afterward to British Columbia. For three years 1906-1908, he was manager for the Berry Creek Mining Co., which was engaged in hydraulic gold mining in the vicinity of Dease lake, Cassiar district. Since that time he has been in the employ of the Provincial Government as Public Works Engineer for Vancouver island. He was widely known and generally esteemed, and his death is mourned by very many friends in British Columbia.

YUKON GOLD.

The New York special correspondent of Mining and Scientific Press wrote recently: Yukon Gold shares have been picking up, probably as a result of the good showing made in the report for 1913. With a gross output of $4,789,402, it showed operating profits of $2,537,447. The eight Dawson dredges made profits of $1,827,800, while the hydraulic work at Dawson showed a loss, since most of the season was spent on washing top gravel. The dredge working in the Iditarod made a profit of $507,800 and should do better next year. The two dredges in California brought in profits of $72,000, but one of them has only been at work a short while. Some comparisons of cost will be of interest. The hydraulic work at Dawson cost 9.7c., dredging at Dawson 29.53c., and at Iditarod 64.33c. per cu. yd. This high cost is largely due to the collateral and overhead costs. Thus at Iditarod a series of dams had to be built before and behind the dredge; large boulders gave trouble, as did heavy sand from workings above, and a stratum of clay which was encountered. The grade was steep—6 to 10 per cent.—and water was scarce. All these combined to make the necessary dredging cost nearly fifteen times what it is in the more favorable California areas. It is necessary for the company to write off large amounts as depreciation each year, and it still owes the Guggenheim Exploration Co. $2,100,000.

GRANBY.

Vice-President Edwin Thorne of Granby Consolidated, in statement accompanying check for dividend of $1.50, payable yesterday, says:

Results of operations at Grand Forks and Phoenix for quarter ended Jan. 31, 1914, show profit of $167,861, taking the unsold copper at 14½ cents, New York. At Anyox the new smelter was completed in January and news of its being in operation is daily expected, the delay being due to extraordinarily severe weather conditions.

Good progress is being made at the various properties leased and purchased during the last year; ore shipments to Anyox are expected from some of the properties during this month.—Boston News Bureau.

STEEL CO. OF CANADA.

The Steel Company of Canada has completed the sale of a block of $850,000 first mortgage bonds to a banking house in England. The proceeds of the issue will go to replacing working capital used up in expenditure on new construction work at the company's plants last year. The total outstanding bonds of the company are now brought up to $8,850,000, less the $500,000 held in escrow to redeem a like amount of Montreal Rolling Mills bonds. While the new block of bonds just disposed of was sold entirely to an English house, when a public issue is made it is probable that a portion of the $850,000 will be offered in Canada.

Haileybury, Ont., March 17.—The Elliott claims adjoining the Teck-Hughes on the west, have been sold to Toronto interests, who intend to form a company and proceed with development with as little delay as possible.

SPECIAL CORRESPONDENCE

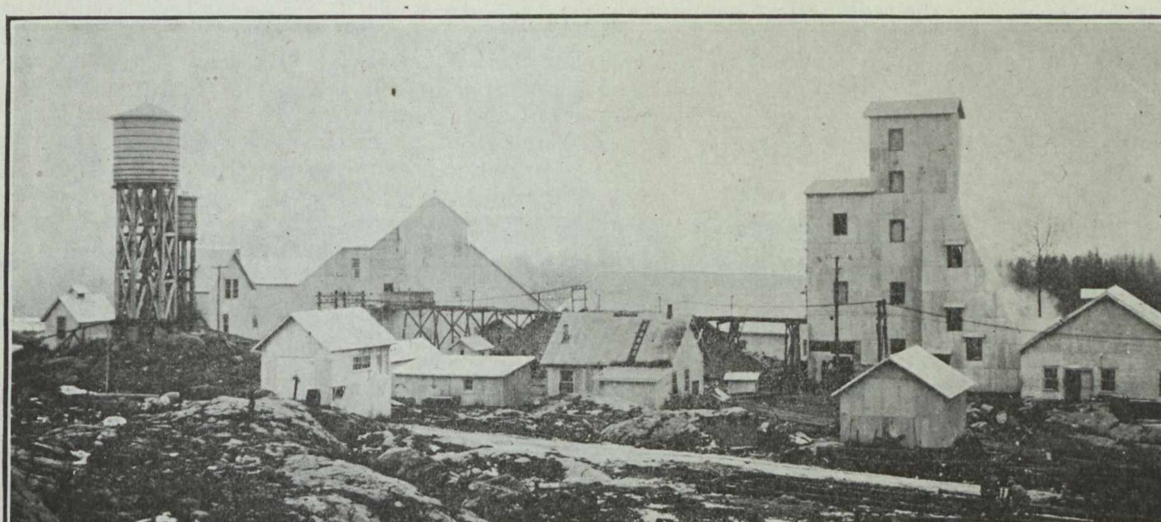
PORCUPINE, KIRKLAND LAKE AND MUNRO TOWNSHIP.

There are unmistakable indications that most of the prospects of merit in the Porcupine camp will be operated before the summer is far advanced. Owing to the keen demand for good gold prospects from London, New York and Cobalt companies, there is hardly a single property of any prospective value that could not now be turned over. It is a question of terms. The most important deal in the camp has been that whereby the McKinley-Darragh-Savage, of Cobalt, will enter the field as the temporary owners of the Jupiter mine. They will hold it on a six months' working option, with no money down, but a contract to do a large amount of development work that should place the Jupiter definitely among the list of regular producers —if the mine is ever to take that rank. The purchasing company will also pay off the bonds which some of the principal shareholders in Montreal now hold against the company.

The Jupiter has been closed down for almost a year. It is well understood that the abandonment of operations was due not at all to the merits of the mine, but to the condition of the money market at the time and the necessity the syndicate then controlling the property found to protect their interests elsewhere. There is not at the present time a plant on the Jupiter large enough to carry on extensive operations, the plant of the adjoining property, the Plenaurum, being utilized at the time when operations ceased. Plans were drawn for a mill in anticipation of the erection of a plant; but the purpose of the McKinley-Darragh will, no doubt, be to put as large a tonnage of ore in-sight as possible during their option. The agreement arrived at between the McKinley and the majority stockholders and bondholders of the Jupiter will probably be confirmed at a meeting of shareholders in Montreal on April 3rd. The Jupiter was mentioned as one of the properties likely to be included in a merger of Pearl Lake properties some time ago.

Foley-O'Brien.—Good ore has been struck in a winze at the Foley-O'Brien, which is now controlled by the Homestake Finance Co. of Buffalo. It was discovered as the result of an extensive scheme of development. A winze was sunk from the 160 ft. level to the 250 ft. level. At this point some excellent indications were found, which led the management to crosscut. Some remarkable ore is now being taken out of the vein. Drifting on the vein on both directions is now being pursued. The ore shoot was found directly under the creek, which runs just west of the town of South Porcupine. The Homestake Mines Finance Co. purchased the control of the Foley-O'Brien. In addition to work near the town, the No. 3 shaft, near the T. &. N. O. tracks, is being sunk to the 250 ft. level.

The Alexo mine, at Porquis Junction, shipped 622 tons of nickel ore last month, the heaviest from the mine in several months. The ore was consigned as usual to the Mond Nickel Co. at Coniston. Nineteen cars were loaded and shipped, more than one, each two days. This ore has been taken out of an open cut at 80 ft. and a drift of 115 ft. taken from the bottom of the open cut. The ore shipped—disseminated and massive—will average 5 per cent. in nickel. The ore, which has a width of about 20 ft. in the drift, is good in the bottom of the working. The plant with which the ore has been removed consists of only one drill run by a small boiler. The ore is hoisted with a small hoist. The working force consists of nine men.



Porcupine Crown Mine Buildings and Cyanide Plant, Timmins, Ont.

Dome Mine.—The statement for Dome mine for February shows a tonnage of 12,000 milled, $69,-000 recovered, and a value per ton of $5.74. The low tonnage milled is due partly to the fact that power was off for four or five days in a short month. The value per ton is the lowest yet shown in the Dome statements. The average value of recovery a ton for 11 months is $8.57. In April and May of last year the value was at a maximum, being over $13 a ton. During January this year the value was just over $8 a ton, and the recovery was $111,500. During that month the mill treated $13,900 tons, one of the best periods shown. The annual meeting of the Dome will be held this month.

North Dome.—The directors elected at the annual meeting of the North Dome Mining Co. were: Messrs. Richard Cartwright, president; Chas. L. Sherrill, vice-president; Alec Fasken, secretary-treasurer; Arthur Whitbeck and W. Thayer, directors. The property is controlled by the Timiskaming Mining Co.

COBALT, GOWGANDA AND ELK LAKE

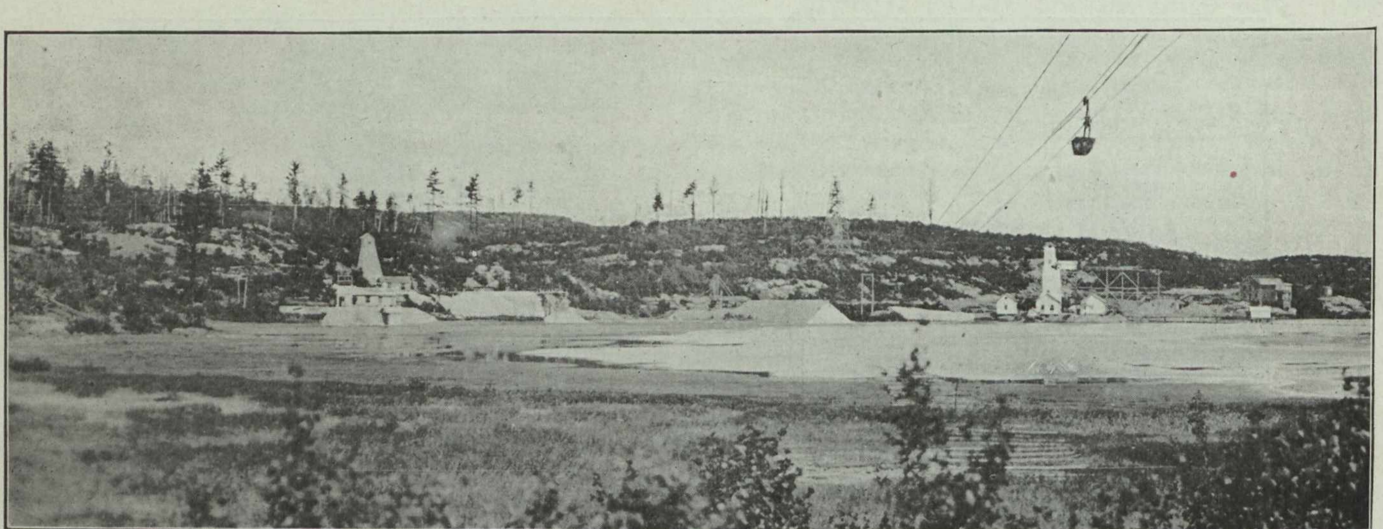
Several cuts in the dividends of Cobalt companies announced during the week has caused much outside comment. In as much as it has been common knowledge in the camp that the margin of profit over net earnings has been very narrow for some time on the Nipissing, the cut from 30 per cent. a year to 20 per cent. has been for some time foreshadowed. The directors felt that the burden of paying $450,000 a quarter was more than the profits on the lower grade of ore now being mined would bear for any length of time. At the same time the big surplus announced shows that the Cobalt Co. could have maintained the extra disbursement for some time had they so chosen.

A Cobalt Merger.—Announcement of the big merger of Cobalt companies controlled in England has been quickly followed by the detailing of plans for centralizing operations, with the Cobalt Townsite as a base. A new main working shaft has been started by the Cobalt Townsite Mining Co. and the steel head frame will be constructed over the working. A raise has been started from the 400 ft. level of the mine and it will break through about 60 ft. north of the mill of the Cobalt Reduction Co. The shaft will have two compartments for hoisting and will serve five levels. The steel head frame, the second in the camp, will be started next month and will be completed early in May. Hoisting from the new main shaft will commence about the first of June. This shaft will also afford a means whereby the City of Cobalt ore can be taken to the mill more expeditiously. It is now being hoisted up the main City of Cobalt shaft and run across a raised tramway to the mill. The City of Cobalt has again appeared on the lists as a regular shipper. Concentrates from this property amounting to over 100 tons have left the camp already this year.

Nipissing.—During the last month the Nipissing mine mined ore of an estimated net value of $255,159 and shipped bullion customs and otherwise of an estimated net value of $403,366.

At shaft No. 64, a depth of 900 ft. has been attained at which point a station has been established and a start made on a crosscut for the vein 255 ft. away. The formation at this depth is rhyolite, but it is expected that the vein will be found to occur in other Keewatin rocks. In order to find the depth of the diabase capping and the thickness of the underlying conglomerate, a vertical hole in now being put down with a diamond drill near Peterson Lake. At the beginning of the month the hole was 244 ft. deep and still in the diabase, although it is expected that the conglomerate may be encountered at any time now. Preparations are now being made for the washing of the surface on the Nipissing property tributary to Peterson Lake. The foundations and piers for the suction of the hydraulic pump are now being put in on the west shore of Peterson Lake, near the southeast corner of R. L. 404.

Right of Way.—Owing to the discovery of another high grade vein on the Right of Way Mining Co.'s shaft at the south end of the lake active operations have been resumed at both shafts. A vein was cut some weeks ago, and it is now beginning to make good ore at the 120 ft. level. There is at the present time in the face a vein two to two and a half in. wide, of 3,000 oz. ore. It has already been drifted upon for 50 ft. For more than a year now operations at the Right of Way have been confined to the milling of dump ore at the Colonial mill.



A view across Cart Lake, showing Seneca-Superior Mine, Cobalt, Ont.

Maidens Property.—At one of the few properties now working in South Lorrain an encouraging development is announced. In a contact vein of the diabase vein and Keewatin, on the Maidens property, some ore of good milling possibilities has been encountered. The new vein shows between eight and ten in. of calcite carrying native silver, while 15 in. of wall rock beside the vein will make profitable milling ore. The vein was found at the 75 ft. level of the No. 2 shaft.

The Caribou Cobalt is to-day paying dividends from profits made on ore which would not even have been milled two years ago. Owing to the fact that the Dominion Reduction Co. is already crowded with ore, the management cannot raise its tonnage milled to more than 1,175 tons per month, instead of the 1,800 tons aimed at. The net profit per month under the tonnage shipped is running between $10,000 and $12,000. Developments in the mine have been favorable. The ore reserves in the mine to-day have been considerably increased by the discovery that the wall rock will pay to mine for some distance farther back from the original drifts than was at first imagined.

More is now in sight than when the mine was taken over from the Drummonds. Stopes are developed from 5 to 13 ft. wide on the various veins in the mine. In one place a chamber, 70 ft. by 70 ft., is being worked. There is some high grade vein matter, low grade vein matter, and a good deal of leaf and ruby silver. The general average of the milling feed is about 33 oz. to the ton.

Seneca-Superior.—The second annual report of the Seneca Superior Mining Co. shows that total production was 1,085,774 oz. and the reserves underground were 3,460,000 oz., an increase of 2,310,000 oz. over last year. The profit from mining operation was $306,854 and the net profit was $286,626. The total dividends paid during the year were $263,126, and the surplus shows $85,290. The cash in bank amounted to $65,492.

Timiskaming.—The fight for control of the Timiskaming mine resulted in the victory of the Wills-Culver party and the appointment of a board of directors favorable to their interests. Mr. Norman Fisher, for many years manager of the Timiskaming mine for the Cartwright control, has announced his resignation. Mr. F. L. Culver, president and general manager of the Beaver, spent several days at the property making a thorough examination, both underground and on the surface.

Miller Lake-O'Brien.—The main shaft of the Miller Lake-O'Brien mine in Gowganda has just reached the 459 ft. level, and drifting on one of the series of veins has commenced. At this depth there appears to be no change in grade or width of veins. At the new Millerett shaft at the 60 ft. level one vein has already been cut. At 300 ft. on the Miller Lake-O'Brien there is a continuous shoot of high grade ore for 500 ft., but it is not more than an inch in width. On the 350 ft. level this same vein is also strong. It is expected that hydro-electrical power will be available in about two months' time, when the management will have 18 drills available for underground work. A new 15 drill compressor is in readiness when the juice is turned on.

Bailey.—According to the report issued by the Bailey Cobalt Mines, Ltd., it is certain that development on that property will be continued. Mr. E. A. Benson and his Chicago associates, who have been providing the money for development for the past two or three years, are satisfied enough with the progress of the company to continue to stand behind the property. The financial statement shows that at the end of the year there was $4,738 cash in bank and $33,545 in accounts receivable. Mr. Weed, the mine manager, declares that the property would receive a fair chance if $37,700 were spent on it during the next 15 months. It would then be possible to maintain development and put ore in sight. On the fifth level in the conglomerate the vein is looking extremely well.

McKinley-Darragh.—The report of the McKinley-Darragh, which has just been made public, shows that ore reserves, which were 5,358,500 at the end of 1912, have now fallen to 3,210,000 oz., a decrease of 2,158,500 oz. in the year. This report is undoubtedly disappointing, but was foreshadowed in the last annual report and in the ever decreasing production as detailed in the monthly statement.

The directors state that new ore developed amounted to but 512,739 oz., showing that a large portion of the dividends were taken from ore reserves. The cost per oz. of mining silver increased from 18 cents to 22 cents. The total silver recovered during the year was 2,214,536 oz., compared with 2,717,383 oz. in 1912.

BRITISH COLUMBIA

COAST DISTRICT NEWS.

A rancher and prospector, who has been in the Peace River country for the last 15 years, when visiting Victoria lately, stated that already valuable mineral discoveries have been made in that region, including placer gold, quartz containing copper and gold, galena and coal. However, owing to the comparative inaccessibility of the country, but little prospecting has yet been done.

The steamer British Columbia was at Tassoo harbor about the middle of March taking on ore from the property of the Tassoo Syndicate, Ltd., situated on the west coast of Moresby island, of the Queen Charlotte group. The intention was to ship about 750 tons to the smelter at Tacoma, Puget sound, Washington. Mr. Robert R. Hedley, of Vancouver, president of the syndicate, went in the steamer to supervise shipment of the ore.

With winter breaking up early, there has been quite an exodus of prospectors and miners from Hazelton to the Omineca country, the men taking the trail when the snow commences to go, so as to cross the summits while the travelling is good and to get over the streams before spring freshets make fording risky. Beside numbers of individual miners, the Royal Standard Investment Co.'s party, and that of the Omineca Gold Mines, Ltd., are going in early. It is predicted that more gold will be recovered from Omineca river and tributaries in the ensuing season than in any year since the early days.

Granby Co.'s New Smeltery.

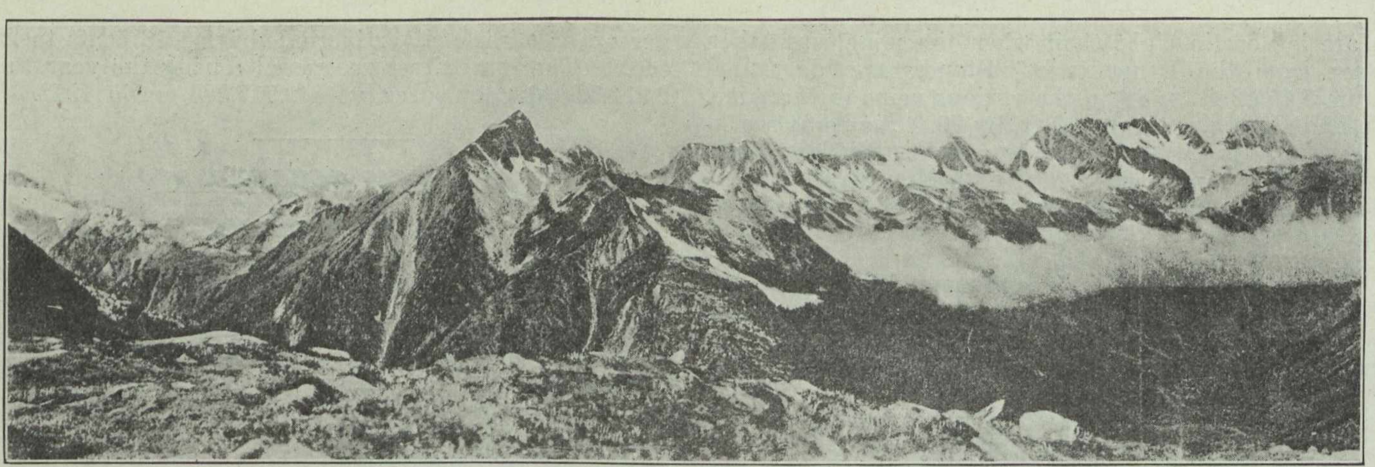
A commencement was made on March 16 to smelt ore at the Granby Consolidated Co.'s new smelting works at Anyox, Observatory inlet. The delay in blowing in had been occasioned by insufficiency of power for all necessary uses. The head of water above the intake pipe at the dam had been inadequate until early in March, when a beginning was made to generate power for the smelter where Nordberg and other blowing engines, compressors, sampling-mill plant, electric locomotives and other power machinery have since been given trial runs. Besides that required for the smelting works, power has to be generated for mine work and ore crushing; in addition, electric light for works and the town of Anyox has to be supplied.

Power is obtained from nine big Pelton wheels. Two direct connected compressors are operated; one supplies power for machine drills, etc., in the mine, and the other for the blowers (one for each of the three blast furnaces), blowing engine for converter plant, and other purposes.

A late estimate of available ore in the company's Hidden Creek mines places the quantity at approximately 9,000,000 tons, and the copper content at 2.2 per cent.

Rambler-Cariboo, Slocan.

Announcement has been made that a financial statement to March 1, 1914, has been issued to shareholders in the Rambler-Cariboo Mines, Ltd., operating the Rambler-Cariboo silver-lead mine in McGuigan basin, Slocan district, and a concentrating mill situated about



Mt. Cheops Mt. Sifton, Swiss Peaks and Mount Hermit.
On main line Canadian Pacific Railway, B.C.

two miles below the mine, on Seaton creek. Current accounts to date of statement had been paid and the company's outstanding indebtedness reduced from $67,000 to $29,000. Accompanying the statement to recent date was a report of operations during the last fiscal period ended April 1, 1913. The following is an excerpt: "Since the annual report of 1912 we have completed the new concentrator at an additional cost of $35,808, and an aerial tram from mine to concentrating mill at a cost of $18,073; both tramway and mill have been operating satisfactorily. We have also built a general office, an assay office (which has been equipped), and new boarding and bunkhouses at the mill, and several new buildings at the mine. More ground has been purchased for $11,000, and we have on hand store supplies and explosives valued at $2,200. There is now due to the company about $12,000 from ore shipments, which will be ample to finance the work when there shall be a sufficient water supply to allow of operations being resumed.

A supplementary report by the company's manager gives the following information: "Because of water shortage operations could not be carried on properly, so ore production was stopped and the mill closed until there should be ample power for again working under favorable conditions. Development work is being continued in the mine, in which there is in sight sufficient ore to supply the mill, operating at capacity, for at least 24 months; meanwhile we should expose other ore bodies as a result of the development work in progress. There are in the mine several places from which we can take out considerable clean shipping ore, so I have good reason to believe that my estimate of increased net earnings for the current year will be verified.

Vancouver Island Collieries Again Exporting Coal.

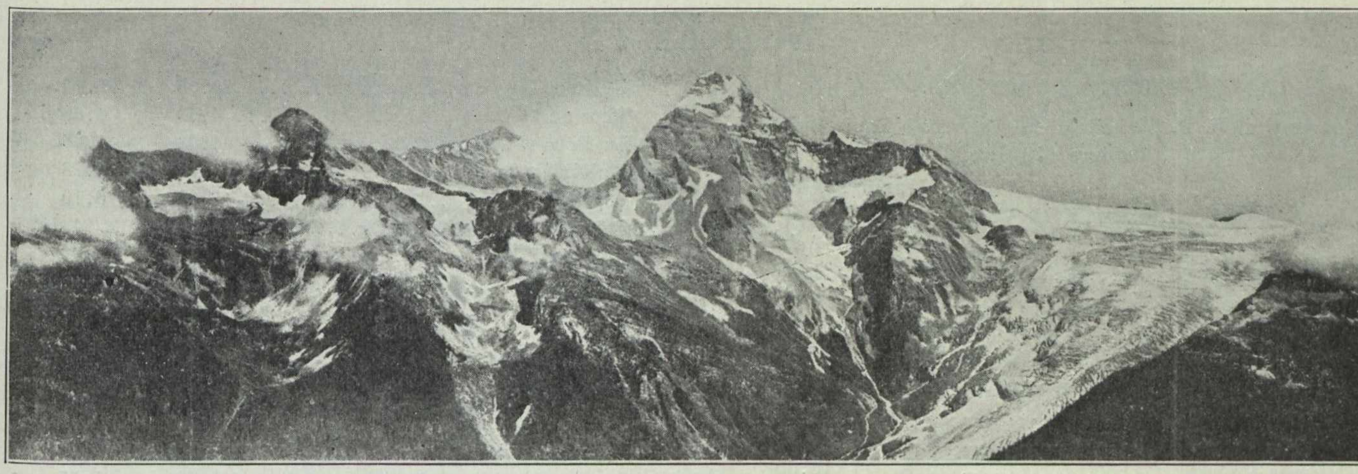
About 1,340 tons of coal was shipped on March 11 from Nanaimo and South Wellington mines to Seattle, Washington, this indicating a resumption of the coal export trade from Vancouver Island collieries after an interruption of ten months, from the time of the coal miners' strike on May 1, 1913. Meanwhile, approximately 77,000 tons of Washington coal has been shipped from Seattle to several British Columbia coast cities, much of it at a price as low as $3.50 a ton, with a prospect of a fair proportion of this trade being retained notwithstanding that Vancouver Island coal mines are all again producing.

Both the Western Fuel Co. and the Vancouver-Nanaimo Coal Mining Co. were busy in March bunkering steamers, chiefly small ones, and loading scows with coal for shipment to the larger cities of the near coast. The Western Fuel Co, now has about 700 nonmembers of the United Mine Workers of America employed in its mines near Nanaimo, and the Pacific Coast Coal Mines, Ltd., about 150 men—also not members of the U.M.W. of A.—at its South Wellington colliery. The Vancouver-Nanaimo Coal Mining Co. is working U. M. W. of A. men at its Jingle Pot mine, three miles from Nanaimo.

The Western Fuel Co. and an Agreement Committee appointed by its employees have signed an agreement, which provides for, among other things, a general increase of ten per cent. on wages rates that were paid prior to the strike, the agreement to continue in force until the end of September, 1916. This advance is similar to that offered by the company last August. Apart from the rates of pay, provision is made for a mine committee to meet the management of the company to adjust all matters of dispute that shall from time to time come up. While this agreemnt only deals with underground employees, the surface men have not been overlooked, for their wages scale is being revised and will shortly be completed. The new schedule to cover their rates of pay will be effective as from the same date—March 6, 1914—as that of the underground employees.

A supplementary agreement has also been signed. It provides:

"(a) It is agreed that in the event of a fatal accident occurring in the mines, or in the event of a death resulting from injuries received in the mine that the operation of the mine in which the accident occurred shall not be suspended on the day of the funeral of the deceased party, but that any employee wishing to absent himself from work for the purpose of attending the funeral shall have the privilege of doing so. All employees working on the morning, afternoon and night shifts of the funeral agree to contribute the sum of one dollar ($1) per man and fifty cents (50c.) per boy to a fund to be given to the nearest relative of the deceased party. The company agrees to duplicate the sum contributed by the employees. For the purpose of this section all employees whose daily wage is less than three dollars ($3) per shift shall be considered as boys. The company is authorized to make collections for this fund from the payroll of its employes in manner similar to other collections. Nothing in this section shall relieve the company of any obligation under the Workmen's Compensation Act, nor



Eagle Peak **Mt. Sir Donald and Illecillewaet Glacier.**
On main line Canadian Pacific Railway, B.C.

shall it relieve the employes of their obligation to the Medical Relief and Accident Fund.

"(b) It is agreed that monthly meetings of the management of the company and the Agreement Committee shall be held on the afternoon of the first Wednesday of each month at the company's general office. Special meetings may be called at any time by the management of the chairman of the Agreement Committee, due notice of such meeting to be given to all parties."

As evidencing that the Canadian Collieries (Dunsmuir) Limited has restored industrial conditions to normal state so far as its Comox colliery, with mines in the neighborhood of Cumberland, Vancouver Island, is concerned, the statement has been published that the Canadian-Australian steamer Marmara commenced taking on bunker coal at Union bay at midnight of March 7, and by 9 o'clock the morning of March 9 had shipped 2,200 tons.

COBALT SHIPMENTS.

(Cobalt Nugget.)

The Right of Way figured in a very light list of ore shipments this week, although almost a quarter of a million ounces of refined silver from the Nipissing high grade camp will bring up the average for the camp. The shipment was of concentrates from the Colonial mill, where the dump ore of the Right of Way is being treated. The Right of Way is now working both shafts again. The extension of one of the producers of the Princess has rewarded their exertions to the south.

The Penn-Canadian car contained about 900 ounce to the ton concentrates and ore mixed. Developments within the past two or three months at the Penn-Canadian Company point to much more regular shipments from this property. The McKinley-Darragh contributed two cars of concentrates and thereby raised the total for the week very considerably. All the ore came from the mines surrounding the town, Kerr Lake and South Coleman, the Casey range not contributing.

The ore shipments from the mines for the week ending March 20, were:

	High.	Low.	Tl.Lb.
Right of Way	83,120	......	83,120
McKinley-Darragh	149,760	......	149,760
Cobalt Lake	63,970	......	63,970
Penn-Canadian	64,630	......	64,630
Dom. Reduction	......	88,000	88,000

The bullion shipments for the week ending March 20th were:

Mine.	Bars.	Ounces.	Value.
Nipissing	199	238,316.33	$138,223.47
Timiskaming	2	1,951.00	1,003.00
Bailey	2	1,462.00	763.25
Penn-Canadian	2	1,291.00	673.38
Hargraves	1	794.00	414.81

MINERAL PRODUCTION OF ONTARIO, 1913.

Metallic.

Product.	Quantity.	Value.
Gold, oz.	220,837	$4,558,518
Silver, oz.	29,724,931	16,580,114
Copper, tons	12,941	1,840,492
Nickel, tons	24,838	5,237,477
Iron ore, tons	195,937	424,072
Pig iron, tons	648,899	8,719,892
Cobalt oxide, etc., lb.	1,188,526	420,386
Nickel oxide, lb.	232,255	13,326
	......	$37,794,277
Less Ontario iron ore (132,708 tons) smelted into pig iron	......	285,322
Net value metallic production	......	$37,508,955

Non-Metallic.

Product.	Quantity.	Value.
Arsenic (refined), lbs.	2,450,758	$64,146
Brick (common), number	386,882,000	3,283,894
Brick (paving, fancy, etc.), number	18,547,000	243,119
Brick (pressed), number	76,138,000	871,291
Building and crushed stone	....	1,117,153
Calcium carbide, tons	2,052	123,100
Cement, Portland, bbl.	3,802,321	4,105,455
Corundum, tons	1,177	137,036
Feldspar, tons	18,615	73,338
Graphite (refined), tons	1,788	93,054
Gypsum, tons	40,581	92,627
Iron pyrites, tons	71,620	171,687
Lime, bush.	2,300,991	390,600
Mica, tons	386	55,264
Natural gas, million cu. ft.	12,559	2,428,881
Peat, tons	500	1,750
Petroleum, Imp. gal.	7,915,761	398,051
Pottery	......	52,875
Quartz, tons	54,320	130,860
Salt, tons	96,799	474,372
Sewer pipe	......	600,297
Sand and gravel, cu. yd.	413,978	229,967
Talc (ground), tons	17,988	100,480
Tile, drain, number	14,265,000	251,705
Non-metallic production	......	$15,491,002
Add metallic production	......	37,508,955
Total production	......	$52,999,957

Note—One ton equals 2,000 lb.

Byers' genuine wrought iron pipe was specified throughout in the plans for the L. C. Smith building, Seattle, the tallest building outside of New York. Byers' pipe is made from all straight pig iron muck bar without the use of scrap of any description—no admixture of any foreign material whatsoever. The non-corrosive quality of wrought iron is due chiefly to the puddling process. Realizing this, the Byers people have never varied from their old-time method of thorough hand puddling by expert puddlers.

MARKETS

STOCK QUOTATIONS.

(Courtesy of J. P. Bickell & Co., Standard Bank Building, Toronto, Ontario.)

March 23, 1914.

New York Curb.

	Bid.	Ask.
British Copper	1.37	1.50
Braden Copper	8.12	8.25
California Oil	352.00	354.00
Chino Copper	42.12	42.37
Giroux Copper	1.00	1.25
Green Can.	38.00	40.00
Miami Copper	24.00	24.25
Nevada Copper	15.87	16.00
Ohio Oil	241.00	242.00
Ray Cons. Copper	21.62	22.00
Standard Oil of New York	240.00	250.00
Standard Oil of New Jersey	420.00	422.00
Standard Oil (old)	1,500.00	....
Standard Oil (subs)	1,080.00	....
Tonopah Mining	7.00	7.12
Tonopah Belmont	7.06	7.75
Tonopah Merger	.55	.58
Inspiration Copper	17.25	17.50
Goldfield Cons	2.87	3.12
Yukon Gold	2.87	3.12

Porcupine Stocks.

Apex	.03¼	.03½
Dome Extension	.11½	.12
Dome Lake	.47	.48
Dome Mines	12.90	13.25
Foley O'Brien	.25	.35
Hollinger	15.90	16.00
Jupiter	.11½	.11¾
McIntyre	2.00	2.15
Moneta	.02	.04
North Dome	.15	.20
Northern Exploration	2.25	2.75
Pearl Lake	.08	.08½
Plenaurum	.40	.60
Porcupine Gold	.12	.12¼
Imperial	.02	.02½
Porcupine Reserve	....	.10
Preston East Dome	.02	.02½
Rea	.15	.20
Swastika	.04	.04½
United	....	.01
West Dome	.10	.12
Porcupine Crown	1.20	1.25
Teck-Hughes	.20	.25

Cobalt Stocks.

Bailey	.04	.04½
Beaver	.31	.32
Buffalo	1.25	1.40
Canadian	....	.10
Chambers Ferland	.19½	.20
City of Cobalt	.51	.60
Cobalt Lake	.63	.68
Coniagas	7.90	8.10
Crown Reserve	1.85	1.87
Foster	.07	.09
Gifford	.03½	.04
Gould	.03	.03¼
Great Northern	.15¾	.16
Hargraves	.02½	.03
Hudson Bay	70.00	75.00
Kerr Lake	4.50	4.60
La Rose	1.63	1.66
McKinley	.74	.78
Nipissing	6.05	6.10
Peterson Lake	.43	.43¼
Right of Way	.04	.06
Rochester	.02½	.03
Leaf	.02	.02½
Cochrane	.40	.50
Silver Queen	.04	.05
Timiskaming	.15	.15½
Trethewey	.23	.27
Wettlaufer	.06	.07
Seneca Superior	3.00	3.25

TORONTO MARKETS.

March 25.—(Quotations from Canada Metal Co., Toronto).

Spelter, 5¼c. per lb.
Lead, 5¼c. per lb.
Tin, 41½c. per lb.
Antimony, 9c. per lb.
Copper, casting, 15½c. per lb.
Electrolytic, 15¼c. per lb.
Ingot brass, 10 to 15c. per lb.

March 25.—Pig Iron—(Quotations from Drummond, McCall & Co., Toronto):

Summerlee No. 1, $26.50 (f.o.b. Toronto).
Summerlee No. 2, $25.50 (f.o.b. Toronto).

March 25.—Coal (Quotations from Elias Rogers Co., Toronto):

Anthracite, $8.25 per ton.
Bituminous, lump, $5.25 per ton.

GENERAL MARKETS.

March 23.—Connellsville coke (f.o.b. ovens).

Furnace coke, prompt, $1.90 to $1.95 per ton.
Foundry coke, prompt, $2.40 to $2.60 per ton.

March 23.—Tin, straits, 38.60c.

Copper, Prime Lake, 14.75c.
Electrolytic copper, 14.35 to 14.45c.
Copper wire, 15.50 to 15.75c.
Lead, 4c.
Spelter, 5.27½ to 5.32½c.
Sheet zinc (f.o.b. smelter), 7c.
Antimony, Cookson's, 7.20 to 7.25c.
Aluminum, 18 to 18.25c.
Nickel, 40 to 45c.
Platinum, hard, 10 per cent., $46 to $47.50 per oz.
Platinum, hard, 20 per cent. $49 to $51.50 per oz.
Platinum, soft, $43 to $44 per oz.
Bismuth, $1.95 to $2.15 per lb.
Quicksilver, $38 per 75-lb. flask.

SILVER PRICES.

	New York cents.	London pence.
March 11	58⅛	26 13/16
" 12	57⅞	26 11/16
" 13	58	26¾
" 14	58⅛	26 13/16
" 16	58⅛	26 13/16
" 17	58⅛	26 13/16
" 18	58	26¾
" 19	58	26¾
" 20	58	26¾
" 21	58⅛	26 13/16
" 23	58⅛	26 13/16
" 24	58⅛	26 13/16