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CANADA
DEPARTMENT OF MINES

HON. P. E. BLONDIN, Minister. **R. G. McCONNELL, Deputy Minister.**

MINES BRANCH

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Map 59A. Wheaton, Yukon Territory.

Map 150A. Ponhook Lake Sheet, Nova Scotia.

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Communications should be addressed to **The Director, Geological Survey, Ottawa.**

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CIRCULATION

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CONTENTS

INDUSTRIAL MANAGEMENT

In the November number of "The Engineering Magazine," the editor, Mr. John R. Dunlap, has some timely remarks on Industrial Management. In view of the fact that Canadian industrial concerns are now called upon to increase output in spite of a scarcity of labor, Mr. Dunlap's comments are especially worthy of attention. He says:

"High wages, shorter hours, increasing labor unrest, the growing shortage of labor in every field of industry, and the enormous increases in the cost of all the staples of manufacture—these are conditions which have finally brought home to all thinking men the pressing importance of now intently studying every possible means of decreasing the costs of production.

"Great captains of industry, like Andrew Carnegie, Charles M. Schwab and Henry Ford, long ago recognized and acted upon the knowledge that this is a mechanical age, that all the secrets of cheap production are to be found in the utilization of mechanical power, that automatic and semi-automatic machinery must be operated by skilled mechanics at high wages, and that standardized production, the largest possible output, and especially continuous operation, offer the only possible solutions of the problems which confront all industrial managers.

"Knowing, also, that engineers and inventors are the men who have revolutionized industry, annihilated distance, made the world a neighborhood, and enormously increased the production of actual wealth, the undeviating policy of all these great industrial leaders has been to surround themselves with, and make partners of, engineers, inventors, superintendents, managers, and salesmen who have distinguished themselves by great constructive and productive achievements. As a sequence, for a generation past the vast mechanical plants erected and operated by these men, under such leadership, have been the marvels and models of this mechanical age. And it is in these wonderful mechanical plants, operated by highly trained engineers and skilled mechanics at high wages, that the cheapest products in all the world's markets have been produced. Andrew Carnegie has said that it is not the lowest, but the highest-paid labor, with scientific management and machinery, which gives cheapest products.

"Just here it is fundamentally important to remind responsible industrial leaders that Mr. Carnegie has always boasted with great pride that he valued his organization, his partners, his engineers and his managers, far more highly than he valued his plants, and if he had to lose either, he would much prefer to lose his plants—because they could be replaced much more quickly than his organization!

"Now that the world war has flooded our markets with orders of every description now that the productive capacity of all our industries is taxed to the limit; now that the great steel industries, the munition manufacturers, the automobile manufacturers, and indeed employers of every kind are paying wages unheard of before, it becomes plainly evident that the

labor question has become the paramount problem before every American manufacturer, great or small.

"In other words, we are now face to face with the Human Problem—we must recognize and promptly act upon the obvious fact that the welfare, the contentment, the good-will, and the physical fitness of the men and women who operate our industrial plants are matters of first and immediate concern to all employers; and that henceforth the management, training, reward, and inspiration of the workers must be studied practically and scientifically, precisely as we have long studied and perfected the machinery of production.

"Conservative, hard-headed, and successful employers of the old school, who believe in "driving" operatives rather than leading them, may be affrighted by the high wages now current and the danger of "labor domination," and they may stand aghast at the thought of abandoning the ten hour or the nine hour day; but these are problems simple enough to enlightened employers who have seriously studied the literature and actually viewed the practice of the new Science of Industrial Management. Not a problem confronting industrial America to-day—be it wages, hours, unions, open-shop, piece-rates, premium, bonus, welfare work or what not—but has been successfully solved in hundreds of cases and in every field of industry."

Mr. Dunlap suggests a way out of a difficulty that is confronting us. He believes that "industrial economy must be studied as a practical science, because it is the very basis of successful industrial administration."

Predictions are being freely made these days that the increasing cost of labor will eventually result in impossible operating conditions throughout North America. It is often stated that laborers are becoming used to more extravagant methods of living because of the temporary higher wages and that after the war it will be impossible to compete with the cheaper labor of Europe. Those who make such predictions believe that there must result a complete disruption of industry caused by the demand for higher wages than the industries can afford to pay. Such disruption would be accompanied by a period of hard times for employer and employee alike and followed by a reconstruction period when the employee is ready to work for lower wages. Mr. Dunlap seems rather to incline to the belief that efficiency can be so increased as to solve the problem.

Anyone familiar with the mining industry knows that efficiency has been greatly increased in the past few years. They know also that it will be increased much more by better methods, better machines and especially by better men. It is to be hoped that there will be no necessity of discontinuing operations because of the high wages demanded by workers. At present the good prices being received for mine products, the scarcity of labor and the high cost of living make high wages reasonable. Increased efficiency may make it possible to continue paying high wages when conditions would otherwise not warrant it.

Just now it is necessary to pay high wages to men who are efficient workers. The scarcity of labor is serious not only in Canada but in the United States, and employers find it necessary to keep men who cannot or will not do a good day's work. There is no compensating advantage for the higher wages being paid. The work done per man per day will not compare favorably with that before the war. Many of the best men are in the army.

Mine managers are now confronted with the problem of maintaining production with a smaller and less efficient force of men. They are naturally devoting a good deal of attention to the problem. The history of mining leads us to expect that they will succeed. In their efforts the managers will have the co-operation of the manufacturers of mining machinery, who are at present themselves confronted with many difficulties.

NOVA SCOTIA STEEL.

After a meeting of the board of directors of the Nova Scotia Steel and Coal Company, held in Montreal on Monday afternoon, Col. Thomas Cantley stated that despite the labor shortage and other difficulties, the company's output for the first nine months of 1916 was 40 p.c. greater than at any previous time. The company is booked practically to capacity operations until midsummer next. Business has been offered for the second half of 1917, but the management is not anxious to hasten the acceptance of contracts further ahead than the first six months of the new year. Col. Cantley declined to discuss the question of dividends on the common stock.

At the board meeting, the directors decided to enlarge the company's shipbuilding activities, by building a second ocean-going vessel, and one about 25 p.c. larger than the first now under construction, and which will be ready for launching in the spring.

DOME.

Dome made a new record in October, milling 40,200 tons, yielding $185,000. The war tax for the fiscal year has been fixed at $27,502.

HOLLINGER.

Hollinger in the four weeks ending October 6th, milled 49,770 tons ore, yielding $433,693. The gross profit for the four-week period was $241,293. The war tax for the year has not been definitely settled, but will be not a serious burden if expectations prove correct.

APEX.

The Apex company will shortly resume prospecting work on its claims in the Porcupine district. A diamond drill will be operated.

NEWRAY.

Manager Charlebois reports on the recent discovery at Newray mine, as follows:

"Diamond drill No. 4 is now down 900 feet. Is on angle of 45 degrees. At 630 feet vertically the core shows 12 feet of quartz carrying lots of free gold. This hole cuts the find between the Anchor vein and the Hanson vein. So far this is the biggest find ever made on the Newray."

It is reported also that a new vein has recently been located in the southwest corner of the property, near the Plenaurum line, from which the management announce some very satisfactory assay results have been received.

ON THE POSSIBILITY OF PRODUCING REFINED COPPER IN CANADA*

By A. W. G. Wilson

Copper Resources of Canada.

Native copper occurs in Canada in a number of different localities, but in no place within reach of existing lines of transport has exploration work disclosed concentrations of the metal in sufficient quantity to render it practical to operate these deposits commercially by present methods, the copper content of the rock being usually less than one per cent.

Minerals containing copper as an essential constituent occur in many places throughout Canada. Those commercially important are the sulphides; carbonates and oxides also occur, usually in association with sulphide deposits, but they are relatively of minor importance. The two sulphides, Chalcopyrite and bornite, both of which also contain iron, are the most important; locally chalcocite, the pure sulphide, is also occasionally found.

At the present time copper sulphide ores are being mined successfully in the following districts in Canada:

1. **Quebec.**—Eastern Townships in the vicinity of Sherbrooke. The annual production varies, has been increasing in the last few years, and may be taken as about 5,000 000 pounds per annum. The Quebec ores are mined for their contained sulphur and are marketed chiefly in the Eastern United States; the copper recovered is in the nature of a by-product, and is recovered in United States plants after the available sulphur has been extracted.

2. **Ontario.**—Sudbury district. The annual production has been increasing in recent years. In 1914 it was about 29.000,000 pounds and in 1915 it was over 39.000.000 pounds. This copper occurs in association with nickel. Locally the ores are smelted and treated in basic converters producing a matte which contains 80-82 per cent of the combined metals, the balance consisting of iron and sulphur and very small quantities of other metals. The matte containing the two metals is exported to the United States and to England to refineries where the two important constituent metals, and certain included by-products, are recovered separately.

3. **British Columbia.**—There are three principal producing districts.

(a) Kootenays, including Rossland, with a production of 3,780 000 pounds in 1914, and Nelson with a production of 586,700 pounds in 1914. In 1915 the production in this district was slightly more than 5,000,000 pounds. These are both tributary to the smelter of the Consolidated Mining and Smelting Company of Canada at Trail. The Rossland ores are essentially gold ores. They, however, contain a small amount of copper in the form of a sulphide, not much over one-half of one per cent, but sufficient to make it feasible to recover the gold by the methods of the copper smelter.

(b) Boundary. The production in 1914 was about 16,400,000 pounds, and in 1915 it rose to slightly less than 17,700 000 pounds. There are two smelters operating in this district, that at Grand Forks, belonging to the Granby Consolidated Mining, Smelting and Power Company, and that near Greenwood belonging to the British Columbia Copper Company. The mines and smelter belonging to this latter company were closed in August, 1914, at the beginning of the war, but reopened near the end of July, 1915. The mines and smelter of the former company were shut down for a period of 122 days at the close of the year 1914, and afterwards re-opened in January, 1915. It appears probable that the production of this district will gradually decline, unless new deposits are discovered and opened up.

(c) Coast Districts. The production of the British Columbia coast districts in 1914 was about 24,000,000 pounds, while in 1915 it was almost 34,000,000 pounds. At present there are three principal producing centres:

(i.) Britannia Mines on Howe Sound, producing ores and concentrates which are shipped to Tacoma Washington. The normal production is 15-18 million pounds of copper per annum, but it fell below that figure in 1914. When work now under way is completed production will be in the neighborhood of 25,000,000 pounds per annum.

(ii.) Anyox on the Portland canal about 110 miles north of Prince Rupert, at which is located a smelter owned by the Granby Consolidated Mining, Smelting and Power Company. The present capacity of this plant is about 3.000 tons of ore per day. The blister copper produced is shipped to Laurel Hill, New Jersey, for refining. A statement as to the present production is not available, but when the capacity of the plant has been increased, as proposed, to about 4.000 tons per day, the annual production should be in the neighborhood of 40,000 000 pounds of copper.

(iii.) Texada Island has produced a small amount of copper during the last few years, chiefly from the Marble Bay mine. In 1914 the production was 771.000 pounds, which may be considered to be about two thirds normal.

(iv.) Other Localities. A small quantity of copper has been secured, from time to time, from a number of other localities along the coast of British Columbia, or from some of the island adjacent to that coast. Prospecting, exploration, or development work is now in progress in a number of localities and it is probable that new and important discoveries will be made from time to time. One new property east of Prince Rupert and near the main line of the Grand Trunk Pacific railway is now a regular shipper of ore to Anyox.

(d) Similkameen. Extensive explorations in the Similkameen district, not far from Princeton, have been in progress during the last four years. They have shown the existence of large bodies of low grade ores. Preparations are now being made to mine these on a large scale, and to treat them in a concentrating mill. The mill concentrates are to be shipped to the British Columbia Copper Company's smelter at Greenwood, B.C., for treatment.

(4) **Yukon.**—Only one copper mine of importance was operating in Yukon—the Pueblo near Whitehorse. The production from this mine during the last three years has been at the rate of about 1,700,000 pounds per annum. How much ore there is in reserve it is not possible to state. The mine was closed at the beginning of the war, but preparations are now being made to re-open it and it is probable that shipments will be resumed early in the new year. During the period

* Published by permission of the Director of the Mines Branch, Ottawa, from the Summary report of the Branch for 1915. Article written in January, 1916.

it was in operation all the ore produced was shipped to Tacoma, Washington, for treatment.

Summarizing the above statements it will be noted that the annual production of copper from existing mines in Canada was in the neighborhood of 80,000,000 pounds in 1914, a little more than one-third of this being produced in Eastern Canada, and a little less than two-thirds in British Columbia. The total copper recovered from ore produced in Canada in 1914 is estimated by Mr. McLeish, Chief Statistician of the Mines Branch, at 75,738,386 pounds. In 1913 it was 76,976,925 pounds, and in 1915 it is estimated as 102,612,486 pounds.

Ore Reserves.

With reference to the known ore reserves, upon which future production must depend, there is little accurate information available. It has not been the custom of the operating companies to make public much information with respect to these reserves, even when they themselves possess it. The larger companies all carry exploration and development work in advance of mining and in the majority of cases know that they are assured of ample reserves to keep their present plants in operation for some years to come.

In Quebec the reserves have not been made public, but they are known to be more than enough to insure production at the present rate for more than two years.

In the Sudbury region of Ontario the known reserves are variously stated to be in excess of 100,000,000 tons of ore carrying about 2 per cent copper besides nickel. The operating companies have not made public any official figures with respect to these reserves. An official of the Ontario Bureau of Mines places the known reserves at 71,000,000 tons.

British Columbia is at present the principal copper-producing province of Canada, copper-bearing minerals being found in numerous localities in various parts of the province. The known occurrences are too numerous to be considered individually. The principal producing districts have already been enumerated. Some of the operating companies publish statements of their ore reserves, others do not, and as a consequence it is not possible to make a definite statement as to the tonnage of ore known to be available. A rough estimate, based in part on the published information supplied by certain operating companies, and in part upon rough, and therefore possibly inaccurate, estimates of the ore reserves of other companies, indicates that the known ore deposits of this Province contain in excess of 500,000 tons of recoverable copper equal to twenty years' supply at the present rate of production. In addition to these known ore deposits, which are now being exploited, there is every reason to believe that other equally important discoveries will be made in the future, not only in British Columbia, but also in Yukon.

Present Methods of Treatment.

1. Quebec ores are nearly all exported to the United States, where the sulphur is first utilized for the manufacture of sulphuric acid and the copper contents of the ores are afterwards recovered at other works.

2. Ontario ores are roasted in open heaps, or in small part in mechanically operated furnaces, to drive off a portion of the sulphur. They are then treated in blast furnaces, or reverberatories, to produce a low grade matte containing the nickel and copper. This matte is further concentrated in basic lined converters until it contains 77-82 per cent. of the combined metals. In this form about 15 per cent of the Ontario production is shipped to Wales, and the balance to the United States for further treatment. A portion of that sent to the United States is again treated to produce the alloy called monel metal, without the separation of the copper from the nickel. The balance of that sent to the United States and all of that sent to Wales is refined by special processes, the copper and the nickel being recovered separately.

3. British Columbia ores are in part sold directly to United States purchasers, and in part given a partial treatment before being shipped to the United States. The smelter at Trail produces a matte containing approximately 42 per cent copper, and a considerable amount of precious metals. This matte is at present being shipped to Tacoma, Washington, for final treatment and refining. I understand that it is the intention of the Consolidated Company to install converters at Trail and to produce Bessemer cakes. This copper will contain an unusual amount of the precious metals, owing to the nature of the Rossland ores, and it will probably be necessary to refine it on the spot. Preparations are being made with this object in view, and it is stated that the refinery will have a capacity of 15 tons of refined copper per day.

(Since Dr. Wilson's report was written, the production of refined copper has been begun at Trail.—Ed.)

The ores from the Boundary district are treated at Grand Forks and at Greenwood, both plants using blast furnaces in which a low grade matte is produced, and afterwards treating this matte in converters to produce Bessemer cakes. This copper which contains 96-98 per cent pure metal is shipped to United States points for refining. The plant at Greenwood was idle during the early part of the year, but has resumed operations.

The ores mined at Anyox, north of Prince Rupert, are treated in blast furnaces, the resultant matte being blown to Bessemer copper in basic converters. The copper is shipped to Laurel Hill, New Jersey, for refining. A small amount of custom ores from outlying points is also treated at Anyox.

The ores mined at Britannia are concentrated in a special plant at Britannia Beach, and then are shipped to the smelter at Tacoma for final treatment. Ore from the Marble Bay mine on Texada Island, and that from the Pueblo mine in Yukon is also shipped directly to Tacoma for treatment.

4. Summary.—The foregoing paragraphs may be summarized by stating that all the copper obtained from ores mined in Canada is recovered in refineries located outside Canada, and chiefly in the United States. About ninety per cent of the copper produced in Eastern Canada is converted into a high grade matte before shipment; about sixty-six per cent of the copper produced in British Columbia is converted into Bessemer copper before shipment, and in all about twenty five per cent of the copper ores mined in Canada is shipped directly to United States points for metallurgical treatment.

Refining of Copper in Canada.

1. Present Conditions.—Canada refines very little copper at the present time. About one-half of her annual output of copper is treated in blast furnaces and afterwards in converters, and is exported in the form of Bessemer copper, containing usually 95-98 per cent copper, a few ounces of gold and silver per ton, and some impurities. About one-third of her output is exported in the form of matte, either high grade and associated with nickel, as from the Sudbury region, or of relatively lower grade, but containing much gold and silver, as from Trail. The remainder of Canada's copper production is exported as ore to foreign smelters

for treatment, some of it being concentrates and some of it untreated. The reasons why this condition exists are various and complicated. In brief it may be stated that the copper producing industry in Canada has been of slow growth, and has been prosecuted largely by foreign capital which already possessed established business connections outside Canada. In the early days it was much cheaper to arrange for the final treatment of the Canadian product in established foreign plants. It was easier, and there were fewer capital risks.

At the present time over 80 per cent of the refinery capacity of North America is located within fifty miles of New York city, and is, therefore, in the immediate vicinity of the largest American markets and shipping ports. An important factor in determining the location of these refineries has undoubtedly been the enormous saving that has been effected by reducing to a minimum the time that capital is locked up in the refined copper in transit. Another factor determining their location in this district was the possibility of securing relatively cheap power, cheap labor, and cheap supplies of all kinds, including appliances and machinery. Moreover the freights on the raw materials and supplies would be lower than on a finished product and on supplies hauled a long distance. All the conditions which brought this about may be summarized by stating that refining could be done more cheaply and conveniently in the district where the large refineries are now located than elsewhere. Once these large refineries were established in their present location it has become increasingly difficult for new organizations to compete against them and break into the market, unless the circumstances are exceptional. Moreover the capital interested in the established refineries is also the preponderating interest, directly or indirectly, in the Canadian Copper production. Under these circumstances it should not be a matter of surprise that Canada's copper is not refined at home, nor can it be expected that the conditions will be changed unless existing circumstances, altered by natural conditions or by design, become such that it will be more profitable to refine Canadian ores in Canada than in a foreign country.

2. Canadian production available for a refinery.—The nickel-copper mattes produced in the Sudbury district, Ontario, present a special problem in refining, involving the recovery not only of the copper, but also of the nickel, and therefore do not need to be considered here. That portion of Canada's copper which can tentatively be considered as available for refining in Canada is the British Columbia production.

A survey of the field shows that the British Columbia copper production may be considered as tributary to two principal localities. The production of Rossland and the Boundary country is all confined to the southeastern part of the province, and geographically, would naturally be tributary either to Trail or to a plant located elsewhere in one of the Kootenays. The balance of British Columbia production comes from points on the Pacific coast and therefore may be considered as tributary to certain points on tidewater.

Again, considering the present development of the various known copper producing mines, we find that the mines of the boundary district have probably reached their maximum production and are now on the decline. The Motherlode, the largest mine tributary to the smelter at Greenwood, is estimated to contain about two years' supply of ore. The mines at Phoenix, tributary to the smelter at Grand Forks, are credited with containing enough ore to keep the smelter working to capacity for only a few years more. The Rossland mines are stated never to have been in better condition, but the total copper content of these ores is comparatively small. Other less well known mines produce ore from time to time but their operation has been more or less spasmodic and they cannot be relied on to produce a large tonnage or to produce continuously for any length of time. Undoubtedly new ore bodies will also be discovered, prolonging the lives of existing plants in this section of the province, but the ore supplies immediately in view are such that it is extremely improbable that the annual production of copper from the Kootenays will materially increase in the near future.

On the coast we find that extensive development work has been in progress for the last three or four years, showing the existence of large ore reserves, particularly at Britannia and at Anyox. On the strength of this development preparations have been made at both localities for handling greatly increased outputs of ore. There are, in addition, a number of other smaller properties from which additional ore supplies may be expected, and in general it may be stated that the districts tributary to the coast appear to be the most promising, in regard to future development.

In 1914 the interior districts produced approximately 21,000,000 pounds of copper, while the districts tributary to the coast produced about 24 000 000 pounds. In 1915 the interior districts produced 22,700,000 pounds, against 33,980,000 pounds credited to the coastal district. It is not probable that the annual production of the interior, within the next few years, will much exceed this amount; the coast districts on the other hand give promise of at least doubling the output within the next two years.

A new district in the vicinity of Princeton, in south central British Columbia, has recently been extensively explored largely by diamond drilling and development is now under way. Plans have also been prepared for the erection of a large concentrating plant, and it is proposed to treat the concentrates in the smelter at Greenwood. It can therefore be anticipated that the production of the interior district, east of the Cascades, will for a time show a considerable increase. On the other hand, if later developments show that it is more economical to produce Bessemer copper from these ores in the vicinity of the mines, or even on the coast, this production would naturally be tributary to a coast refinery, particularly, when the direct railway to the coast, now nearing completion, is ready for traffic. The establishment of a refinery in British Columbia and its location would have an important bearing in determining the location of a new smelting and converting plant for the treatment of the Similkameen ores, assuming that other controlling conditions are satisfied.

If the establishment of a refinery were dependent only on the assurance that an adequate supply of Bessemer copper can be produced, it may safely be stated that there is enough ore in sight to supply the copper necessary to keep a plant of at least 50 tons daily capacity (36,500,000 lbs. per annum) in operation for an indeterminate number of years, a period of time, however, which would be longer than the normal life of the plant. In reaching any conclusion as to the probable commercial feasibility of such a refinery there are a number of collateral conditions that must be considered and weighed and there are numerous conflicting interests which must be apprised and adjusted. These conditions are set forth in the succeeding sections of this report.

Opposing Conditions.

1. Present Ownership. The only large Canadian controlled corporation now engaged in mining and smelting copper ores in British Columbia is the Consolidated Mining and Smelting Company of Canada, with smeltery at Trail, and mines at Rossland and elsewhere. All the other important producers of copper or copper ores are controlled by United States capital. Stating the same fact in another way, it is to be noted that only about 10 per cent of the copper production of British Columbia is home controlled, the balance, about 90 per cent, is foreign controlled. When the anticipated increase in production from coast points takes place, this balance will approximate 95 per cent of the total.

2. Existing Contracts. Nearly all the companies which are mining copper ore in British Columbia and all the smelters which are producing blister copper have contracted for the disposal of their output. These contracts usually run about five years, and existing contracts have at least two years yet to run.

3. Smelter Capacity. The smelter capacity at present available on the coast is not sufficient to treat all the ores now produced there. It is reported that the smelter at Anyox is to be enlarged to a capacity of about 4,000 tons of ore per day (the present capacity is about 3,000 tons), but this will provide only for the output from Anyox and for a few smaller tributary properties. Another smelter, especially equipped to treat concentrates as well as ordinary ores of copper, would be required to treat the ores and concentrates from Britannia, and such other ores as may be available from time to time. The capacity of this smelter should be at least 500 tons per day, and provision should be made to double this capacity, if necessary. It is possible that the Company now operating the Britannia mine might consider the erection of a smelter to treat their own ores, and to produce blister or Bessemer copper, but at present their entire output is sold under contract. The smelter at Ladysmith, now idle, is capable of treating some of the ores, but not so economically as a more modern plant specially designed for the purpose. It would probably seriously handicap the development of a coast refinery to attempt to adapt the Ladysmith smelter as it now stands to the needs of such refinery.

4. Marketing. One of the most difficult problems confronting a Canadian refinery would be the marketing of its products. Hitherto Canada's total consumption of copper has been about 20,000 tons per annum, slightly less than half the production of British Columbia. The greater part of this copper is imported into Canada in manufactured forms, particularly as wire, rods, and sheets. The surplus production from a Canadian refinery would have to be sold in the open market. If it is produced under natural conditions and at reasonable cost, there appears to be no reason why it could not successfully compete with copper produced elsewhere. The competition of the large purchasers in the United States and in South America would have to be faced, and even possible price-cutting. On the other hand, there is a possibility that the cheapness of production and the geographic location of the refinery might give certain advantages which it would be very difficult to offset.

Under existing conditions eastern manufacturers who require refined copper can, or could before the war, often obtain deliveries within a week of the placing of the order. Eastern refineries often had their orders booked in advance of the refining, and as a consequence there was little capital locked up in the copper in transit.

A refinery in Western Canada, operating under existing conditions, would have the following factors to contend with:

i. Long haul to eastern market on a refined product, and therefore a higher rate.

ii. An unusually long interval must elapse between the receipt of orders and the time of delivery—resulting in proportionally larger interest losses on copper in transit.

iii. Variety of forms in which refined copper must be delivered to suit the requirements of individual consumers of small lots, means an expensive plant for a small output.

iv. Canadian demand is chiefly for copper in manufactured forms. The demand for refined copper in ingots, wire, bars, and cakes is very small.

v. Competition of foreign copper, much of which can be laid down in the eastern market more cheaply.

It therefore appears desirable that other markets than that offered by eastern America be considered. Data with respect to the requirements of these markets are not immediately available. It may be pointed out, however, that refined copper from a British Columbia coast point can be laid down in British ports, and in certain continental ports at less cost per pound than from many of the interior United States producers. The Asiatic markets for manufactured products, and the Australian market are also open to a coast refinery, with corresponding low freights. It appears extremely probable that any surplus production from such a refinery could be very easily disposed of in the face of eastern competition.

I am inclined to think that it would be most profitable for a coast refinery to transform its own refined copper into manufactured products such as wire, rods, bars, sheets, and tubes. These products could be marketed as easily as the refined copper. There would be a very considerable saving in interest losses on copper in transit and a probable saving in refinery equipment.

5. Power Problems. The principal individual item of expense in the operation of a copper refinery is the cost of power. Hydro-electric power can be produced at a number of points on the coast of British Columbia at a cost of less than $10.00 per horse power a year. The most desirable and convenient power sites appear to have been transferred to private hands, but most of them are neither being utilized nor developed. The tax which these holding interests are inclined to levy on bona fide industries requiring the power is apt to be almost prohibitive. Before a refinery could be established it will be necessary to arrange to obtain power at a reasonable figure, which should not exceed $10.00 per horse power year, delivered at the plant. The operating company should own and control its own plant, and there should be sufficient available power in reserve to provide for reasonable expansion, and the development of subsidiary industries.

6. Diversity of Products. The nature of the products from the different centres makes certain commercial adjustments difficult but not impossible.

The Bessemer copper which will be produced at the Trail smelter will contain an unusual amount of gold, so much so that it will be practically impossible to satisfactorily and safely sample it. For this reason the owners of the Trail smelter would probably hesitate in agreeing to supply their blister copper to an independently controlled refinery unless special arrangements are made for its separate treatment. They have al-

ready made arrangements to install two Great Falls type copper converters, and I understand are preparing to refine their own copper on a small scale.

Again, the production of the Britannia mines, which will be about 25,000,000 pounds per annum within two years' time, is in the form of ore and concentrates. Several other mines on the coast also produce ore and do not reduce it to matte or Bessemer copper. As already noted, a smelter would have to be provided, especially equipped to treat these products.

Organization of a Refinery.

The organization of a copper refining company in Canada will require much consideration and some educative work. At present there are four large companies operating in British Columbia, whose interests are more or less conflicting. The total Canadian output available for treatment in an electrolytic refinery is comparatively small and it is therefore very desirable that as much as possible of the copper which these companies produce be treated at one plant.

One of these companies, the Consolidated Mining and Smelting Company of Canada, operating at Trail, is largely Canadian owned and is in the best potential position to start refining, both as regards equipment and technical staff. The plants at Trail now include a blast furnace equipment, an electrolytic lead refinery, and an electrolytic zinc refinery. Two basic converters, Great Falls type, are being provided for the production of Bessemer copper. Under the circumstances it was a comparatively easy matter for this company to arrange to refine their own copper. It will be possible to commence operations on a very small scale, and to expand as the circumstances require. There need be no serious increase in the present overhead charges, and the necessary capital expenditure will not have to be very great. Power costs will probably be comparatively high, about $20 per H.P. year, and the location of the plant is not favorable to cheap freights for incoming supplies and outgoing products. A refinery at Trail would naturally receive copper from the smelter at Grand Forks, including a rail haul of about 88 miles. Any copper produced at Greenwood might also easily be sent to Trail, the rail haul being 103 miles. Existing business arrangements and other economic conditions may, however, prevent any of this copper from the Boundary district reaching a refinery at Trail.

On the other hand not only is the amount of copper that will be tributary to the plant at Trail small, but the copper produced from the Rossland ores contains unusually large amounts of gold, seemingly somewhat irregularly distributed through the cakes, and I am informed that experience has shown that it is practically impossible to sample copper of this character satisfactorily without excessive expense. Therefore it is to be expected that while Trail will be able to produce refined copper from the products of its own plant, or from any Bessemer or blister copper that may be sent to it for treatment, it is natural to infer that they will not be willing to co-operate in the establishment of a refinery elsewhere, unless they can obtain specially favorable terms for the treatment of their own copper, or be guaranteed its separate treatment.

The companies operating at Grand Forks and Greenwood, which points, as already noted, are naturally tributary to Trail, would undoubtedly be willing to contribute their copper to some other point than Trail, the only questions involved being commercial ones.

The two principal producers on the Pacific coast of British Columbia are the Granby Consolidated Mining, Smelting and Power Company, with smelting works and mines located 110 miles north of Prince Rupert, and the Britannia Mining and Smelting Company, with mines near Britannia Beach on Howe Sound, about 30 miles north from Vancouver. If the interest and co-operation of these two corporations could be secured the success of such a project would be secured. Without the co-operation of both these producers the amount of copper available would be too small to warrant the establishment of a refinery on the coast. Both companies have existing contracts which will have to be completed before they are free to accept new obligations and these contracts have several years to run. Both would probably be willing to enter into new contracts with a Canadian refinery, but strictly on a commercial basis—that is the Canadian refinery must at least give them as favorable terms as they now receive, or are offered when renewing contracts.

The Canada Copper Corporation, which now controls the interests of the British Columbia Copper Company, and which has been developing the new deposits in the vicinity of Princeton, B.C., is controlled in the United States. At present a small amount of converter copper is produced at the Greenwood plant from Boundary ores, and is shipped to a United States refinery under contract. Plans are under way for the erection of a concentrating plant to treat the ores from the mines near Princeton. The concentrates at this plant are to be sent to the smelter at Greenwood, and it is to be presumed that the copper from this ore will also be shipped to the United States for refining.

Location of a Canadian Copper Refinery.

The following points have been considered in an attempt to reach some conclusion as to the best location for a Canadian copper refinery: A St. Lawrence point, Quebec; Sault Ste. Marie, Ontario; Port Arthur, Ontario; Trail, British Columbia; two Pacific coast points, British Columbia.

The following are the principal factors that have been considered in each case: Relation to sources of supplies of blister copper; Relation to probable markets for refined copper; relation to sources of materials for construction and maintenance; probable freights inward and outward; power costs; Fuels and other supplies; labor costs; interest losses on copper in transit.

My conclusion is that British Columbia offers the best locations for the refining of the copper at present available for treatment. With respect to the location of a refinery on the Pacific coast as opposed to one at Trail I consider that the coast unquestionably offers the best site for a commercial refinery.

The coast production will, in a few years' time, be at least ten times that of Trail, apart from the copper which might be sent to Trail from the two interior smelters. These smelters, however, could also contribute to a coast refinery, and therefore their production does not need to be specially considered when weighing the comparative merits of locating at Trail, or at a coastal point. Trail would have lower capital and overhead charges to meet than a coastal point, but the power costs fuel costs, and labor costs would be higher, as would freights on supplies and products.

Almost any coastal point accessible to one of the trans-continental railroads is favorably located with respect to freight rates on raw materials and finished products and has, moreover, an enormous tributary area with low freight charges. Certain points offer particularly low power costs, and cheap oil fuels are

available. Inasmuch as eastern manufacturers in Canada would require not more than half the output of such a refinery, even if they were equipped to handle such a quantity, the balance would have to find another market. The potential possibilities of the British, Asiatic and Australian markets are such that the available surplus could probably be placed in these markets more cheaply from the British Columbia coast than from any other point in Canada.

In brief, I consider that marketing conditions alone render it inadvisable to locate a refinery anywhere in eastern Canada for the primary purpose of refining British Columbia copper, and I consider that certain Pacific coast points would afford the best location.

2. Selection of a site.—Since it is assumed that if a copper refinery were to be established on the coast it would be operated as a commercial enterprise, the site selected should be chosen only on its merits. Primarily it should be on tide water, and hydro-electric power should be available. The amount of power should be much in excess of the immediate requirements to allow for expansion, and the development of certain related manufacturing industries if these appear desirable. The site, moreover, should be centrally located to facilitate the assembling of the products of the different contributing centres, and should be where climatic conditions are most favorable.

Equipment Required.

1. Power site.—A suitable site for the development of hydro-electric power will be required. This should be capable of supplying not less than 5,000 horse power per day, on 24 hour service. This is much in excess of the power required for a 50 ton refinery alone, but scarcely allows for reasonable expansion. There are a number of power sites available where about 20,000 horse-power could be secured and developed at a cost not exceeding $100 per developed horse-power. At the start it would not be necessary to develop the whole of such a power.

2. Refinery and Auxiliary Equipment.—A complete refinery will include the following equipment:

Office building; chemical and assay laboratories; physical testing laboratory; water supply system; power plant, coal bins and equipment, fuel oil tanks and equipment, boiler room and equipment, engine room and equipment, generator room, transformers, motors, switchboards and equipment; furnace building, cranes and charging machine, small water-jacketed blast furnace, anode furnaces, cathode furnaces, casting machines, cast iron and cast copper moulds for anodes, wire bars, ingots, and cakes, moulds for making casting machine moulds, charcoal storage; tank house and equipment; precious metal refinery and equipment; copper sulphate plant; supply storage for furnace department, and for tank house; copper storage, incoming and outgoing; sampling shop and drills; scale house; repair shops, forge and blacksmith shop, foundry, boiler shop, machine shop, carpenter shop, paint shop; shop supply storage; yard, tracks, haulage motors, cars, trucks, and other yard equipment.

3. Smeltery.—If a smelter is established to treat the tonnage of ore for which there is no present provision, the additional equipment needed will depend upon the character of the ores available and their quantity. One or more reverberatory furnaces, and one or more basic lined converters will be required. It is also possible that a blast furnace would be needed though this is not essential. The offices, laboratories, shops, and storage warehouses provided for the refinery would also serve for the smeltery, except that they would have to be made slightly larger.

4. Docks and Equipment.—Docks capable of affording wharfage to at least two vessels, of about 7,000 tons capacity, would be required. They should be equipped for unloading ores, concentrates, blister copper, and supplies as expeditiously as possible. They would also have to be equipped for loading the products of the refinery. The initial cost would vary with the location, and with the size of the plant.

5. Subsidiary Industries. — The establishment of subsidiary industries in close connection with the copper refinery is worthy of consideration. The primary products of such a works would be copper wire or bars, plates and tubes. With the production of electrolytic zinc, it would be possible also to produce brass either in ingots or in manufactured forms.

6. Working Capital.—It is not possible, at the present time, to arrive at any satisfactory estimate as to the amount of capital required, either for the establishment of such a works or for their operation. The exceptional circumstances attendant on the marketing of the products of a refinery located in British Columbia may render it necessary to have a very much larger working capital than is usually required.

Copper refiners as a rule do not purchase the copper treated at their works. They usually levy a fixed treatment charge, and make a percentage deduction from the weight of the crude copper received to compensate losses in treatment. This fixed charge varies with the nature of the product to be treated from $10 to about $20 per ton. They also pay for the gold and silver recovered at current market rates. In the eastern refineries the copper in transit is rarely tied up for more than a week or ten days, exclusive of time consumed in transportation. In a refinery on the British Columbia coast it is probable that the copper in transit through the works and en route to market would be tied up for at least a month, and possibly for two months or more. It seems probable, therefore, that there would never be less than 3,000,000 pounds of copper locked up, and very frequently the amount in transit would be double this quantity. At an average market value of 12 cents per pound this means the loss of interest on a sum of money lying between $350,000 and $750,000, according to the circumstances. Since nearly all the available copper ore, mattes, and converter copper also contain small quantities of gold and silver, the value of these metals, when in transit through the works, would also have to be considered. Their probable value cannot be readily estimated without an accurate knowledge of the products to be treated in the plant. The length of time these metals would be locked up would probably not be less than two weeks, and never more than four.

It is thus apparent that the circumstances of location and marketing may entail a somewhat larger interest loss on metals in transit than would normally occur, and compensatory adjustments for this extra charge would probably have to be made by the refinery.

General Conclusions.

The author's conclusions may be very briefly stated as follows:

1. The province of British Columbia is the only province which produces enough copper annually to support an electrolytic copper refinery.

2. Within a very short period of time the total amount of copper produced from districts tributary to the Pacific coast of British Columbia will probably be

more than half the total production of Canada, and will be much in excess of that tributary to interior points.

3. For various reasons, which have been cited, the author concludes that the Pacific coast of British Columbia offers the best choice of sites for a refinery.

4. The Canadian consumer does not demand refined copper in any quantity, but purchases copper in manufactured forms; therefore refined copper produced in Canada would for the most part be unsaleable unless provision is also made for its conversion into manufactured forms, particularly bars, rods, wire, sheets and tubes.

5. A market for the surplus copper would have to be obtained. It is probable that refined copper could be marketed in Europe as cheaply as from a refinery in the Eastern United States. It is also possible that the Australian and the Asiatic markets might require the surplus material if converted into manufactured products.

6. There appears to be an opening for the organization of a very considerable commercial enterprise which might include among its activities any or all of the following principal departments:

(a) Copper smelter (treating about 500 tons of ore per day).

(b) Copper refinery (producing about 50 tons of copper daily).

(c) Zinc refinery (producing about 40 tons of zinc daily, including zinc in oxide).

(d) Brass making plant.

(e) Rolling mills (for copper, zinc, and brass).

(f) Bar and wire mill.

(g) Tube mill.

7. The organization of any considerable commercial enterprise founded on the copper productive capacity of British Columbia, either to produce refined copper alone, or to carry on any or all of the associated industries here suggested, is a matter for private enterprise. The successful operation of a refinery is dependent upon the securing of contracts for refining the greater portion of the output of the productive properties tributary to the coast districts of British Columbia. The majority of the producers in these districts have already well established business connections in various quarters and it is not to be expected that they will be willing to enter into new agreements unless reasonable proposals are made to them which it will be to their material advantage to accept.

REFINERY CONSTRUCTION.

Port Colborne, Ont.—Things are humming across the canal where the Foundation Co. are constructing the nickel plant. The former Grove Hotel is now one large office building occupied by the superintendent and those in charge of various departments of the work.

Two hundred and fifty men are at work and additions to the staff are being made at the rate of about twenty men a day. From 800 to 1,000 men will be at work on the job by spring. One bunk house which will accommodate 150 men is now ready for habitation.

Large quantities of machinery and construction material are arriving daily.

It is safe to say that every place in Port Colborne where living quarters are obtained is now occupied. The demand for furnished suites, single rooms and houses has more than exceeded the supply, and the private citizens, as well as every merchant, have already experienced a benefit from the activity caused by the commencing of the big work.

GOLD DREDGING IN YUKON*

Dredging has rapidly developed in the Yukon as a highly profitable industry, and dredges are operating successfully not only in the beds and on the bars of rivers, but also on the frozen placer creek claims in the Klondike district. A short time ago the rich claims on the more prominent creeks in the Klondike district proper were being worked by the most modern methods of what is known as ordinary placer mining. Gravels, from which large quantities of gold dust were recovered by this method are now being worked by dredges adapted to the special conditions which exist in that district.

Yukon Gold Co.

The Yukon Gold Co. is incorporated under the laws of the State of Maine, and commenced operations in the Yukon in 1906. The president of the company is S. R. Guggenheim, the secretary-treas., Chas. K. Lipman, the consulting engineer and general manager, O. B. Perry, all of 120 Broadway, New York and the resident manager is C. A. Thomas, Dawson, Y.T. The holdings of the company comprise 555 creek, hill and bench claims in the Klondike district.

The Yukon Co. has constructed several dredges. These are in operation on Bonanza Anderson concession, Hunker Gold Run and Eldorado.

The power for operating dredges is obtained from the company's hydro electric plant operated by water from the Little Twelve mile river carried through five miles of flume and delivered to the plant under 650 feet net effective head. The installation consists of three 650 K. W. generators, directly connected to three water wheels of the impulse type. The main transmission line is 36 miles in length, operating at 35,000 volts, with 18.2 miles of extensions and secondaries.

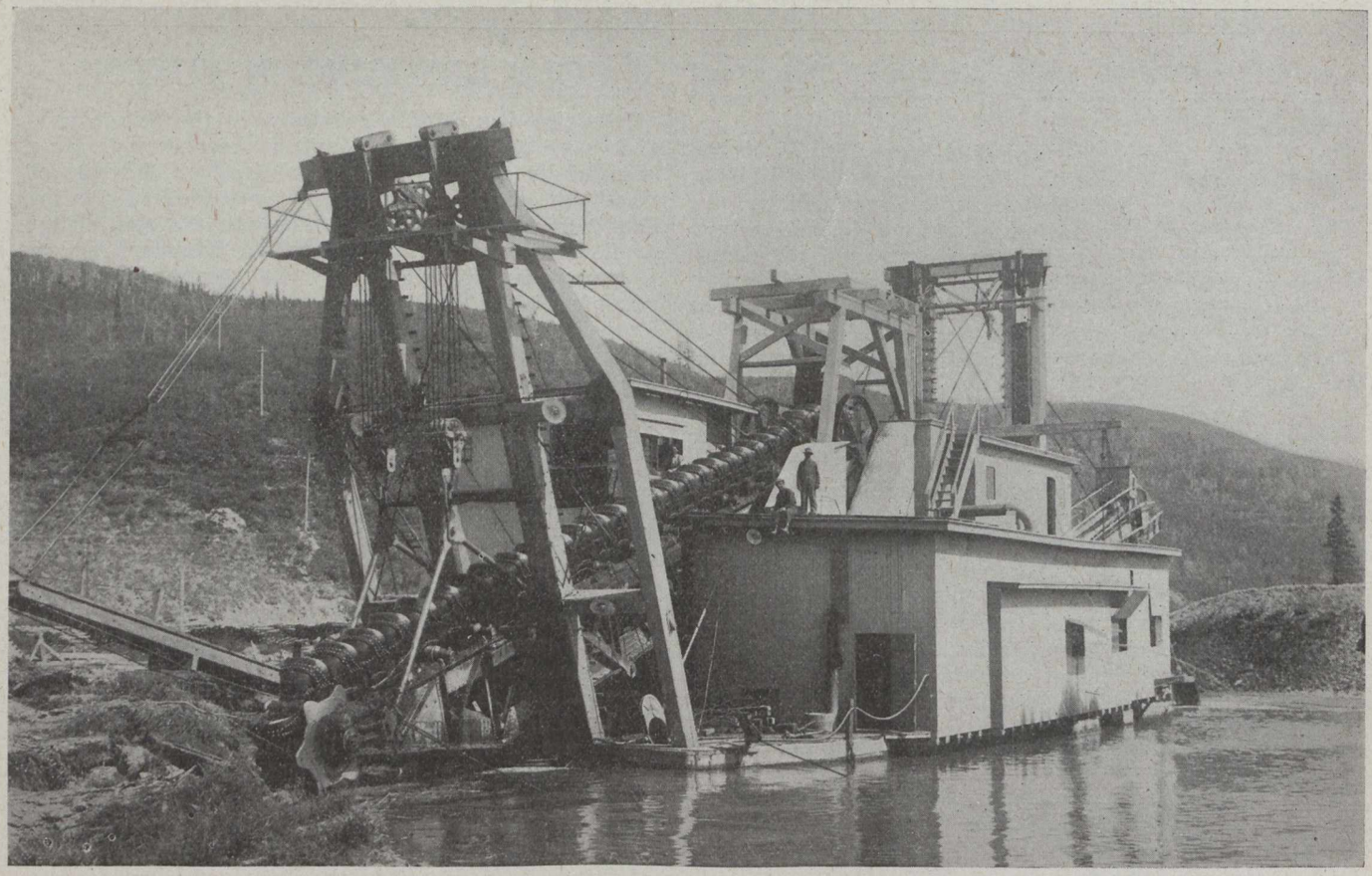
Canadian Klondike Mining Co., Limited.

The original company from which the present Klondike company has been evolved was incorporated under the laws of the Dominion of Canada, in November, 1904, and commenced operations in August, 1905, on Hydraulic Mining Lease No. 18, which is known as the "Boyle Concession" on the Klondike river. J. W. Boyle, Dawson, Y.T. is general manager of the company.

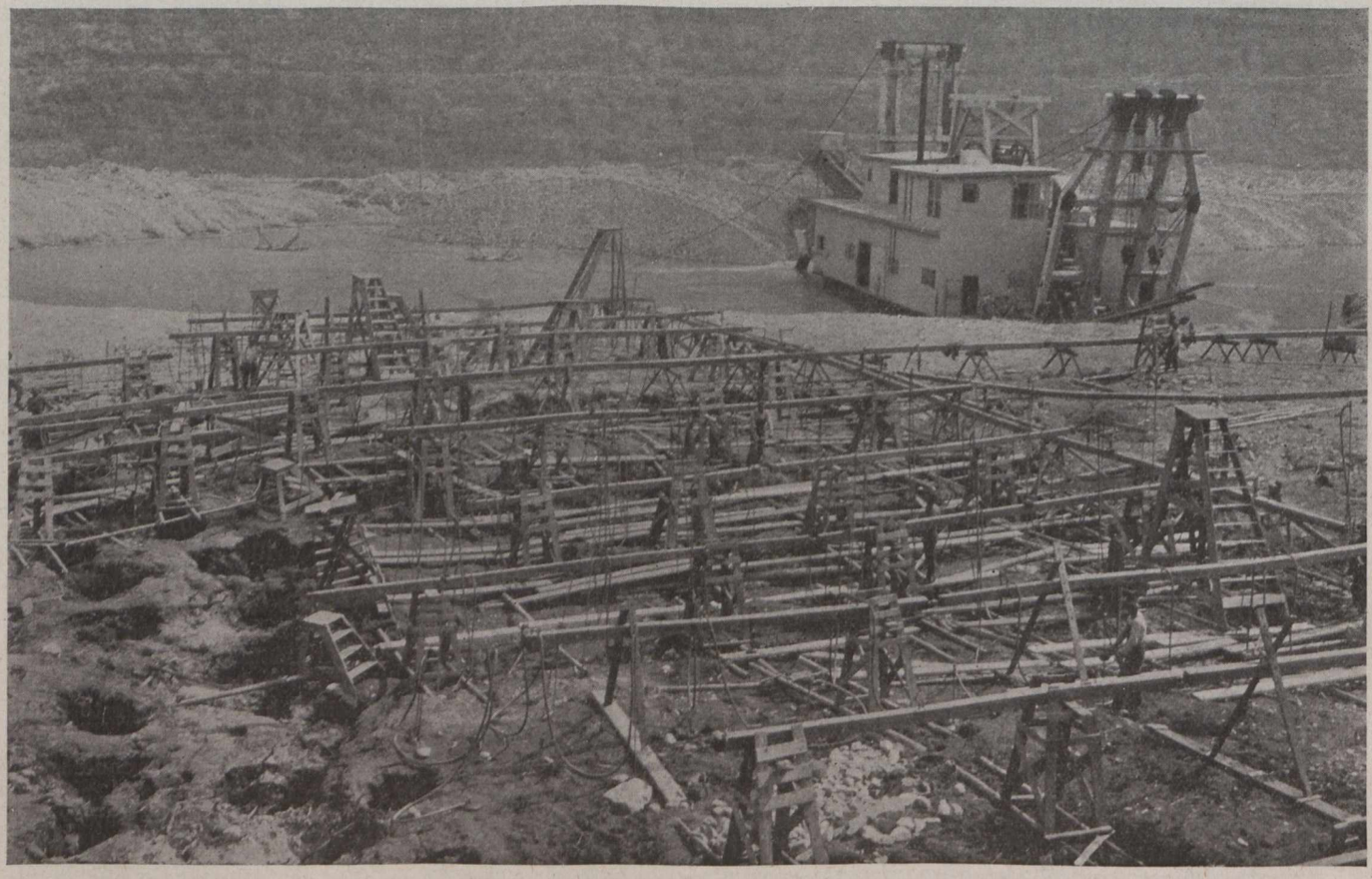
Mr. Boyle states that the approximate area of dredging ground within the Boyle concession, insofar as physical conditions are concerned, consists of approximately six and three-quarters square miles, being the entire flat of the Klondike valley within the confines of the concession. It is estimated by the general manager that this area contains 250,000,000 cubic yards of material, of which approximately 120,000,000 cubic yards have been proven by drilling and sinking of shafts to contain values which will be profitable for dredging. Prospecting is still being conducted on the undeveloped portion of the concession, and there is every indication that approximately 50,000,000 additional cubic yards will prove valuable, although at present insufficient prospecting has been done to positively establish the values.

Operations were commenced on the Boyle concession in August, 1905, with dredge Canadian No. 1, a 7 1-2 cubic foot dredge, electrically driven with power developed with a steam driven turbo-generator plant of 400 K.W. capacity. Both dredge and power plant were erected on the flat of the Klondike valley directly opposite the mouth of Bear creek.

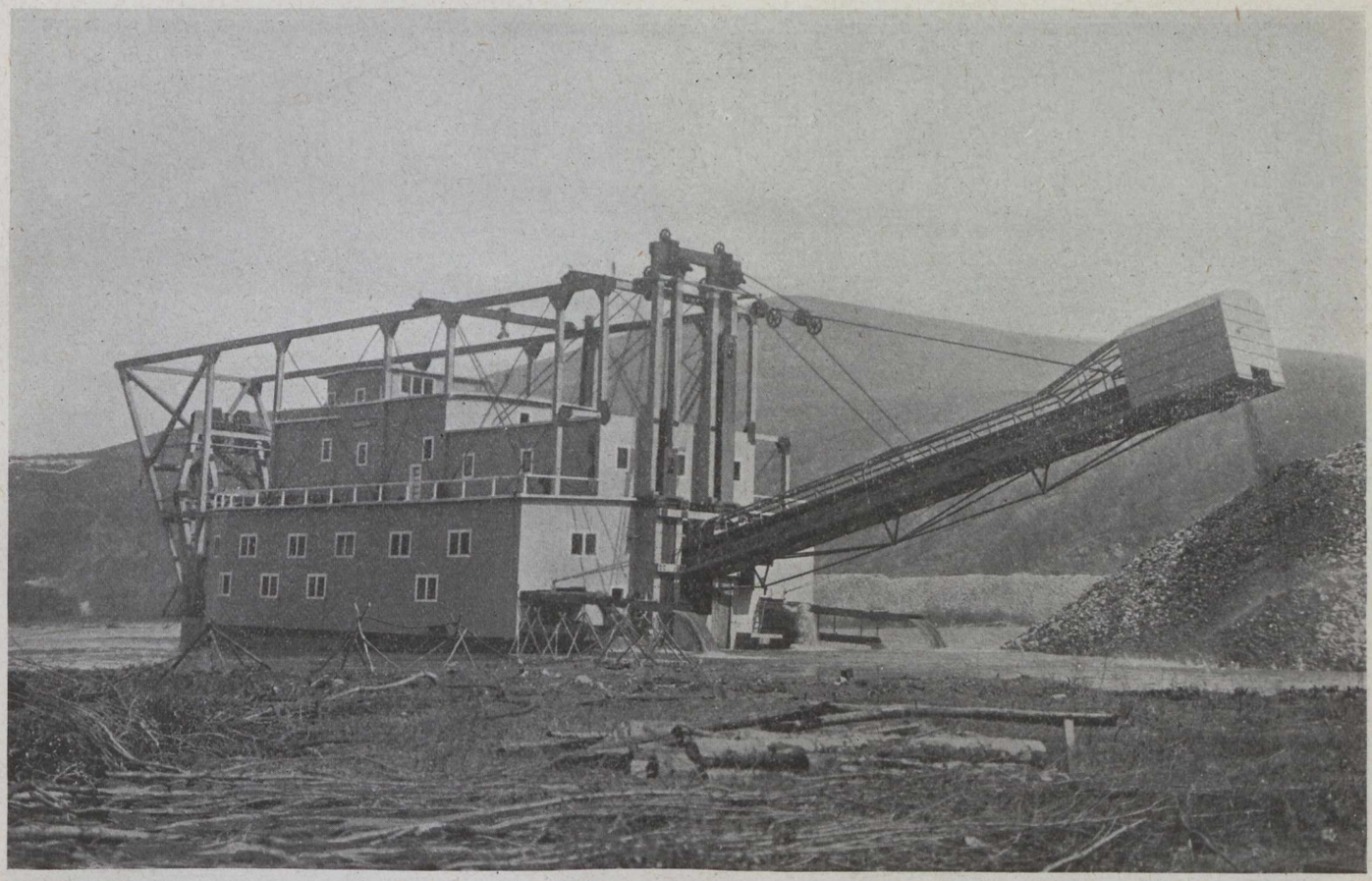
* Extract from a report published by direction of the Minister of the Interior.



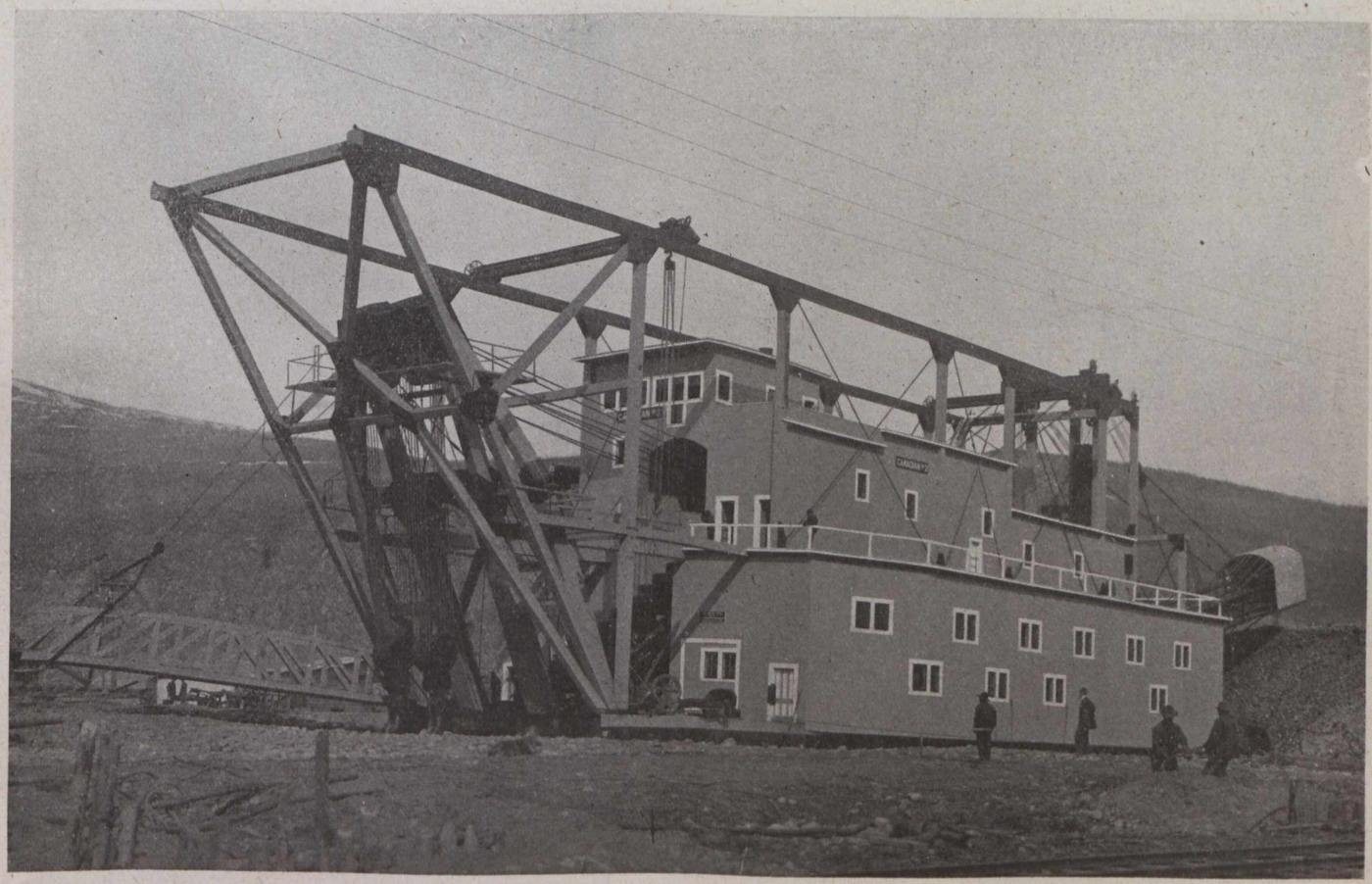
Dredge Yukon No. 4, operating on Lower Hunker creek.



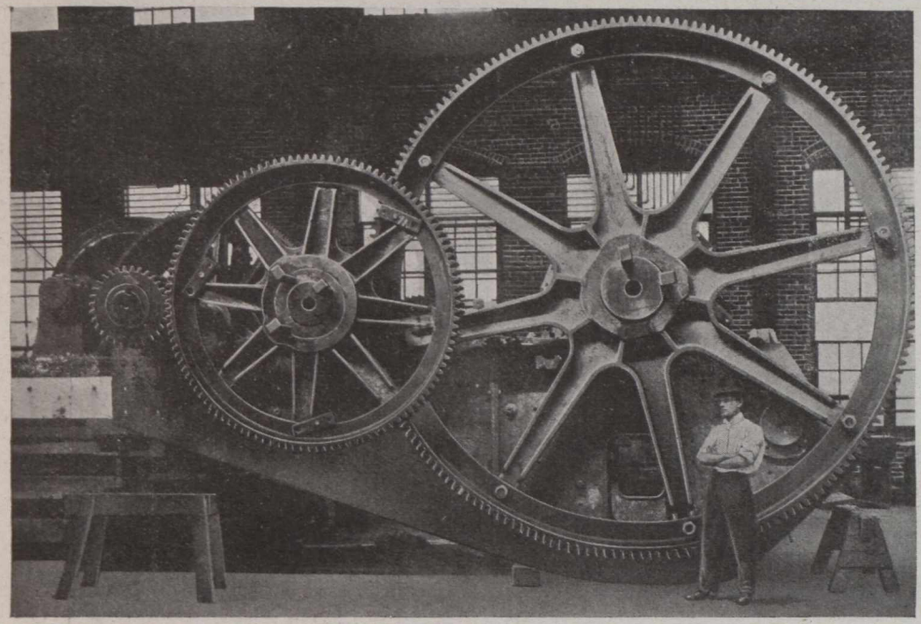
Dredge Yukon No. 5, operating on Bonanza creek.



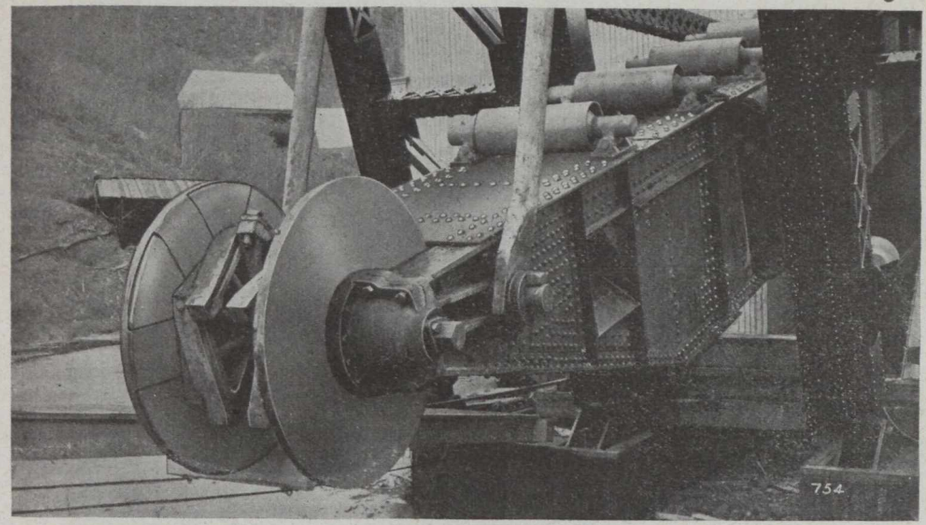
Stern view of dredge Canadian No. 3.



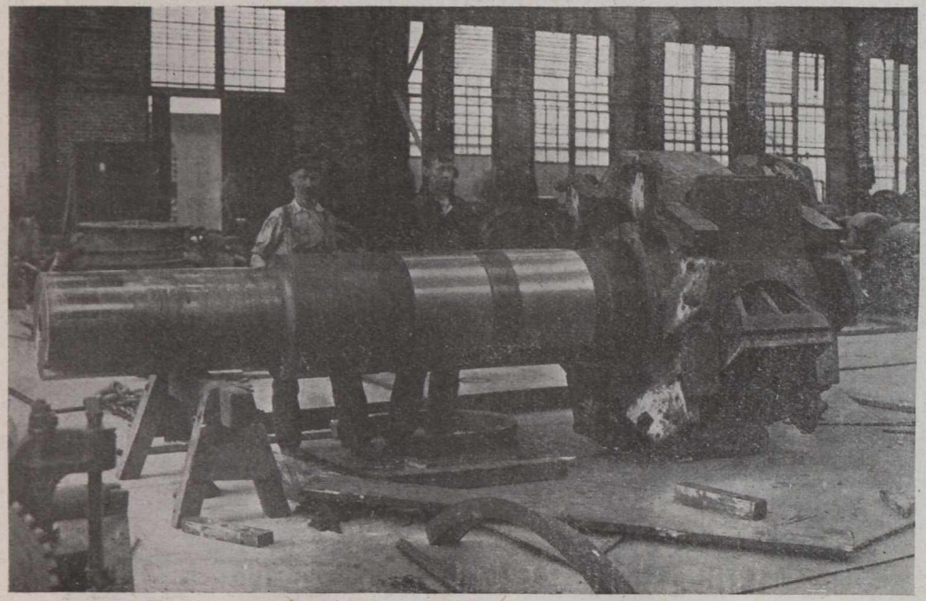
Dredge Canadian No. 3 in operation.



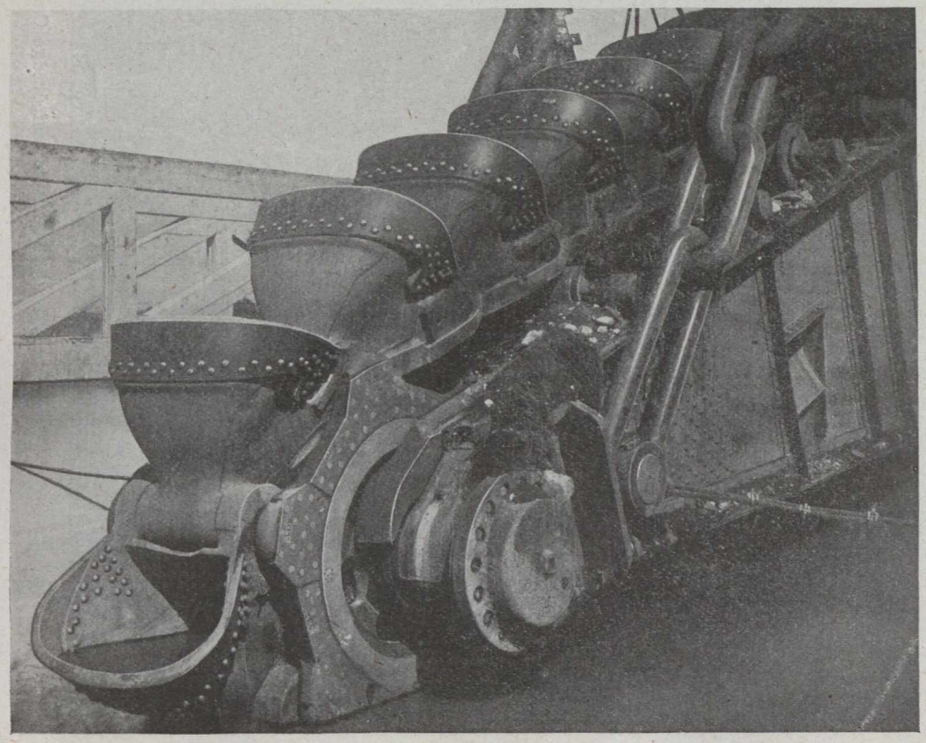
Main drive set up, on dredge of Canadian Klondike Mining Company, Limited.



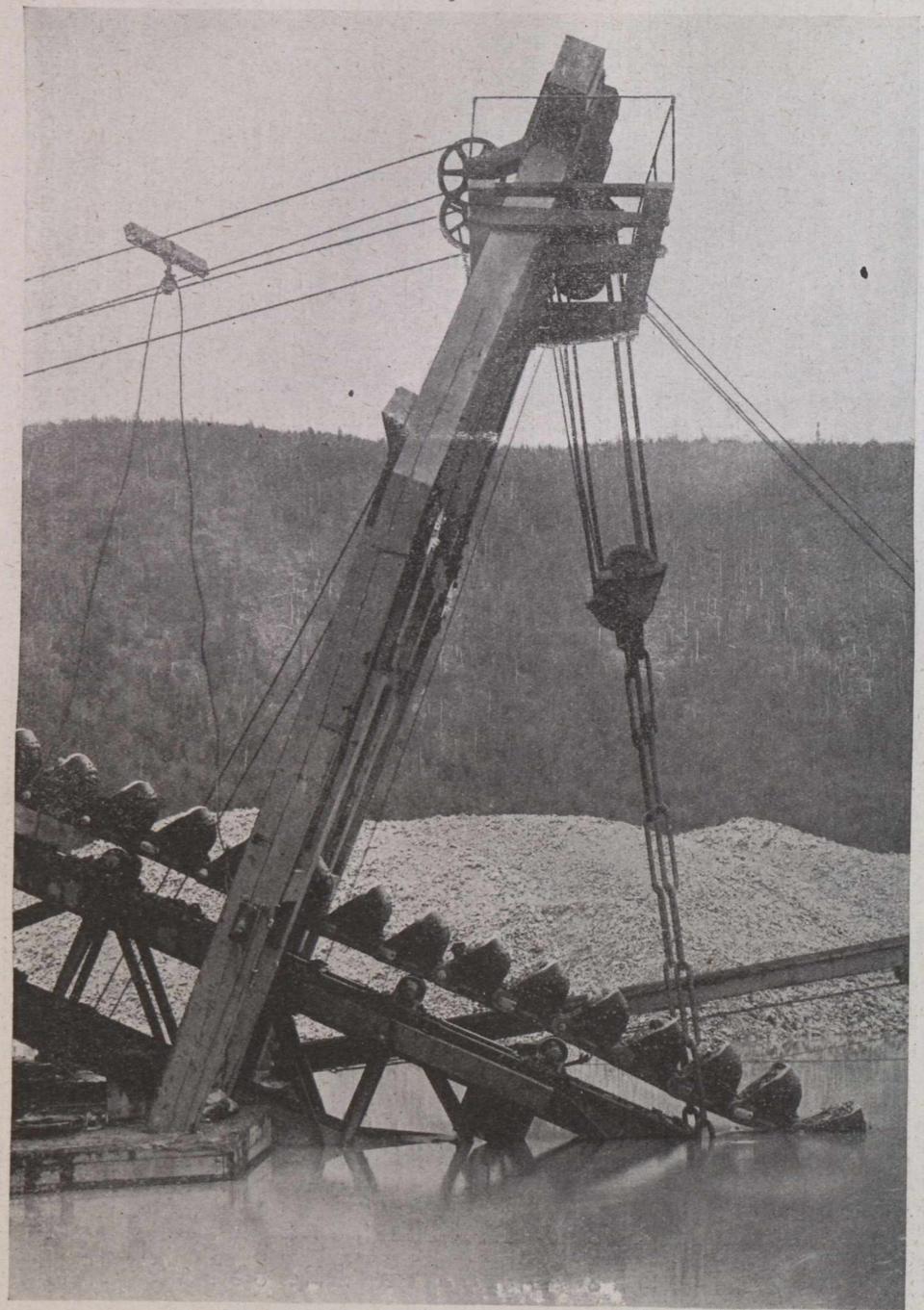
Lower tumbler with bucket line of steel Bucyrus, 7 foot dredge, Yukon No. 9.



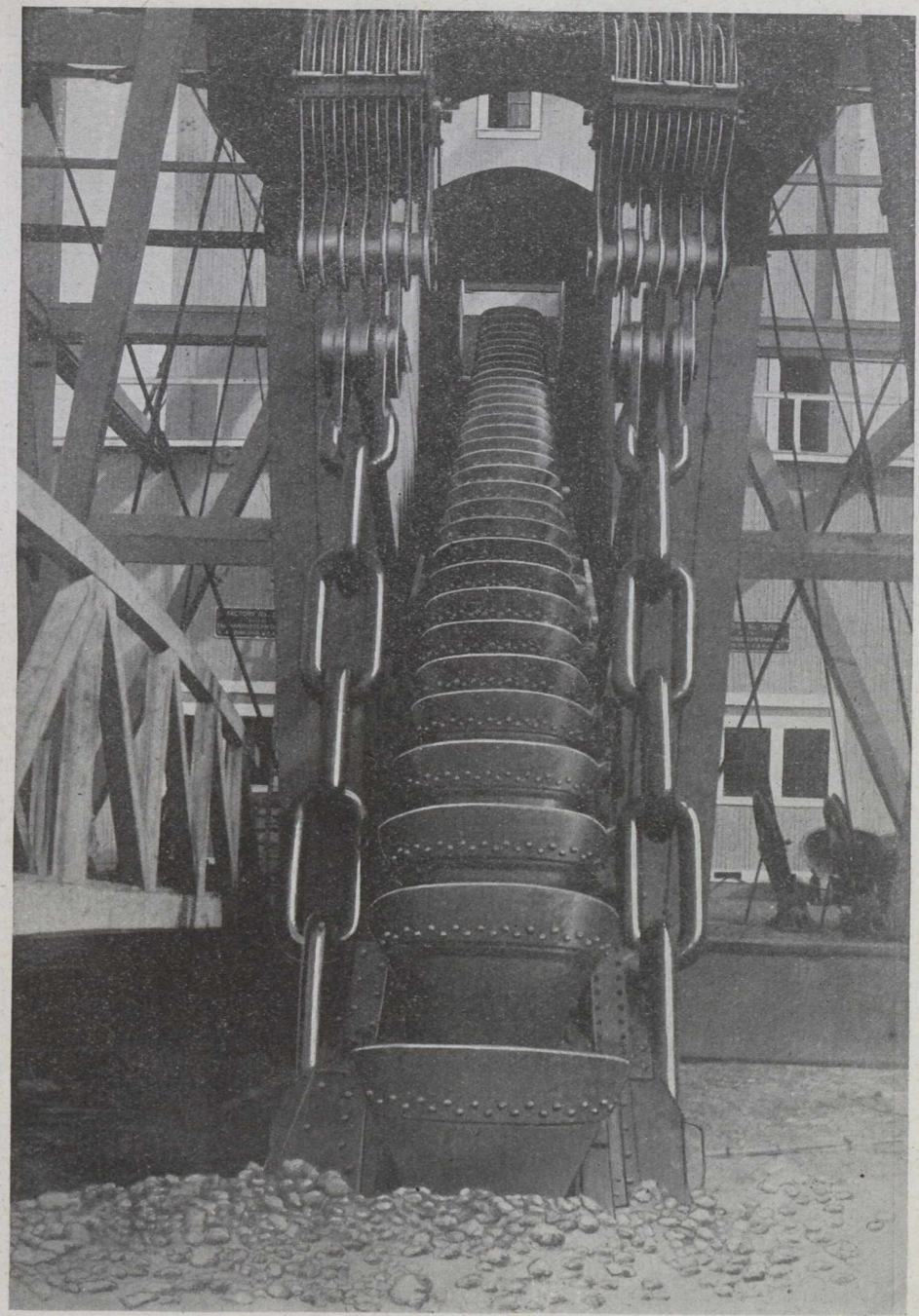
Upper tumbler with shaft, showing tumbler about to be pressed on.
Canadian Klondike Mining Company, Limited.



Digging line, Canadian No. 3.



Bow gauntree of 5-foot steel dredge.



Bucket line, Canadian No. 3.

This dredge operated on the Boyle concession during the open season of each year from 1905 until 1912, inclusive. In the fall of 1912, dredge Canadian No. 1 was dismantled at a point on the Klondike valley about two miles below Bear creek. In the spring of 1913 this dredge was reconstructed on claim No. 21, below Discovery on Hunker creek and worked claims Nos. 22 and 22A below Discovery. The dredge then worked up stream on Hunker creek continuously during the open season of 1913 and 1914 and is now operating on claim No. 8, below Discovery.

Dredge Canadian No. 2, a 16 cu. ft. dredge, was erected in the summer of 1910 at a point on the flat of the Klondike valley about one mile below the mouth of Bear creek. This dredge was completed and commenced operating on the 4th of November, 1910, and continued operations until the 4th of December following. It was also operated continuously during the open season of each year from the spring of 1911 until the 10th of October, 1914.

Dredges Canadian No. 3 and Canadian No. 4 were constructed in 1912 and 1913.

Dredge Canadian No. 3 commenced operating on the 10th of May, 1913, and has since operated continuously during the open season of each year.

Dredge Canadian No. 4 commenced operations on the 20th of May, 1913, and since that time has operated continuously during the open season of each year.

The Canadian Klondike Power Co. Limited.

This company was formerly known as the Granville Power Company, Limited, and was incorporated under "The Companies Act" of the Dominion of Canada on the 29th of April, 1910. The officers of the company are, president, James McDougall, secretary, A. E. Nash, and manager, J. W. Boyle.

The plant of the Canadian Klondike Power Co. is situated on the Klondike river, 26 miles from Dawson. The manager states that twelve dredges have been supplied with power from this plant, and that the cost of power varies according to the quantity supplied, the highest price charged being 3 cents, and the lowest 2 cents per kilowatt hour.

Construction work was commenced in June, 1910, and the plant started generating power on the 6th of May, 1911. The following statement was furnished by the manager concerning:—(a) water grant and ditch, (b) equipment and (c) transmission lines:—

Water Grant and Ditch.—The water diverted for power purposes is obtained under authority of three water grants from the Canadian Government which provide for a total diversion of 30,000 miner's inches (equivalent to 45,000 cubic feet of water per minute) from a point on the north fork of the Klondike river about four miles from its confluence with the main channel thereof.

The water is conveyed from the point of diversion by means of a ditch six miles in length. The ditch is 18 feet in width at the bottom and 28 feet in width at the top, with a minimum depth of 5 feet. The ditch conveys the water to the hillside facing the main valley of the Klondike river, and is delivered to the water wheels through two lines of pipe graduating from 72 to 66 inches in diameter, each 1676 feet in length, and with an effective head of 228 feet.

Electric Plant.—Two 5,000 H.P., I. P. Morris reactionary turbines direct connected to two 3,000 K.V.A. Westinghouse alternators, 2,300 volts, 3-phase, 60 cycle, 514 R.P.M. One 85 K.W. exciter, direct connected to a 36 inch Pelton impulse wheel. One 85 K.W. exciter, direct connected to a 110 H.P. induction motor. Two banks of transformers, each bank consisting of three 1,250 K.W., 2,300 volts to 33,000 volts, 60 cycle, water-cooled, single phase transformers, delta connected. Each transformer is housed in a separate concrete vault. The switchboard is made up of six panels on which are mounted all the necessary instruments and switching devices, including graphic recording volt meter, watt-meter, power factor meter, frequency meter and Tyrell regulator. All switches carrying over 125 volts are located in a concrete vault in the basement of the power station.

Transmission Lines.—There are two lines of transmission from the North Fork power station.

1. The Dawson line which runs to the city of Dawson, a distance of 22 miles from the power house, and supplies power to: Canadian Klondike Mining Co.'s large centrifugal pumping plant at the mouth of Hunker creek, at which point is situated a sub-station with 1,000 K.W. transformer capacity; Dredge Canadian No. 2, Canadian Klondike Mining Co.'s machine shops, and the main camp of the mining company are supplied through Bear creek sub-station which has 1,000 K.W. transformer capacity; Dredges Nos. 3 and 4 of the Canadian Klondike Mining Co.'s equipment, which receive power from Bonanza basin sub-station of 2,000 K.W. transformer capacity; The city of Dawson, for the purposes of the Dawson Electric Light & Power Co. Limited, and the Dawson City Water & Power Co. Limited, which furnish the city of Dawson with all power, light and water services (including fire protection service) all of which is electrically operated. This power is also furnished from Bonanza basin sub-station.

2. The Dominion line which runs to the head of Dominion creek, 20 miles distant from the power house. 14 miles out on this line there is a branch line 4 miles long to the Hunker sub-station of 300 K.W. capacity.

The transmission is phase, 33,000 volt. Wooden poles are used, which are 35 feet above ground and are spaced 32 to the mile. Lightning arresters are installed at the power house and at all sub-stations.

The plant employs a station foreman, two operators and two oilers. The Bonanza basin sub-station has a day and a night attendant. The other sub-stations are cared for by electricians in the employ of the dredging corporation using same. An average of 4 men are employed in connection with the intake and ditch operations.

Approximately 1 1-2 miles of the ditch are in gravel and 4 1-2 miles through muck and glacial silt. In order to retain the frost, during the summer months, for the greater stability of the banks, the lower bank of the ditch, excepting in gravel cuts, is faced with brush as a protection from the sun's rays. As soon as the cold weather sets in and ice starts to form, the ditch is filled bank full, allowed to freeze over until a coating of from 18 inches to two feet of solid ice has formed—or sufficient to remain up in the form of a bridge—when the water is dropped two or three feet, leaving an air space between the bridge of ice and the surface of the water in the ditch.

Electric heaters are installed at the intake and at intervals of about two miles in the ditch and at the pressure box at the head of the pipe lines, through which approximately 90 K.W. of heat are used, enabling the plant to operate the entire year and through temperatures extending to 70 degrees below zero; and in one instance operating through a week with average temperatures of over 60 degrees below zero, without any difficulty.

The pipe line has been covered, there being a roof built for the upper part of the pipe, leaving an air space; the roof consisting of poles covered with about one foot of moss and one foot of gravel.

North West Corporation, Limited.

The North West Corporation, Limited, is an English company which was formed in 1913 with an authorized capital of £1,500,000. Its holdings are within the Indian river watershed in the Klondike mining district, and consists approximately of 75 miles of valleys, which have been estimated to contain 600,000,000 cubic yards of gold-bearing gravels.

Overlying the pay gravels in the valleys is a heavy covering of overburden consisting of moss and muck cemented with ice. This overburden is a non-conductor, and prevents the underlying gold-bearing gravels from being thawed by atmospheric conditions.

Ground-Sluicing.—This company employs, on an extensive scale, the ground-sluicing method of preparing the valley ground for actual digging. By the use of surface and pressure water conveyed through canals and ditches to the ground being prepared, the moss and muck are worked off to the underlying gravels, and carried away in suspension to the main creeks and rivers. The underlying gravels, being exposed to the sun's heat, soon thaw to bedrock. The greater the area treated the quicker the gravels thaw to bedrock, the depth of thaw each season varying from 10 to 16 feet in gravel.

Muck.—Muck overburden is a frozen substance having the following characteristics: Gray to black in color, composed of organic matter with particles of sand and silt cemented by ice. The temperature of frozen muck varies from 8 degrees to 12 degrees below freezing point.

Overburden removed in 4 years amounted to 3,307,670 cubic yards, at a cost varying from 2 cents to 8 cents per cubic yard.

Ditches constructed and being used for ground-sluicing purposes include: Dominion-Granville ditch, capacity 1,000 miners' inches, length 14 miles; Burnham-Jensen ditch, capacity 600 miners' inches, length 8.25 miles; Caribou-Nevada ditch, capacity 3,000 miners' inches, length 8 miles; Quartz creek ditch, capacity 1,000 miners' inches, length 7 miles; Other ditches 15 miles. The average number of men employed during the summer season is 140.

North American Transportation & Trading Co.

This company has a dredge of the Risden type, steam driven, open bucket line, and a bucket capacity of 5 1-3 cubic feet, operating on Miller creek. This dredge was built on Walker's fork in the year 1907, and was moved to Miller creek during the winter of 1912. The agent of the company states that prior to the installation of the dredge, a considerable area of ground was thawed to bedrock by the method of ground-sluicing, and that the quantity dredged in 1914 was 218,447 cubic yards.

Notes on Dredge Construction.

From experience gained by the Canadian Klondike Mining Company in connection with No. 1 dredge, alterations were made on dredges Nos. 2, 3 and 4, for the purpose of overcoming the difficulties of operating in cold weather, and the result is that these dredges have been operated without difficulty through temperatures exceeding 50 degrees below zero, and have lengthened the dredging season (which was formerly accepted as being about 150 days per season) to about 240 days during an ordinary season. A record operation of 270 days was made by Canadian No. 2.

The principal alterations made to effect this change were: Construction of a box girder type digging ladder with raised sides and a heating compartment in the ladder to prevent ice from forming thereon. Tailing stacker built in the form of a box girder with the return rollers placed inside of (instead of underneath) the stacker, the whole being enclosed during cold weather with canvas housing stretched over steel angle arches. The interior of this is steam heated, and the only exposure of the belt to cold weather is where it passes over the drum at the outer end of the stacker. The construction of a carefully built double boarded house enclosing all machinery and stairways, steam heated throughout by means of a 70 H.P. boiler installed within the hold of the dredge, from which hot water is used to keep ice from forming on the exposed sheaves in use on the bow of the dredge.

Owing to the difficulty experienced in handling heavy pieces of machinery on board the dredge first constructed, alterations were made in dredges Nos. 3 and 4 by erecting an overhead framework upon which a 20-ton travelling crane is operated, thereby eliminating all doors in the sides of the dredges, access to the dredge for the purpose of removing or installing machinery being had through hatchways in the roof of the housing. This structure extends 16 feet beyond the bow gauntree so that any piece in use on the dredge can be picked up on the shore by the crane, carried aboard, and placed directly over the machine to which it belongs, with the exception of parts of the winches and ladder hoist.

In operating dredge Canadian No. 2, the hull of which, like all other conveyor type dredges, was built in the form of a box, it was found that the increase in the weight of machinery at the bow had been disproportionate to that of the washing plant. The result was that the dredge was down at the bow to such an extent that it interfered with the proper washing of the material on the tables, owing to the loss of grade in the stream-down sluices. The design of the hulls of dredges Canadian No. 3 and Canadian No. 4 was therefore altered, so that instead of being 12 feet in depth throughout, as in the case of Canadian No. 2, these dredges were constructed 12 feet in depth at the stern and 14 feet 6 inches at the bow.

Instead of using a single steel digging spud, and a wooden spud for stepping on, all three of the 16 cu. ft. dredges were equipped with two steel digging spuds placed as close together as the width of the trailing stacker would permit, and as a result no loss in time was sustained in stepping forward. This altered the system in vogue on other dredges of dropping the wooden spud and swinging the entire width of the pond for the purpose of moving the dredge forward.

The Bucket Line.

The bucket-line is the most important part of a dredge and is the most expensive both in initial cost and in maintenance. There are two types of bucket-line, namely, open-connected and close-connected. In the open-connected there is alternate bucket and link and in the close-connected no link intervenes. The original idea of an open-connected bucket was that it would dig better in hard ground and in soil containing large boulders, but nearly all modern dredges use the close-connected bucket-line.

The bucket includes a bottom or back, a hood and a lip and these are fastened together with a pin and bushings. Buckets differ greatly in shape. The chief difference being in length of pitch, angle of lips, depth and width.

The general manager of the Canadian Klondike Mining Company has furnished the following information concerning the construction of buckets in his company's dredges:

The bucket is cast in a single piece insofar as the bottom or base and the hood are concerned, and except where there is a flaw in the casting it has a minimum life of about 600 days. Both high-carbon steel and manganese have been used in the construction of buckets. Where high-carbon steel is used an inserted plate of manganese steel is placed just back of the lower end or single eye of the bucket where it is subjected to the greatest wear, in order that this part may be renewed when the bucket wears down. This practice was found unsatisfactory, however, and since 1912 in all buckets constructed for the company's use manganese steel has been used.

The lip is composed of manganese steel, 2 3-4 inches in thickness, and 1 1-2 inches deep, with an average life of from 180 to 200 days.

The buckets for the 16-foot dredges have given considerable trouble due to the enormous amount of friction on the pin and bushing, and after many experiments the company adopted the use of manganese steel throughout, that is, manganese buckets, pins and bushings. The size of the pin has also been increased from its original diameter of 7 inches to 7 1-2 inches, using a hollow cast manganese steel pin which is now giving satisfactory results.

The bucket lip originally installed was 2 1-4 inches thick by barely 14 inches deep, of which approximately 10 inches were available for wear, since, when this portion was worn off, it became a matter of economy to discard the unworn part and instal a new lip.

In 1914 an alteration was made by increasing the thickness of the lips half an inch, and the height approximately 2 1-2 inches in the middle, and in addition to the longer life and smaller percentage of waste in these lips they stand up much better under severe service, as the first lips in some instances gradually bent in the middle. The alteration of the lip in this manner has increased the carrying capacity of the buckets from 16.1 cubic feet to about 17.2 cubic feet.

The principal difference between the shape of the buckets used by the Canadian Klondike Mining Co. and those of other companies is that the former are for the most part more rounded on the lip and have less pitch, with slightly more angle to the lips, which has the effect of preserving a thicker cutting edge.

Bucket pins for the 16-foot dredges are composed of manganese steel; are 7 1-2 inches in diameter and vary in weight from 350 to 400 pounds. There are generally 68 buckets in a line, but the number varies from 67 to 71 depending upon the depth at which the dredge is digging.

The Tumblers.

The tumblers are the heavy castings at each end of the bucket-line and around which the chain of buckets revolves. In discussing the number of sides in a tumbler, Weatherbe, in "Dredging for Gold in California" observes:

"The question of increasing the number of sides in tumblers so that they more nearly approach a circle in section has been discussed many times, and the question has now been pretty well settled by practical experiment. The number of sides must remain limited for two reasons:

1. In the case of the upper tumbler, after increasing the number of sides to six, its essential duty of holding, pulling round and dumping the bucket-line is impaired and no practical solution in the shape of a sprocket arrangement, any more than is now formed by the lugs and bottoms, as has been suggested, has been evolved; nor is it likely to be, on account of the immensely increasing weights and consequent strains set up. 2. The objection to the lower tumbler-section being increased to more than six or seven sides as a limit, is chiefly on account of the slippage and consequent wear."

The chief considerations that control the shape of the upper tumbler, however, are those which make for the most efficient and thorough emptying of buckets when dumping into the screen-hopper, and the least wear on pins and bushings. To aid this, jets of water are often used, playing into the full bucket as it rotates over the upper tumbler.

The general manager of the Canadian Klondike Mining Company Limited, states that his company's dredges have 6-point tumblers protected with manganese steel wearing plates at all points where they come in contact with the buckets, in addition to which the lower tumbler has a manganese steel tip wearing plate on each point, and the entire outside of the cheeks of the tumbler is sheeted with manganese steel wearing plates, which are replaced when necessary.

All wearing plates on tumblers are designed with a view to wearing through an operating season, which with the company, is approximately 240 days, for the purpose of avoiding lost time during the operating season, and new plates are installed during the general repairs, which are executed in March and April of each year before starting the season's operations.

Bow Gauntrees.

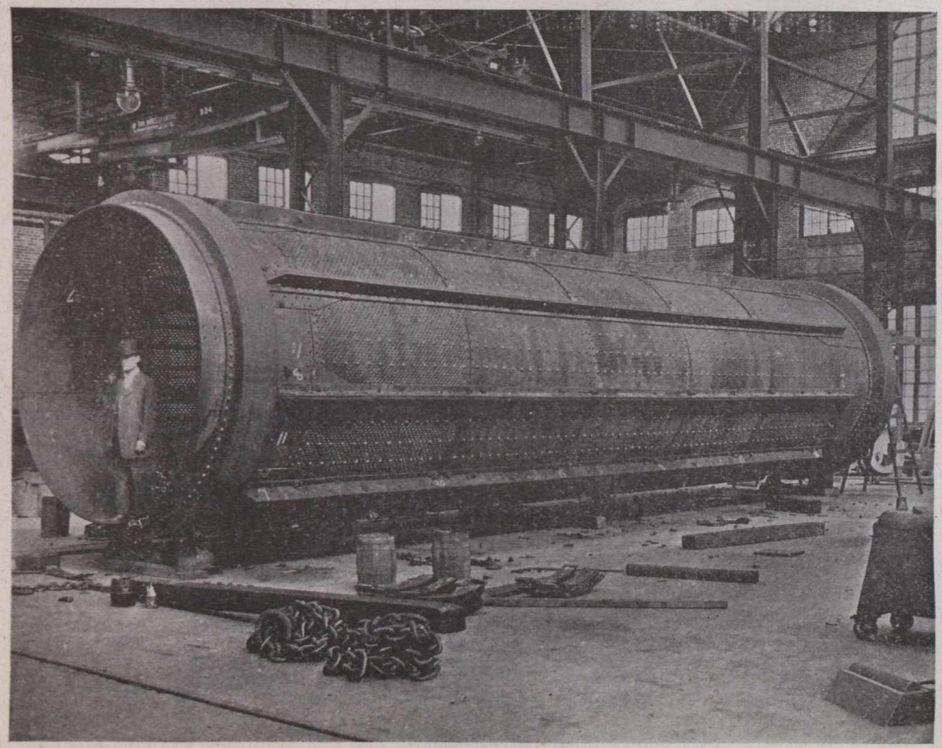
The bow gauntrees installed on the dredges of the Canadian Klondike Mining Co. are constructed of timbers fortified at all joints with steel plates, using a steel box girder type cap. The gauntrees are almost identically the same as those in use on large dredges in California. The stern gauntrees are constructed along the same lines as the bow gauntrees insofar as fortification is concerned, steel cap being used, and are similar to gauntrees in use in California.

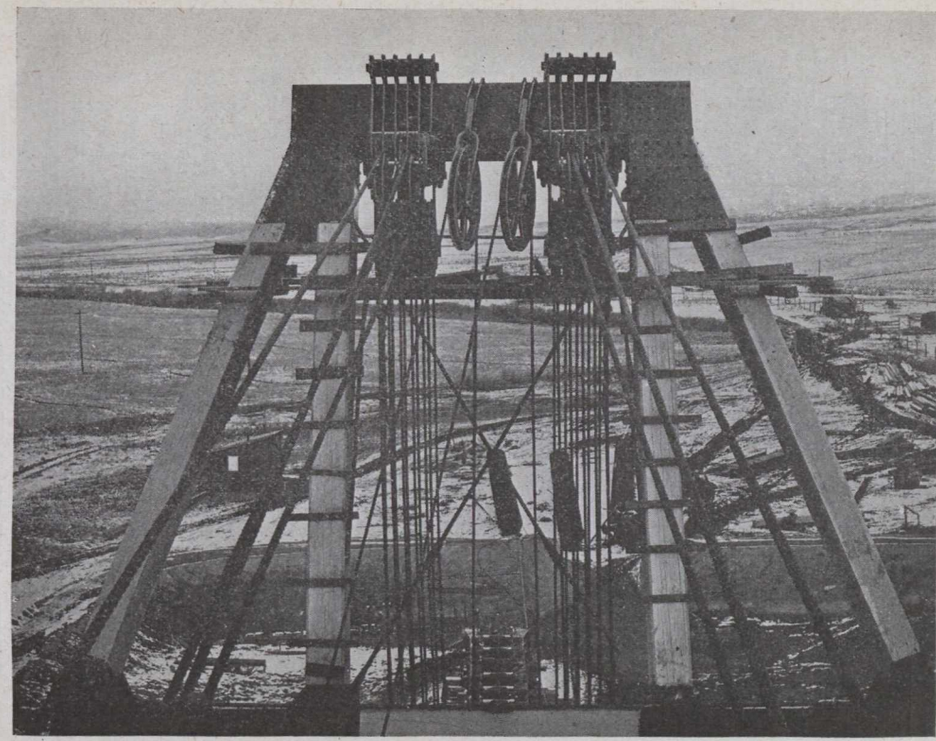
"Gold Dredging in California" contains the following information on the subject of gauntree construction: "The dredge hulls built during the last five years have greatly increased in weight, and are strongly braced with two overhead trusses extending the entire length of the boat on either side of the well-hole; also an overhead truss across the hull in the centre, which is attached to and distributes the loads upon the tumbler gauntree, thereby stiffening the hull fore and aft and athwartships. These trusses generally consist of 14 by 14-inch posts, having 14 by 16-inch cap stringers, and are braced by heavy steel diagonal truss rods between the posts."

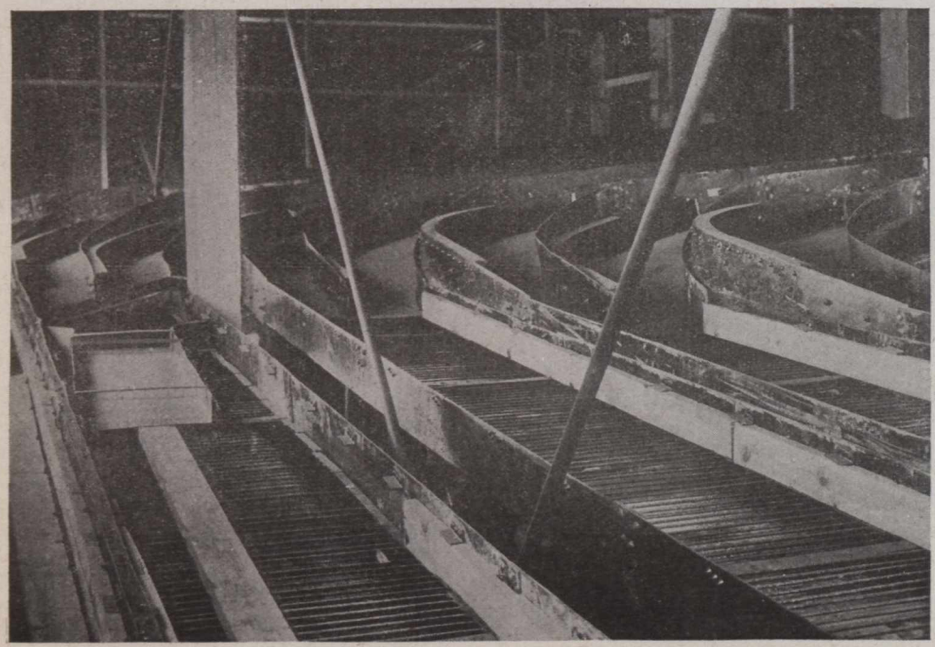
"To prevent the forward pontoon sections on either side of the well-hole from warping and sagging, which was a fault of the earlier boats, the bow gauntrees have been stiffened and redesigned to form a truss. The gauntree now consists of four posts 14 by 20-ins., rising about 36 feet above the deck, two being located on either side of the well-hole and two on the outside of the bow, well braced with steel rods and timber struts."

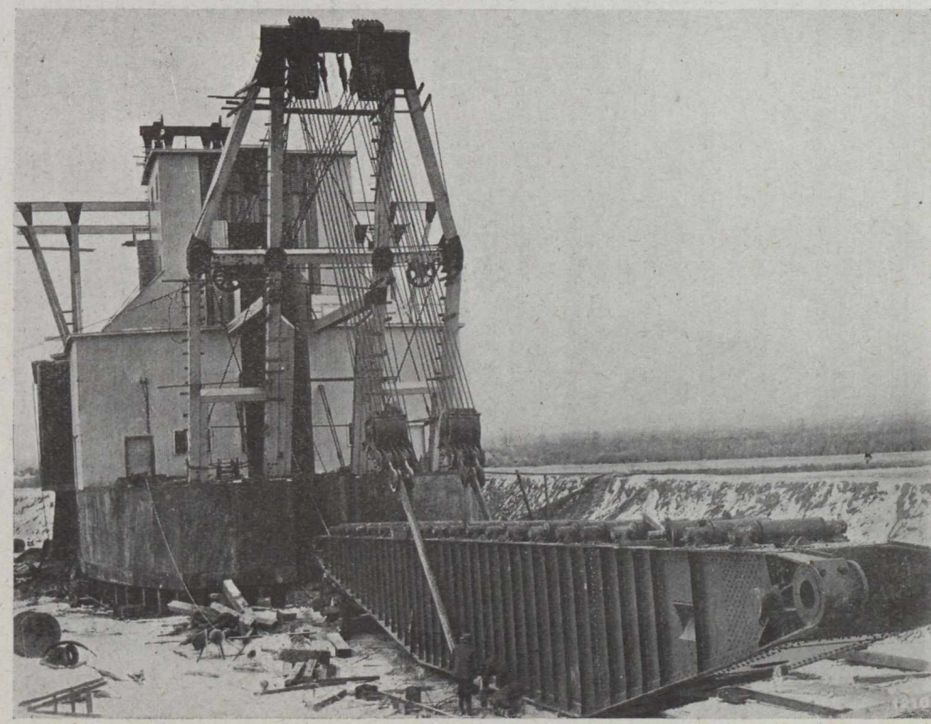
The middle or tumbler gauntree posts are 16 by 20 inches and of sufficient length to support the upper tumbler at a height of 23 to 25 feet above the deck. The stern gauntree posts are 14 by 16 inches and rise about 50 feet above deck resting on heavy timbers inside the hull.

Views showing gauntree construction, digging line, washing screen and sluice tables, Canadian Klondike Company's dredges.









The gauntree caps for the 5-cubic-foot and 7-cubic-foot machines are usually of timber, with steel side-plates the full length of the caps and extending down the gauntree posts, giving a substantial fastening to same. The larger machines are provided with structural steel caps.

Main Drive and Upper Tumbler.

The main drive, like all other machines on the 16-foot dredges of the Canadian Klondike Mining Co. is direct connected, the upper tumbler being driven by a 300 H.P. motor located on the main or upper tumbler gauntree, which is built of timber and heavy castings. These castings support the upper tumbler shaft the two intermediate driving shafts, the ladder suspension shaft, and also the bow gauntree guys. The castings are so constructed as to form when bolted together and connected with a large cast-steel plate that forms the foundation for the main drive motor, a solid bed plate for the entire drive.

The motor is mounted on the cast steel bed plate above mentioned and geared direct to the tumbler by means of a train of steel spur gearing, all gears having cut teeth. The upper tumbler shaft is 25 inches in diameter, reduced to 18 inches in diameter at the bearings, which are 30 inches long and hollow bored. The main drive gears are 14 feet in diameter, with a 12 inch face.

The second intermediate shaft is 14 inches in diameter with bearings 24 inches long. The intermediate gears are 91 1-2 inches in diameter with 10 inch face and the pinions meshing with the main gears are 26 inches in diameter.

The first intermediate shaft is 10 inches in diameter, fitted with a pinion at each end and near the middle carries a gear meshing with the pinion on the motor shaft. A friction clutch is mounted on this shaft for disengaging the motor and also acts as a slipping device.

Equalizing Gear.

The equalizing gear consists of bushing firmly keyed at quarters into the hub of the intermediate gear, this bushing at one end of the shaft being firmly keyed to the shaft, while at the other end two flat-backed keys are driven back to back, one into a key-way in the shaft, the other into a key-way in the bushing. These keys being 4 inches wide on the face, 1 1-2 inches thick and 24 inches long.

The gears are set as nearly perfect as possible and any slight inequality will adjust itself through the small allowance of slip by the keys and insures a perfect mesh of the gears on both ends of the shaft.

Belts.

The belt conveyor stacker of the 16-foot dredges is 48 inches wide by 238 feet long. The stacker is 115 feet in length. A straight idler is used with small idlers set at an angle at either end thereof, so as to create a concave form in the belt when running throughout the entire length of the stacker while carrying material, the driving drum on the other end of the stacker being straight and the belt returning on straight idlers.

The Canadian Klondike Mining Company use belts consisting of 8-plys of canvas with a convex reinforcement of rubber 5-16ths of an inch thick in the middle. When the belt shows appreciable wear in the middle, a 30-inch 7 ply rubber belt is attached in the form of a pad belt, which while running over the same drum on the outer end of the stacker has a separate idler set up on brackets at the lower end, same being separately adjustable, thereby insuring continuous running in the middle of the main belt.

The belting used by the Yukon Gold Co. is 32 inches wide, 7-ply; upper side has coating of 3-16 inch of rubber over 24 inches in the middle of the belt, tapering to 1-8 inch on edges. The average life of a belt is the period involved in handling about 1,000,000 cubic yards of material.

From the Canadian Klondike Mining Co., the following information has been obtained respecting: (a) clean-up, (b) materials resulting from clean-up, (c) melting, (d) gold saving devices, and (e) treatment of black sand:

Clean-up.

The gold saving system consists of a set of tables, made in the form of sluice boxes placed side by side on the foundation extending the entire length of the perforated portion of the screen, from the middle of the boat to each side, delivering into sluices running fore and aft and extending (in the case of the 16-foot boats) 30 feet beyond the stern.

At the head of the tables, on both sides of the screen, the first 42 inches of each sluice consists of a cocoanut mat on which is laid an expanded metal riffle, held firmly in place with wooden wedges. Below this set of riffles all sluices are fitted with angle-iron riffles with the angle bent slightly beyond 90 degrees for the purpose of creating a riffle at each angle.

The cocoanut mats are taken up each morning and replaced which operation takes from seven to fifteen minutes and is performed during the period in which the crew are oiling the lower tumbler, thereby causing no lost time.

A general clean-up takes place whenever the angle-iron riffles become filled to an extent which would in any way interfere with their ability to save gold, and in consequence the periods at which these clean-ups occur vary from once a week to twice a month, and are to some extent influenced by the question of repairs.

Immediately after the mats are changed and the oiling is completed, the dredge starts operating, and the clean-up crew proceeds to wash the mats in the tubs set up on each set of tables, piling the mats on a platform prepared for that purpose, ready to replace on the following morning those then in use. The material washed from the mats is run through a long-tom suspended from the ceiling over the tables, and over two sets of under-current riffles, the tailings from which are returned to the sluice tables of the dredge.

The long-toms are fitted with small cocoanut mats and expanded iron riffles, exactly similar to those installed at the head of the sluice tables, and after the material collected on the mats has been run through the long-tom, these mats are rolled up and taken to the clean-up room at the camp where they are washed, and the gold panned and blown, after which it is melted into small bricks for shipment to the mint. The tailings from pannings and blowings are amalgamated in a muller or grinding barrel, and when fully charged, the amalgam is retorted and the gold melted into bricks.

All sluices running athwart-ship on the dredges are 30 inches wide, stream-down sluices vary in width depending upon the number of athwart-ship sluices delivering into them, all sluices having a grade of 1 1-2 inches to the foot.

Materials Resulting from Clean-up.

With the exception of the silver contained in the particles of gold recovered, no material of value has

been found in the clean-up. A careful analysis was made of concentrates by fire assay and chemical and physical tests, and it was found that practically all of the gold was free; that the pyrites carried scarcely any gold; that the non-magnetic material consisted largely of quartz and ordinary alluvial rocky matter; and that the material which sank in bromoform consisted largely of cubes and fragments of yellow iron pyrites free from copper or arsenic. Small quantities of zircons were also found. No fluor-spar was found. No topaz was found either by chemical tests or microscopic examination, and it was decided that, with the exception of the gold, the material carried no commercial values.

Melting.

The treatment of gold dust is very simple as no attempt is made at refining the product, all of which is shipped to the Canadian mint.

The gold is melted in a plumbago crucible, the ordinary small open top furnace with gasoline jet being used. A flux of sodium carbonate (one part) and borax glass (two parts) is used and the melted gold skimmed with a small iron skimmer and poured into small bricks, which are then shipped by mail.

Efficiency of Gold Saving Devices.

It is impossible to say exactly what loss occurs in the process of winning the gold, but on one occasion it became necessary to dig through a considerable quantity of tailings already deposited by the dredge. Before entering the tailings the dredge was thoroughly cleaned and again carefully cleaned after reaching the other side. The recovery amounted to almost exactly 1-10 of 1 per cent of the amount recovered by the dredge when previously digging the same ground in its virgin state, and as nearly all of the gold recovered from the tailings was coarse it was assumed that it was gold which had passed through the dredge in chunks of bedrock which had been practically pulped together by the bucket lips in digging. At this particular place the bedrock consisted of decomposed schist, carrying considerable graphite, which when dug closely resembles clay and in many instances did not disintegrate on the screen. In consequence any gold contained within lumps which did not disintegrate would be carried out on the stacker, but as this particular bedrock when exposed to the weather for a season dries out, decomposes and washes readily, any gold which it contained would then be recovered.

Tests of tailings have been made by catching a tub of fine material from the stream-down sluices at the stern of the dredge, where they are returned to the pond, and with the exception of an occasional very fine color, no gold has been recovered, and in nearly every instance, although great care was taken in the panning, no recovery was made.

Treatment of Black Sand.

The black sand, and the very fine flour gold from which it is impossible to separate it by means of ordinary precipitation, are treated in a clean-up barrel or muller, which has a cement bottom, with a three-tooth grinder, the material being heavily charged with quick-silver and allowed to run for several hours, after which the amalgam is removed, retorted and the gold melted as already described.

The following notes were obtained from the Yukon Gold Company on the subject of the treatment of materials resulting from clean-up:

Clean amalgam is retorted directly and the quicksilver returned to the dredges. Cast-iron tube retorts holding five cast-iron-pans and heated by wood fire in a special brick furnace, are used. The retorted cake gold is broken by hammer and placed in a crucible heated in a gasoline furnace. The molten gold is poured in bricks, cleaned and weighed. Sampling is done by drilling and assaying by usual method.

Concentrates are amalgamated by putting them into a large cast-iron barrel with iron balls and revolving same for several hours. Water and sodium amalgam in quantity are present, and by this means the gold and lead are thoroughly amalgamated. This barrel then discharges slowly into a sluice through which water is pumped. The amalgam, lead, nails and iron remain in the sluice. These are removed, screened and washed after which the gold grains sink in quicksilver, and the base metals float. The two are separated and treated separately resulting in gold bullion and base bullion.

HUDSON BAY RAILWAY.

Winnipeg, Man., Nov. 7.—Construction operations on the Hudson's Bay Railway and on the Port Nelson terminals have closed down for the year. Rails are laid as far as Kettle Rapids, in accordance with the program planned for this season. This is 330 miles north of The Pan. During the winter two bridges over the Nelson River will be completed and track-laying will be finished to Port Nelson early next summer.

TORONTO UNIVERSITY AND THE WAR.

President Falconer of the University of Toronto in a recent interview said: "To impress the significance of this war on our students and as far as possible on the country about us is our chief object just now. At the beginning of the present term we had the names of 3,041 Toronto graduates and undergraduates who were on active service. Ninety members of our staff are in khaki, and these have not been replaced. Their work is being done in the classrooms by their colleagues, who are doubling their regular academic duties. Our Department of History has lost its entire staff of lecturers, two of whom have won Military Crosses. The English Department has given up one of its professors as a training officer. Modern languages are being taught by a greatly reduced staff. Two of our men from the Physics Department are doing X-ray work for the British Government. In the Department of Mineralogy we have a Belgian scientist, who was driven from his native university by the Germans, and he is here now, as the guest of the staff of our university. In chemistry we have also lost two professors, who are serving the purposes of the war. The Faculty of Medicine, of course, is represented on the western and Balkan fronts by the very best of its men. The Base Hospital at Saloniki, for example, is manned entirely by Toronto professors and graduates, and it is gratifying to know that they are doing such magnificent work off there in Greece. The women of the university have done noble work in helping to equip the hospital at Saloniki, and now they have turned their efforts towards helping the Red Cross organization."

BEAVER.

Cross cutting on the 1,600-foot level is proceeding without interruption, and several veins, very familiar in character to those worked above the diabase sill, have been encountered. No drifting has as yet been done, but cross cutting will be continued until the ground is thoroughly blocked out.

INCREASE IN WAGES TO THE WORKMEN OF THE DOMINION COAL COMPANY, AND THE DOMINION IRON AND STEEL COMPANY.

Further enhancement of the cost of living has necessitated the further increasing of the wages paid in the coal and steel industries.

In May last the Dominion Coal Company gave its workmen at the collieries an increase of ten per cent., of which increase six per cent. became effective on the 1st of June, 1916, the remaining four per cent. being given on the 1st of January, 1917. The Dominion Coal Company had an agreement with the Provincial Workmen's Association covering a period of three years, which expired at the end of 1916, and provided for no change in wages until that date. As, however, it has always been the basis of these long term contracts that general conditions remained unaltered, the workmen felt that the sudden and large increase in the cost of living entitled them to ask for consideration of this fact. The company recognized the justice of these representations, and gave the aforesaid increase of ten per cent. The company thus anticipated the expiry of the contract by six months, and concluded a new agreement holding until the end of 1918, giving a ten per cent. increase on the wages paid under the old agreement, but anticipating six per cent. of this by six months, in consideration of the increased cost of living.

As, however, the upward tendency of all classes of goods has continued, the workmen again approached the company, and asked for further increase in wages.

After negotiations with the representatives of the Provincial Workmen's Association, the company has announced the following increases, effective 1st November, namely, a ten per cent. increase on all wages at the collieries, as a "war bonus"; anticipation of the four per cent. increase due at the 1st of January, which instead becomes effective at the 1st of November, plus a five per cent. bonus for steady work, which will be paid on the earnings of all underground producers who work 22 days out of each four weeks working period. Counting the increase of six per cent. given in June, the workmen have therefore been given a total increase of 21 per cent. on the wages under the old agreement, and where a man earns the five per cent. bonus for steady work, his wages are increased 26 per cent. over the rates of last May.

Such an increase is unprecedented in the history of coal mining in Nova Scotia, and could only be justified by abnormal conditions.

In addition to granting the aforementioned advances in wages, the Coal Company undertakes to keep the price of coal and rent to its employees at the existing low figures, and it is further endeavoring to maintain some equilibrium in the cost of living by making judicious advance purchases of the necessities of life, for retail through its company stores.

This attitude on the part of the company is one that shows a commendable solicitude for the welfare of its workpeople, because the company's position is beset with many other serious troubles.

Owing to the heavy enlistment drain, the company has lost 4,500 workmen out of the maximum force of 11,500 men. This loss has been almost entirely among the underground producers, and of course the men who have gone were in every respect the pick of the workers. Production of coal has dropped about forty per cent., thereby reducing the tonnage of coal on which profits can be made, and increasing the overhead charges. Any increase in the price of coal which has been obtained is swallowed by the increases in the cost of transportation. Freighting costs, as is well known, have soared to heights not previously dreamt of, and charter-rates are increased about one thousand per cent.

All classes of pit material have advanced in price, and the company has found it necessary to carry the burden of the increase in the cost of explosives, which it is now supplying to its workmen at prices very much less than the maker's price. For example, the cost of detonators has increased about 300 per cent.

There is only one way out of these difficulties, and that is an increase in the selling price of coal. Shortage of labour, high cost of transportation, high cost of all materials, actual shortage of coal supply when compared with the requirements of the country, and increased wages, are a combination which will compel an increase in the selling price of coal, for which the public must prepare itself.

The same conditions that have rendered an increase to the coal miners necessary are operating in the steel trade, and simultaneously with the increase given to the miners, the Dominion Iron & Steel Company have announced an increase of ten per cent. on all tonnage and day rates paid at the Steel Works, effective 1st of November, 1916. This increase follows a ten per cent. advance given in May last, and is equivalent to an increase of 21 per cent. on the wages of the steel workers when compared with those paid in May last.

DOMINION STEEL.

Mr. Mark Workman, president of the Dominion Steel Corporation, returned to Montreal last week from an inspection trip over the properties of the corporation in Cape Breton, says The Montreal Star.

Mr. Workman was accompanied by D. H. McDougall, general manager, and was very much impressed with the improved conditions at Sydney as regards organization. The appointment of Mr. McDougall some months ago has co-ordinated the activities of the Dominion Iron and Steel and Dominion Coal Companies, resulting in greatly increased efficiency.

Since that time, efforts have been directed towards the upbuilding of an efficient administration at Sydney. As a result of this R. F. Randolph and W. H. Bishop have recently allied themselves with the activities of the Dominion Steel Corporation, the former as general superintendent of the steel works, and the latter as steel expert. Both these gentlemen have for several years past occupied similar positions with the Bethlehem Steel Co. of Bethlehem, Pa.

Mr. Bishop assumes the title of assistant general superintendent, and takes charge of the coke ovens, blast furnaces and open hearth departments. A further change has been made by promoting H. E. Rice to the position of assistant general superintendent, his jurisdiction to extend over the various mills of the steel company. George D. Macdougall, mechanical superintendent of the steel works, has also received promotion, having now assumed the position of chief engineer. Several other changes have been made of somewhat lesser importance.

President Workman states that in recognition of the higher cost of living, a voluntary increase in wages in the form of a war bonus has been recently granted to the corporation's many employees, making the second advance since the beginning of the current year. He further stated that he was extremely gratified with the output of the steel works, every department of which is at the present time operating to full capacity.

REFINING ZINC AND COPPER AT TRAIL.

The circular to the shareholders of the Consolidated Mining and Smelting Company of Canada, Limited, setting forth the reasons for the new stock issue in detail, is as follows:—

"To provide the requisite additional permanent capital to meet the expenditure involved in the enlargement of your plant at Trail and the increasing mining activities of the Company, your directors have resolved to increase the share capital by one-quarter.

"Early this year at the request of the Imperial Munitions Board your company undertook additional contracts of considerable magnitude for high grade zinc to be supplied to the Allied Governments. While a portion of the cost of the plant requisite for manufacturing this zinc was advanced by the Governments, your company was required to substantially supplement the amount.

"The copper refinery has been increased in capacity.

"Plants for the production of both sulphuric and hydro-fluo-silicic acid have been installed so as to make your refining operations independent of an uncertain and expensive supply.

"Because of the further zinc contracts undertaken and the extensions in your plant, various changes and enlargements have been necessary to bring the smelter up to the increased demands upon it.

"War conditions have increased the cost of construction very materially over the original estimates.

"Your mining operations are being extended and will be further extended. An option has been taken upon a copper property of large possibilities at the north end of Vancouver Island, close to tide-water. Development of this property is now proceeding. Other properties are being examined, some of which no doubt will be taken over. As there has not been, and as there is not likely to be for some time any cessation in the development of your properties already being worked, these new properties, as acquired, will need substantial expenditure on capital account before they are on a shipping basis.

"Producing at one place and on a fairly large scale, as you do, no less than five refined metals (i.e., gold, silver, lead, zinc and copper), your capital, even with the increase resolved upon, is moderate. In fact, it is small as compared with the capital of many United States companies engaged in much more restricted operations.

"The annual stock-taking is now in progress. The usual dividends have been earned together with a fair surplus for profit and loss account. During the past year the operations of the smelter and refinery were affected by heavy and continuous construction work and by very great increases in the cost of both labor and supplies.

"Your zinc plant has already produced and shipped a considerable amount of refined product and regular shipments are now going forward which should gradually increase in volume.

"In connection with the increase of capital each shareholder of record at the close of businesss on the 21st day of October, 1916, will have the right to subscribe at par for one share for every four shares then held by such shareholder. The right to subscribe will expire at noon on the 1st day of December, 1916.

"No subscription for a fraction of a share will be recognized and no fractional share will be allotted, but certificates of rights to subscribe will be issued, and fractional rights may be added together for the purpose of subscriptions for full shares.

"Failure to pay any instalment on or before the date it is due renders previous payments liable to forfeiture.

"Subscribers may pay all or any installments in advance. All shares paid for in full on or before January 1st, 1917, will rank for dividend thereafter. Shares paid for in installments will rank for dividend only after April 1st, 1917.

"The directors reserve the right to extend the times fixed for subscription and payment in the case of any shareholders residing outside of Canada who may not have received sufficient notice to enable them to exercise their rights."

COBALT SHIPMENTS.

Cobalt, Nov. 4.—The Cobalt companies made a big showing for the past week in ore shipments. These were away above normal, a total of 1,153,807 pounds being sent out. Nipissing led with 348,660 pounds, some of which was sent to Welland, Ont., and the remainder to Birmingham, Eng. The Dominion Reduction and Trethewey and Kerr Lake shipped to United States smelters.

Bullion shipments for the same period were:

Company.	Ounces.	Value.
Mining Corp.	50,160.34	$34,359.83
Nipissing	144,116.47	$99,449.36

Ore shipments for the week ending last night were as follows:

Company.	Pounds.
Nipissing	348,660
Kerr Lake	60,455
Dom. Red.	146,000
Coniagas	249,400
McKinley Darragh	165,535
Buffalo	63,385
Trethewey	41,010
Hudson Bay	79,362
Total	1,153,807

INTERNATIONAL NICKEL CO.

When its proposed construction and improvement work in Canada has been completed, the International Nickel Co. will have increased its capacity approximately 40 per cent., or from an annual output of 60,000,000 pounds of nickel to between 80,000,000 and 90,000,000 pounds.

Original plans called for the expenditure of $2,000,000 on a Canadian refinery. The management, however, decided later to increase facilities all along the line through a single appropriation of $5,000,000. Smelting facilities at the Canadian Copper works will be enlarged and water power capacity increased.

International Nickel Co. has between $8,000,000 and $9,000,000 cash and securities, including $2,000,000 Anglo-French bonds.

International Nickel handles about 850,000 tons of ore annually, running consistently about 4½ per cent nickel. Copper values average about one-half nickel content, or 2¼ per cent. The company saves about 92 per cent. of its nickel.

The nickel to be turned out in the Canadian plant will amount to from 20,000,000 to 30,000,000 pounds a year. With an increase in nickel output, copper production is expected to increase from about 30,000,000 pounds to better than 40,000,000 pounds per annum.—Boston News Bureau.

PERSONAL AND GENERAL

Mr. David Sloan has returned from Arizona and is now at Matheson, Ont.

Mr. W. F. Ferrier has returned to Toronto from British Columbia.

Dr. A. W. G. Wilson has been in Toronto recently in connection with the manufacture of steel-coated shrapnel bullets.

D. H. Symmes of Niagara Falls, Ont., has been elected a director of McIntyre-Porcupine Mines, Ltd., succeeding I. J. R. Muurling of New York, who resigned.

Mr. Geo. Watkin Evans, has returned from his Alaskan trip to his Seattle office.

Mr. H. J. Stander, of Brunswick, Ga., will superintend experimental flotation work for the Mond Nickel Co. at Coniston, Ont.

Mr. C. H. Withers has been appointed manager of Messrs. Escher Wyss & Co.'s head office for Canada in Montreal.

Mr. Stanley Anthony, who is now on the electrolytic zinc staff of the Consolidated Mining and Smelting Co. at Trail, B.C., beside having had other connections in the Northwest as a metallurgical chemist, was engaged at the Silica mill, near Rossland, when, some years ago, much experimental and metallurgical research work was done at that plant.

Mr. C. J. Seymour Baker, of Barkerville, Cariboo, has left British Columbia for England to spend the winter in the Old Country.

Mr. H. Foster Bain, editor of The Mining Magazine, published in London, England, arranged to sail on November 2nd by the S.S. Empress of Japan from Vancouver, B.C., for China.

Mr. Frederick Bradshaw, of Tonopah, Nevada, general superintendent for the Tonopah-Belmont Co., has been at the company's Surf Inlet gold mine, on Princess Royal Island, British Columbia.

Dr. D. D. Cairnes, of the Geological Survey of Canada, was in White Horse, Southern Yukon, at the end of September, and went thence to Atlin, B.C. It was his intention to leave for Ottawa about the middle of October.

Mr. W. A. Carlyle is resident director in Ontario for the British-America Nickel Co. It is stated that the chief object of his recent visit to Montana was to make final arrangements with Mr. E. P. Mathewson, of the Anaconda Mining Co. to become general manager for the British-America Nickel Co.

Messrs. Edwin E. Chase and son, of Denver, Colorado, have been visiting mining properties in British Columbia.

Mr. J. H. Cunningham, of Ladysmith, B.C., manager of the Canadian Collieries (Dunsmuir) Ltd.'s Extension colliery, near Ladysmith, Vancouver Island, left that town about October 11 to pay a visit to his old home in Nova Scotia.

Mr. Ed. Dedolph returned to Kaslo, Kootenay lake, B.C., from Spokane, Washington, last month, negotiations for the establishment in West Kootenay, B.C., of a new zinc reduction works, with which he was to be officially connected, having come to an end for the time.

Dr. Chas. W. Drysdale, and Mr. M. N. Bancroft, of the Geological Survey of Canada, were in Slocan district of British Columbia early in October.

Dr. W. F. Ferrier, of Toronto, who has been examining mineral claims in British Columbia on which antimony-bearing ore occurs, early last month paid a visit to the Alps-Alturas mine, situated high up in mountains in the neighborhood of Three Forks, Slocan district. He has since returned to Ontario.

Mr. Thos. French, manager for the French Complex Ore Reduction Co., has returned to Nelson, B.C., from a visit to St. Louis, Missouri, and other United States manufacturing centres, whence he had been to try to hasten shipment of machinery and plant for the electrolytic zinc reduction works his company is equipping at Nelson.

Mr. A. C. Garde, of Prince Rupert, B.C., acting for Mr. C. H. Sproat, of Portland, Oregon, who has bonded a mining property situated within a few miles of Evelyn, in Omineca mining division, a small station on the Grand Trunk Pacific railway, 217 miles east of Prince Rupert, is directing the work of a few men engaged in developing some silver-lead ore occurring on the property.

STEEL PRICES.

New York, Nov. 4.—Advance to a new high in average price of eight leading steel products this week 25 cents a ton, to $64, compared with $63.75 a week ago, was due to advance of $2 in bessemer pig iron at Pittsburgh to $26.95 per ton, against $24.95 last week.

Price changes have been witnessed during the week in a number of products not included in the eight from which the average is obtained. The following shows the most important of these changes.

	Nov. 2	Oct. 20
No. 2 iron, valley furnace (per ton).	$23.00	$21.00
No. 2 iron, Cincinnati	19.90	18.90
No. 2 iron, Birmingham	17.00	16.00
Basic iron, valley furnace	22.00	20.00
Malleable bessemer iron, Chicago..	24.00	21.50
Gray forge iron, Pittsburgh	22.95	20.95
Forging billets, Pittsburgh	75.00	73.00
Wire rods, Pittsburgh	60.00	55.00
Iron bars, Pittsburgh (per 100 lbs)..	2.85	2.75
Skelp, grooved steel, Pittsburgh....	2.70	2.50
Skelp, sheared steel, Pittsburgh....	2.80	2.60
Galvanized sheets, Pittsburgh	4.90	4.75

Prices for old material have also moved up 50 cents to $1.50 per ton. Discounts on lap-weld iron and steel pipe and on woven wire fencing were reduced one point, representing an advance of $2 a ton.

PLATINUM IN MANITOBA ORES.

The Pas, Man., Nov. 3.—The latest news from the Northern Manitoba Mining and Development company's property is that the shaft is down forty feet, and the ore still showing up good. A picked sample from McCafferty's vein shows $49 in gold and $17 in platinum. This shows that the platinum is widely distributed, as it is five miles between McCafferty's and the N. M. M. & D. Co.'s property, which also carries platinum.

Samples from the Rex and Elizabeth mines are now being tested for platinum, and should give further information on the subject.

It is said that R. J. Jowsey and associates will take up their option on the Kiski group.—The Pas Herald.

GOWANDA.

The Miller Lake-O'Brien find is proving to be one of great importance. Development work has disclosed a large body of rich ore.

THE UNION DRAWN-STEEL CO.

The Union Drawn Steel Co., Beaver Falls, Pa., manufacturer of cold drawn steel, in shafting and other forms, is building a plant at Gary, Ind., which is expected to be in operation about Jan. 1. The plant will be of steel and concrete, two stories, 150x456 feet and will be equipped to turn out a full line of this class of goods to supply the western trade. Its location is close to the plant of the Illinois Steel Co. at Gary and railroad service is excellent.

Special machinery for producing cold drawn steel is being built at Beaver Falls for installation at Gary, as this form of equipment is not available in the market.

The company now operates two plants at Beaver Falls and one at Hamilton in Canada, the Gary plant being the fourth in its chain.

MANNESMANN TUBE.

The anglicising movement which has absorbed so many German works in Great Britain has resulted in the transfer to British owners of the German interest in the British Mannesmann Tube Co., Ltd., Swansea, Wales. The German shares in this company have now been sold by the public trustee to a British group of capitalists, which includes Sir Hugh Bell, A. J. Dorman, Balfour Williamson & Co., and Higginson & Co. It will be seen that this group includes some of the best known steel magnates in Great Britain.

The transfer of the shares was taken under the trading with enemy act of 1916, which gives the board of trade power, when there is a predominant enemy interest, either to wind up the firm, or to vest the enemy interest in British hands. The enemy shares were put up to open tender. There were only four British buyers, but the price paid was considerably in excess of that for which the owners were prepared to sell at the outbreak of the war.

BOOK REVIEWS.

Metallurgists' and Chemists' Handbook—By Donald M. Liddell—Published by McGraw-Hill Book Co., New York—Price $4.00—For sale by Book Department, Canadian Mining Journal.

This is a compilation of useful tables. The several sections are headed: Mathematics, Price and Production Statistics, Physical Constants, Chemical Data, Sampling, Assaying and Analysis, Ore Dressing, Cyanidation, Fuels and Refractories, Mechanical Engineering and Construction, General Metallurgy, First Aid. Under these headings the chemist and metallurgist will find 588 pages of valuable data.

ARTIFICIAL GAS.

The use of artificial gas as a domestic and industrial fuel is increasing. In households gas is replacing coal for cooking and to some extent for heating, and in the industries gas—mainly that from by-product coke ovens—is now used for raising steam and firing open-hearth steel furnaces. The advantages of gas as a fuel, not the least of which are its cleanliness and its ease of control, are well known, and it is being supplied to many small cities and towns by pipe lines from the larger cities where it is made. The use of artificial gas for illuminating, however, is decreasing, mainly because of competition by electricity.

Water gas enriched with oil—carburetted water gas—is more generally used in cities than coal gas.

NIPISSING.

The location of a new ore shoot in Vein 490 is proving to be one of the most important finds ever made on the company's ground. It is estimated that development so far done on this ore shoot has added 1,000,000 ounces of silver to the ore reserves. There are good possibilities for other veins in the immediate vicinity, as several cross veins have already been encountered in the 490 drifts.

IN DELORO.

A diamond drill is in operation on the Thomas claims, Deloro township.

The Coniagas company is continuing work on the Anchorite property and the La Rose has been granted an extension of its option on the Maidens-McDonald. These properties adjoin and the activities of the two companies should result in careful testing of this area.

A representative of New York capitalists, Mr. Edward Hinman, Jun., is stated to have bonded a group of mineral claims on Ecstall river, in Skeena mining division, which stream flows into the Skeena river near its mouth, at Port Essington.

TORONTO MARKETS.

Cobalt oxide, black, $1.05 per lb.
Cobalt oxide, grey, $1.15 per lb.
Cobalt metal, $1.25 to $1.50 per lb.
Cobalt anodes, $1.50 to $1.75 per lb.
Nickel metal, 45 to 50 cents per lb.
White arsenic, 5½ to 6 cents per lb.

Nov. 8.—(Quotations from Canada Metal Co., Toronto)—
Spelter, 15 cents per lb.
Lead, 9 cents per lb.
Tin, 45 cents per lb.
Antimony, 16 cents per lb.
Copper, casting, 29 cents per lb.
Electrolytic, 31½ cents per lb.
Ingot brass, yellow, 17½ cents; red, 20½ cents per lb.

Nov. 8.—(Quotations from Elias Rogers Co., Toronto)—
Coal, anthracite, $9.00 per ton.
Coal, bituminous, $10.00 per ton.

SILVER PRICES.

	New York, cents.	London, pence.
October 20th	67⅜	32⅛
" 25th	67⅜	32⅛
" 26th	67⅜	32⅛
" 27th	67⅜	32⅛
" 28th	67⅝	32¼
" 30th	67¾	32¼
" 31st	68⅛	32½
November 1st	68⅛	32½
" 2nd	68⅛	32⅞
" 3rd	68⅛	32½

MOLYBDENITE PRICES.

Schedule of prices per unit (20 lbs.) of Molybdenite in ore delivered at concentrator, Renfrew.

Ores carrying between 2% and 3% MoS_2, $13.00 per unit.
Ores carrying between 3% and 5% MoS_2, $14.50 per unit.
Ores carrying between 5% and 10% MoS_2, $16.00 per unit.
Ores carrying between 10% and 15% MoS_2, $17.00 per unit.
Ores carrying between 15% and 20% MoS_2, $18.00 per unit.
80% concentrates $1.00 lb. of MoS_2.
Penalties imposed for copper and bismuth.

MARKETS

NEW YORK MARKETS.

Nov. 14.—Connellsville Coke—

Furnace, spot, $7.25 to $7.75.
Furnace, contract, $3.75 to $4.00.
Foundry, prompt, $8.00 to $9.00.
Foundry, contract, $5.00 to $6.00.
Straits tin, f.o.b., 42.12½ cents.

Copper—

Prime Lake, nominal, 28.37½ to 28.62½ cents.
Electrolytic, nominal, 28.75 to 29.25 cents.
Casting, nominal, 27.50 to 27.75 cents.

Lead, Trust price, 7 cents.
Lead, outside, 7 to 7.12½ cents.
Spelter, prompt western shipment, nominal, 10.67½ to 10.80 cents.

Antimony—

Chinese and Japanese, 12.87½ to 13.12½ cents.
American, nominal.

Aluminum—nominal—

No. 1 Virgin, 98-99 per cent., 64 to 66 cents.
Pure, 98-99 per cent. remelt, 58 to 60 cents.
No. 12 alloy remelt, 45 to 47 cents.
Powdered aluminum, $1.00 to $1.15.

Metallic magnesium, 99 per cent. plus, $3.50.

Nickel—

Shot and ingot, 45 cents.
Electrolytic, 50 cents.

Cadmium, nominal, $1.45 to $1.50.

Quicksilver, $80.

Platinum, $90.

Cobalt (metallic), $1.25.

Silver (official), 68⅛ cents.

Metal Products—Following base prices represent the outside market except where otherwise specified and are entirely nominal except in the case of lead sheets and sheet zinc:

Sheet copper—

Hot rolled (f.o.b. mills), 37.5 cents.
Cold rolled (f.o.b. mill), 38.5 cents.

Copper in rods, 43 cents.

Copper in rolls, 40 cents.

Copper wire (f.o.b. mill), 33.25 cents.

Copper wire (f.o.b. mill), December, 32.75 cents.

High brass—

Sheets, 42 to 46 cents.
Wire and light rods, 45 to 48 cents.
Heavy rods, 41 to 45 cents.

Tubing—

Brazed brass, 45 to 50 cents.
Brazed brass (f.o.b. mill), 43.75 cents.
Seamless copper, 47 to 49 cents.
Seamless brass (f.o.b. mill), 46 to 48 cents.

Naval bronze—

Rods (f.o.b. mill), 40 cents.
Sheets (f.o.b. mill), 41.50 cents.

Muntz metal—

Rods, 38.5 cents.
Rods (f.o.b. mill), 36.5 cents.
Sheets, 42 cents.
Sheets (f.o.b. mill), 40 cents.

Full lead sheets (f.o.b. mill), 8.5 cents.
Cut lead sheets (f.o.b. mill), 8.75 cents.
Sheet zinc (f.o.b. smelter), 16 cents.

STOCK QUOTATIONS.

(By courtesy of J. P. Bickell & Co., Toronto.)
As of close November 8th, 1916.

New York Stocks.

	Bid.	Asked.
Can. Car.	30.00	40.00
Curtiss Aeroplane	15.00	30.00
Can. Copper	2.12	2.25
Canada Cement	68.50	69.00
Con. Ariz.	2.87	3.00
Emma Copper	2.37½	2.50
Howe Sound	5.50	6.00
Inter. Nickel (new)	51.25	51.38
Kennecott Copper	55.12	55.37
Maxim Munitions	7.25	7.75
Midvale Steel	70.25	70.37
Mother Lode	37.00	38.00
Steel of Canada	77.00	78.00
Submarine Boat	42.00	44.00
Tonopah Extension	5.62½	5.84½

Porcupine Stocks.

	Bid.	Asked.
Apex	.08⅝	.09
Dome Extension	.30	.31
Dome Lake	.58	.58½
Dome Mines	24.00	25.50
Foley O'Brien	.72	.81
Hollinger	6.85	6.90
Homestakes	.60	...
Jupiter	27½	.29
McIntyre	1.80	1.81
McIntyre Extension	.43	.45
Moneta	.15	.16
Porcupine Crown	...	.72
Porcupine Imperial	.03¾	.03⅞
Porcupine Vipond	.41	.42
Preston East Dome	.04⅛	.04¼
New Ray	.99	1.01
Teck Hughes	.41	.45
West Dome	...	.34½

Cobalt Stocks.

	Bid.	Asked.
Adanac	...	.33
Bailey	.08	.08½
Beaver	40	.42
Chambers Ferland	.18	.19
Coniagas	4.75	5.00
Crown Reserve	.47	.48
Foster	...	.07
Gifford	.03¾	.04
Gould	...	.00⅝
Great Northern	.09¾	.10
Hargreaves	.02¾	.03½
Hudson Bay	...	.75
Kerr Lake	4.75	4.85
La Rose	.55	.60
McKinley	.59	.63
Nipissing	8.35	8.60
Peterson Lake	18	.18¼
Right of Way	.05	.06
Seneca Superior	...	.09
Shamrock Cons.	.15¼	.15¾
Silver Leaf	.01¼	.02
Temiskaming	.62	.62½
Trethewey	.16	.17½
Wettlaufer	...	.11
Vacuum Gas	1.09	1.10
Inspiration	.24	.24½

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Northern Canada Supply Co.
Sullivan Maclinery Co.

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Sullivan Machinery Co.

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Armstrong, Whitworth of Can., Ltd.

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Northern Canada Supply Co.

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Jones & Glassco.

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Darling Bros., Ltd.
Smart-Turner Machine Co.
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Can. Ingersoll-Rand Co., Ltd
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Smart-Turner Machine Co.
Canadian Ingersoll Rand Co., Ltd.
Fraser & Chalmers of Canada, Limited

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

Pumps—Steam—
Can. Ingersoll-Rand Co., Ltd
Darling Bros., Ltd.
Mussens, Limited.
Northern Canada Supply Co.
Smart-Turner Machine Co.

Pumps—Turbine—
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Smart-Turner Machine Co.
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Allan, Whyte & Co.
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Fraser & Chalmers of Canada, Limited

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Roberts & Schaefer Co.

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Hendrick Mfg Co.

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Smart-Turner Machine Co.

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Canada Metal Co., Ltd.

Sheets—Genuine Manganese Bronze—
Hendrick Mfg. Co.

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W. Fraser.

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Fraser & Chalmers of Canada, Limited

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Smart-Turner Machine Co.

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Armstrong, Whitworth of Can., Ltd.

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Hendrick Mfg. Co.
Pacific Coast Pipe Co., Ltd.

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Roberts & Schaefer Co.

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Tube Mills—
Fraser & Chalmers of Canada, Limited

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Escher Wyss & Co.
Fraser & Chalmers of Canada, Limited

Winding Engines—
Canadian Ingersoll-Rand Co., Ltd.

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Northern Canada Supply Co.
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