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Canadian Mining Journal, Vol. 35

JANUARY 1st, 1914 TO DECEMBER 31st, 1914

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*—Illustrated.
E—Editorial.

THE CANADIAN MINING JOURNAL

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Editor

REGINALD E. HORE

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CIRCULATION.

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CONTENTS.

THE YEAR 1913

A Review

The past year has witnessed substantial growth in the mining industry. The output was large and good prices were obtained for most of the products.

The Nova Scotia coal and iron industry has been fairly successfully carried on as far as output is concerned. The demand for the furnace products has, however, been slack for some months and low prices rule.

In Quebec many of the asbestos mines have been worked profitably. A considerable number are, however, still idle.

In Ontario the nickel, copper, silver and gold output was large and there were important new developments at Cobalt, Sudbury and Porcupine.

In British Columbia the copper, gold, lead and silver production was large and the chief copper producers had an unusually profitable year. The coal mines of Alberta and British Columbia made good records with the exception of those on Vancouver Island.

A strike of coal miners on the Island was accompanied by acts of violence that make the strike stand out as a conspicuous dirty page on an otherwise clean and encouraging year's record. The Nova Scotia miners, by peaceable means, have achieved much better results than have the Vancouver miners by violence.

Geological Congress in Canada.—An event of unusual importance to mining men in Canada was the session of the International Geological Congress held this year. Numerous excursions to the mining districts were held in connection with this meeting of geologists and mining men, who came from all parts of the world. The publicity thus given to our mineral industry cannot fail to bring good results.

Legislation.—The bill providing for a Federal mining law has been under consideration during the year, and is expected to come before the House at an early date. In Ontario two noteworthy changes in the laws affecting miners, one enacted and the other in the form of a final report, soon to be discussed by the Legislature, are attracting attention. The first, which goes into force on January 1, 1914, requires that underground miners be not required to work more than eight hours per day. The second, not yet passed, provides that conpensation for workmen injured is to be paid from a fund to which the employers and the Government will contribute.

Canadian Mining Institute.—Members of the Institute are taking into serious consideration the problem of providing suitable headquarters. It is expected that the present inadequate rooms will soon be given up. As the Montreal members are planning to raise funds for suitable quarters for the branch, this is considered an opportune time to take steps towards securing permanent headquarters.

In addition to the question of ways and means it will be necessary for the members soon to decide where permanent headquarters should be established. For some time the Secretary's office has been in Montreal, and many will prefer that the location be not changed. Many others, owing to the increasing prominence which Ontario is taking in mining affairs, would like to see the headquarters of the Institute established in Toronto. Many arguments can be, and doubtless will be, advanced in favor of either location. It is not unlikely that the Institute will be called upon to take definite steps on the headquarters question during the coming year.

Another subject which is engaging the attention of members of the Institute, and which will have to be discussed by the Council during the coming year, is the proposed Compensation Act for Ontario. While the bill proposed is, on the whole, a reasonable one, there are some details which will not meet with the support of many members.

During the past year there has been no regular publication of bulletins. More prompt publication of papers presented would be very desirable.

Government Surveys.—The past has been a rather unsatisfactory year as far as field work is concerned. Owing to the great amount of work in connection with the Geological Congress the regular work of the several Federal and Provincial surveying departments has been somewhat neglected.

The work done in compiling and publishing the numerous reports and maps in connection with the Congress excursions has, however, in a measure offset the regrettable lack of new field work. The available knowledge has been collected and the maps corrected. The brief up-to-date summaries will make a very useful basis for future work.

PORCUPINE AND COBALT

Very encouraging results have been obtained recently at Porcupine and Cobalt.

A new impetus has been given to development in the Kerr lake section. The draining of the lake resulted in the discovery of a splendid vein of rich ore and the prospects for other important discoveries are very good. At the east end of the lake the Caribou-Cobalt and Drummond Fraction properties are being developed. Now that the lake has been drained the Crown Reserve and Kerr Lake Companies will be able to safely mine from near the surface a large tonnage of rich ore from veins that have been already mined at lower levels. There is good reason to believe that the Kerr lake section of the Cobalt silver area will give a good account of itself during the coming year.

At Porcupine there is every evidence that gold production is soon to be largely increased. At the Dome mine forty new stamps are being placed on their foundations. Preparations are being made for the erection of large tanks for the leaching of sands. During the past few months the output of the present 40 stamp mill has been increased to about 480 tons per day With the additional 40 stamps and the sand leaching plant there is good reason to expect that in a few months the mill will be treating 800 tons per day.

At the Hollinger development is proving satisfactory and arrangements are being made for the more rapid development of the adjoining property of the Acme Gold Mining Co.

The McIntyre has been obtaining better results lately. The Porcupine Crown is meeting with much success and has recently installed a very satisfactory cyanide plant. The adjoining North Thompson lot is being vigorously explored by new owners. The Schumacher has been recently equipped with an up-to-date plant.

It is probable that much more mining will be done in the Porcupine goldfield during the coming year than during the past, and that the gold output will be much increased.

OXYGEN BREATHING APPARATUS

In this issue Mr. F. W. Gray discusses criticisms of the rescue-apparatus now in common use in this country. His comments are reassuring and go to show that the chief cause of failure is not defective apparatus, but rather carelessness in keeping and using it. He points out that the apparatus should be carefully kept and frequently tested and that it should not be used by anyone not thoroughly familiar with it.

Mr. Gray's remarks have special interest, as he was the first person on this continent to bring over a rescue apparatus of the oxygen type. He was educated at the colliery where the first rescue station in Great Britain was established, and has seen the development of rescue apparatus from the old Giersberg-Walcher apparatus in 1901 to the present perfected types.

CONCENTRATES

Under this heading our esteemed contemporary, The Mining and Scientific Press, San Francisco, publishes short paragraphs on many subjects. In the November 15th issue we find the following:

"Kieselguhr is one name for fuller's earth, which usually is a diatomaceous earth, made up of the minute silicious skeletons of diatoms. It is also known as Tripolite, and by various trade names. Aside from its proper uses as a bleaching agent and as an absorbent for unstable materials, as when used in making dynamite, it is frequently employed as an adulterant and for 'loading' cloth and other materials. The compact varieties are cut into filters and it is also crushed for use as a polishing material and for making heat-protecting packing for pipes. Large quantities are used in the chemical industries such as the making of water glass, paper, pigments, safety matches, and papier mache. It occurs in many parts of the world, and deposits have recently been reported in Chile where they may be of importance in the local manufacture of dynamite."

The concentrating machinery of the "Mining and Scientific Press" has not been very successful in treating kieselguhr. The product can scarcely be called a concentrate.

Fuller's earth is a claylike substance, used originally for the fulling of cloth; but now chiefly used in bleaching, clarifying or filtering fats, greases and oils.

Kieselguhr is the siliceous absorbent commonly known as infusorial earth. In England the terms 'infusorial' earth and 'tripoli' are used for the fine sediments consisting of the fragments of the remains of certain aquatic plants known as diatoms. By the U. S. Geological Survey the term 'infusorial' earth is used for such deposits; but the term 'tripoli' is used for a porous siliceous rock supposed to have resulted from the leaching of calcareous material from siliceous limestone.

SLOCAN STAR MINES, LTD.

At the second ordinary general meeting of shareholders of the Slocan Star Mines, Ltd., operating the Slocan Star silver-lead mine, situated near Sandon, Slocan district, British Columbia, the following report of the directors was submitted:

"Your directors herewith submit the second annual report of the operations of the company, financial statement of accounts and balance sheet, together with the auditors' report for the year ended October 31, 1913.

"The operations of the company during the year have been confined largely to development work, with very satisfactory results.

"At the annual meeting a year ago your directors reported that at a distance of 2,100 ft. from the portal of the No. 10 crosscut tunnel, the vein was struck on September 7, 1912, and that since that time, drifting on the vein to the east had proceeded for the purpose of encountering the central ore shoot on its downward continuation. Since then, a working raise has been made 444 ft. up from No. 10 drift to connect with No. 6 level and from this raise levels Nos. 7 and 8, about 100 ft. apart, have encountered at depth the vein which contains ore similar in character to that shipped from the upper levels. Shipments were made during the course of, and from, such development amounting, at the close of the fiscal year, to a gross value of $28,732.37.

"Details of the work and results obtained will be submitted to the meeting in the report of Mr. Oscar V. White, mine superintendent.

"The most striking development has taken place in No. 8 level where a shoot of high-grade silver lead ore was encountered early in the month of October last. The superintendent reported this ore body to contain 2 ft. of clean ore and 4 ft. of concentrating ore. This shoot has been drifted upon east and west for a distance of approximately 100 ft., and at this date the drift has ore in both faces similar to that reported, while the eastern face shows that it has widened to about twice the width.

"Your President, in company with Mr. Andrew G. Larson, M.E., consulting engineer, visited the property early in November last and fully confirmed the superintendent's report. Since that time drifting has been commenced from No. 10 level with a view to finding this ore shoot at greater depth.

"The mine development for the year consists of 757 ft. of crosscutting, 844 ft. of drifting, and 444 ft. of raising, or a total of 2,045 ft. of development work.

"During the month of November, 112 tons of high-grade ore was shipped. Returns for this have not yet been received. It is expected that larger shipments will be made as soon as the necessary arrangements have been made for stoping.

"It is proposed to continue development, also shipment of clean ore during the winter and to operate the concentrator in the spring when water shall be available and the flume lines have been repaired, as the tonnage now in sight in the mine is sufficient to keep the mill in continuous operation for a considerable time.

"It should be mentioned that for some months past the mine has been on a self-sustaining basis and with the present outlook it can confidently be expected to discharge all obligations and provide a substantial cash reserve for the development of the eastern and western ore shoots during the year, whereupon, it can be reasonably expected that the property will be upon a dividend-paying basis.

"Your directors desire to point to the fact that the development work outlined in the report of Mr. Larson, made at the time of the consolidation of the Slocan Star and Rabbit Paw groups of mines, has been fully justified by the results obtained under the capable supervision of the mine superintendent, whose conduct of the mining operations calls for an expression of much satisfaction from your directors."

The meeting was held at the registered office of the company in Vancouver, B.C., on December 19.

TITANIFEROUS IRON ORES.

Mr. Joseph T. Singewald, in a bulletin published by the Bureau of Mines, U.S.A., says that there is little hope that such ores can be treated in the blast furnace; but that some may be treated successfully in the electric furnace.

The evolution of the modern blast furnace has taken place in such a direction as to make the utilization of titaniferous iron ores impracticable. Notwithstanding numerous experiments that have been conducted with a view to discovering a furnace charge that will make the use of these ores practicable from the standpoint of furnace operation and economy, there is to-day no hopeful feeling in regard to the possibilities of smelting these ores in the blast furnace. On the other hand, the introduction of the electric furnace holds out a new hope for the direct reduction of the titaniferous ores.

The results of magnetic-separation experiments conducted with these ores are very promising in some cases and extremely disappointing in others. No rule of general application can be formulated as to the behavior of the ores. Some deposits are very amenable to magnetic separation, and yield concentrates that require the admixture of only a small proportion of non-titaniferous ores to make a satisfactory ore mixture. Other deposits are less amenable and yield concentrates that would have to be mixed with three or four parts of non-titaniferous ores for furnace use. There are many other deposits in which the percentage of titanium separable in this way is extremely small, so that the utilization of such ores seems to depend on the discovery of a process that will make their use feasible.

The cause of the difference in behaviour of the ores toward magnetic separation is revealed in their microstructure which is readily studied by the metallographic method. This method of investigation shows that the titanium occurs in these ores in the form of ilmenite grains in about the same order of magnitude as the magnetite grains, as ilmenite inclusions and intergrowths of microscopic size in the magnetite, and as an integral part of the magnetite molecule itself. The titanium occurring in the first form (as ilmenite grains) is readily separable by means of magnetic concentration, excepting in the finest grained ores with which the degree of crushing required would make such concentration impracticable. The titanium occurring in the two latter forms is inseparable by mechanical means. The percentages of titanium occurring in these different forms varies greatly in the different ores, and, consequently, every case must be tested for itself. A metallographic study of the ores of any deposit will at once decide the question of the amenability of the deposit to magnetic separation.

As regards chemical composition, except for their titanium content, the ores are very desirable. The coarser-grained ores are usually high grade in their natural condition, whereas a magnetic separation of the leaner ores yields a high-grade concentrate, with the deleterious constituents at a minimum.

As the iron industry at present demands large deposits of definite extent, the outlook for most of the deposits of titaniferous iron ore in the United States is not promising. As a rule, the deposits are relatively small and of irregular extent and distribution. Further they are lean to medium grade, and inaccessibly situated as regards transportation facilities. In other words, to put the deposits on a producing basis would require a heavy initial outlay of capital, which the size and irregularity of occurrence does not warrant. There are, however, the two large, high-grade deposits of Sanford Hill, N.Y., and Iron Mountain, Wyo., which are so readily workable that, despite their titaniferous character, their utilization within a few years seems certain.

IRON ORE IN MICHIGAN AND BRAZIL.

Michigan.—In the government suit against the United States Steel Corporation, Professor Leith, of the Geology Departments at the Universities of Chicago and Wisconsin, stated on the stand in court at New York last month that of all the available iron ore in the Michigan districts the Steel Corporation in 1911 owned about 30 per cent. and less in 1912. This offset the contention by the government that the corporation had a monopoly. Professor Leith said that in the last thirteen years the shipments from the Michigan mines had totalled about 130,000,000 tons. The Steel Corporation has been least active in developing and purchasing new ore reserves in old range properties in recent years. He named several companies, including the Cleveland-Cliffs, Pickands-Mather, Rogers-Brown, M. A. Hanna and others, which had done much more exploration work. The Cleveland-Cliffs Company controls about twice as much ore reserve in the old ranges as does the corporation, he testified.

Professor Leith said that if a new steel company wanted a fifty-year supply of ore, or about 100,000,000 tons, it could easily procure it in the Lake regions from one property now on the market, not including the Hill ores, or those held by independent companies or those not yet developed. On account of the large supply now available, little development is now going on. The merchant ore mining companies are not at present able to sell their capacity output in the open market. Regarding competition in ore, the witness said that some of the larger independents, including Jones & Laughlin, Lackawanna and Inland Steel, have recently added to their ore holdings, without causing a ripple in the ore market. It is not possible for any one company to obtain a monopoly of iron ore in the Superior district. Such a procedure would only cause greater exploration by companies which wished to sell to the company attempting the corner and would bring to light enormous additional supplies.

Brazil.—The witness, who had visited the Brazil ore regions, said the best grades in Brazil run as high as 69 per cent. in iron and very low in phosphorus. Of the highest grade hematite ore it is estimated that in the Riodoce valley alone there is about 600,000,000 tons in sight without going lower than the lowest outcropping. At a depth of 600 feet he estimated 1,000,000,000 tons revealed. Of soft ore, running 64 per cent. iron, in the same locality, there is about 365,000,000 tons proved and about 1,000,000,000 tons as a conservative estimate at less than 600 feet. Of the highest grade ore there is about 2,000,000,000 tons so far brought to light in that district. The district is tapped by several railroads, including the National Railways of Brazil, these roads entering a territory well supplied with high grade ore. Of surface or blanket ores, which cover the surface about fifty feet thick and for several square miles, running 54 to 64 per cent. iron content, about 1,000,000,000 tons is available at present.

In all Brazil, Professor Leith estimates about 4,000,000,000 tons of ore showing 64 per cent. iron or better. This ore is practically in sight and does not have to be drilled for and is more than twice what is estimated of the same class in the Superior district, both in sight and as shown by drillings at a maximum depth of 2,700 feet. Professor Leith said this district has climate the most healthy in Brazil, and is the most thickly populated. A company is being exploited to ship this ore to Atlantic coast ports here and to European ports at a cost of eight to nine cents per unit. He estimated the steamship haul from Victoria to New York at about \$3 per ton, compared with the present rate of about \$2.75. The new company will have a line of vessels, docks at Victoria and a railroad from Victoria to the mines.

The Tacoma Steel Co. is continuing the development of its Marble Bay mine, situated near Van Anda, Texada Island. The ore is bornite and chalcopyrite, generally occurring in pockets or lenses in limestone. In parts native silver has been found freely associated with gold and much copper. Ore is being mined at the 1,300-ft. level (incline), which is at a vertical depth of more than 1,000 ft. The occurrence of bornite at this depth is of interest to mining men, some of whom are not accustomed to finding it at so comparatively great a depth. Local men are working the neighbouring Cornell mine on lease and are mining some nice ore. Not much has been done lately at the Little Billy mine, while the Copper Queen has been idle a long while. All these mines are situated in the northern part of Texada Island.

A VISIT TO SOME PACIFIC COAST MINES

(Notes on Excursion C8 of the International Geological Congress.)

By E. S. Moore.

On the evening of August 28th, the C8 excursionists, numbering over 40, left Vancouver on the special steamer, Princess Maquinna, for Yakutat bay and the Klondike. On reaching Prince Rupert the party divided, a few going up the Skeena to Hazleton, on the new G.T.P. line, while the remainder visited the Hidden Creek copper mine. Prince Rupert proved of special interest to the foreign geologists because it illustrated in such a striking manner the development of a new town in Western Canada. The building of houses and streets among and over the stumps and the blasting away of whole hills of rock to make room for buildings and roads were all works of unusual interest. The fact that such a fine harbour is being opened more than four hundred miles nearer Japan than any other large harbour on the Pacific coast will have an important bearing on Canadian commerce.

Hidden Creek Mine, Granby Consolidated Co., B.C.

The Hidden Creek Copper Mine.

This mine on Granby bay near the northeast end of Observatory inlet, has been quite recently opened. It is owned by the Granby Consolidated Mining, Smelting and Power Company. Since it is situated within a mile and a half of a good harbour it has splendid shipping facilities and should have a rapid development. Mining operations are still in their infancy, but over 30,000 ft. of diamond drilling and 17,000 ft. of tunnelling and drifting are stated to have shown the presence of three ore bodies, with at least 7,500,000 tons of 2 per cent. ore, above the 150-ft. level. Higher grade ore running as high as 8 per cent. is said to have been found below sea-level.

The ore minerals are pyrite, pyrrhotite and a smaller percentage of chalcopyrite in a gangue of quartz, schist and argillite. In No. 1 ore body a little calcite occurs with the slate. Small quantities of graphite lie along slicken-sided surfaces. The deposit is cut by a number of dikes varying, where seen by the writer, from 4 inches to 4 ft. in width and consisting of what appeared in the hand specimen to be basalt and minette. The dikes seemed to be more numerous in the ore body than in the surrounding rocks, and this may be due to the fact that the ore is more brittle than the adjacent rocks and that the ore body has been developed in a weak area in the strata. They are generally vertical or nearly so.

The topographic relief of the Hidden Creek area is considerable, the mountain tops being bare and snow-covered, while the lower levels are covered with forest of hemlock, spruce and cedar. The timber is large enough for lumber, but it is comparatively soft and it was stated by one of the engineers that where an 18-inch "shooting post" would stand the strain at Phoenix, a 22 to 26-inch post is required at the Hidden Creek camp, because of the softer character of the wood.

Following the principle adopted at Phoenix of keeping the cost of labour and of mining low, by employing automatic, mechanical devices for handling the ore, the company is installing a very efficient system. All the crushing machinery is placed underground in the 150-foot level, and this tunnel will be used for shipping purposes. A 2,000-ton smelter is under construction near the coast.

The West Coast to Yakutat Bay, Alaska.

From Prince Rupert thirty-eight passengers turned northward to Alaska and the Yukon, while the remainder of the party returned to Vancouver. The chief points visited on the northern journey were the mines on Douglas Island, the faults and glaciers near Yakutat bay, the glaciers on Glacier bay, and the gold deposits of the Klondike district.

The mines on Douglas Island are commonly known as the Treadwell mines, but they include the properties of several companies, viz.: the Alaska-United, the Alaska-Mexican, and the Alaska-Treadwell. These companies are all under one management, but each has its separate mill. The output is about 5,000 tons per day and these rank among the largest gold mines in the world. They are, however, surpassed in output by some of those in South Africa, and possibly by others. On the opposite side of the bay from these mines and just behind Juneau some deposits are being opened up which will rival if not surpass these. The ore, which consists of gold-bearing pyrite in quartz and "albite-diorite," is stamped, passed over the Frue Vanner tables, where about 50 per cent. of the gold is said to be extracted, and the concentrates are then passed on to the cyanide plant. It was in this cyanide plant that the air agitated tanks, which work so successfully, are said to have been first employed.

The ore body is very large and it takes the form of a great, light coloured dike with greenstone on one side and slate on the other as contact rocks. On account of the large size of the ore body and the very efficient system of mining, the ore is handled as cheaply, if not more cheaply, than elsewhere on the continent. The Homestake mine, in South Dakota, is reported to run about the same. The average value of the ore mined is only a few cents over $2.00 per ton. Oil is used as a fuel with very satisfactory results.

Yakutat bay and vicinity has many points of special interest. The Malaspina glacier, the largest of piedmont type in the world, the panorama of the St. Elias range, conceded to be the most beautiful to be found anywhere, and the recent faults, all go to make this a veritable garden for geologists. The faulting seems undoubtedly to have occurred at the time of the great earthquake in September, 1899. The sea coast along Disenchantment bay rose 47 feet and the shore of Haenke Island now stands 18 feet 6 inches above its former position. The faulting near Nunatak glacier largely took the form of step faulting, and some of the steps show throws between four and five feet. A prospector made the complaint that he had lost a remunerative beach placer by its sinking beneath the sea during this disturbance.

Geologists at 150 ft. Level Entrance to Hidden Creek Mine, B.C.

Skagway to Dawson City.

Pueblo Copper Mines.—Near Whitehorse, in the Yukon Territory, the party visited the Pueblo copper mines. These mines show large bodies of oxidized ores with a very interesting set of contact metamorphic minerals. The ore minerals consist chiefly of malachite with lesser amounts of bornite, azurite and cuprite in micaceous hematite or magnetite. At the mine it is hematite, while at the "Best Chance" prospect it is magnetite, the latter sometimes banded with garnet and diopside. The ores lie near the contact of granodiorite and limestone, both of which are considerably altered, the former showing a large development of epidote and the latter garnet and diopside.

Tantalus Coal Mine.—A short time was also spent at the Tantalus coal mine, situated 155 miles above Dawson. This mine lies on the bank of the river, and the coal may be loaded directly on scows and shipped down stream to Dawson, where it is said to sell at about $12 to $15 per ton, although at times running considerably above or below these figures. The daily wage paid to all miners is $5 per day, this being that of the Klondike district. The coal is of Jura-Cretaceous age. It is a good quality of soft coal and the seams are of fair thickness.

The Klondike.

The Placer Deposits.—From Dawson City the party was driven up the Klondike River, Hunker Creek, over "The Dome," down Dominion Creek, up Sulphur Creek, across "The Dome," and down Bonanza Creek to the Klondike River. Probably the most surprising feature of the trip was the extent of the placers. It is estimated, and I believe on a fair basis, that there are 200 miles of gravel, in the district, with a pay streak an average of 200 feet in width. The great bulk of this gravel has either been worked over by the individual miner or it is low-grade, but it may be profitably hydraulicked or dredged.

The dredges.—The Boyle Concession Company is operating four dredges, two of which are said to be as large as any in the world. They were built at a cost of $480,000 each and they are capable of handling 11,000 cubic yards of gravel per day, at about 6 cents a yard, where the gravel is not frozen and of considerable thickness. Each dredge requires 1,005 electric horse-power for operation; it has 68 buckets, each weighing about two tons and holding 16.1 cubic feet of gravel. There are two shafts upon which it may be supported and rotated, each weighing 32 tons, and it is said it required 22 teams of horses to haul each of them from the wharf to the place where the dredge was assembled.

Thawing frozen ground.—The greatest obstacle to mining in the Klondike is the frozen ground, it being frozen to a maximum of approximately 200 feet, in restricted areas. Interbedded with the gravel is a bed of black muck varying in thickness from a few inches to 30 feet, and beneath this the gravel does not thaw. In the days of individual mining the miners sank a shaft through the muck and drifted beneath it, as it formed a satisfactory roof, but for dredging purposes the ground is either thawed by "steam points" or the muck is stripped from the gravel by means of a monitor and the gravel left to thaw by sun's heat. The Granville Mining Company considered that by the latter method the gravel could be prepared for dredging at a cost of about 2 cents per foot, while the former method costs usually from 10 to 17 cents per foot. The ground sluicing method makes the operator dependent upon the slow work of the sun, and since this method may be said to be in the experimental stage it seems probable that it will be found necessary to dredge off the thawed surface in order to permit the penetration of the heat to the lower levels.

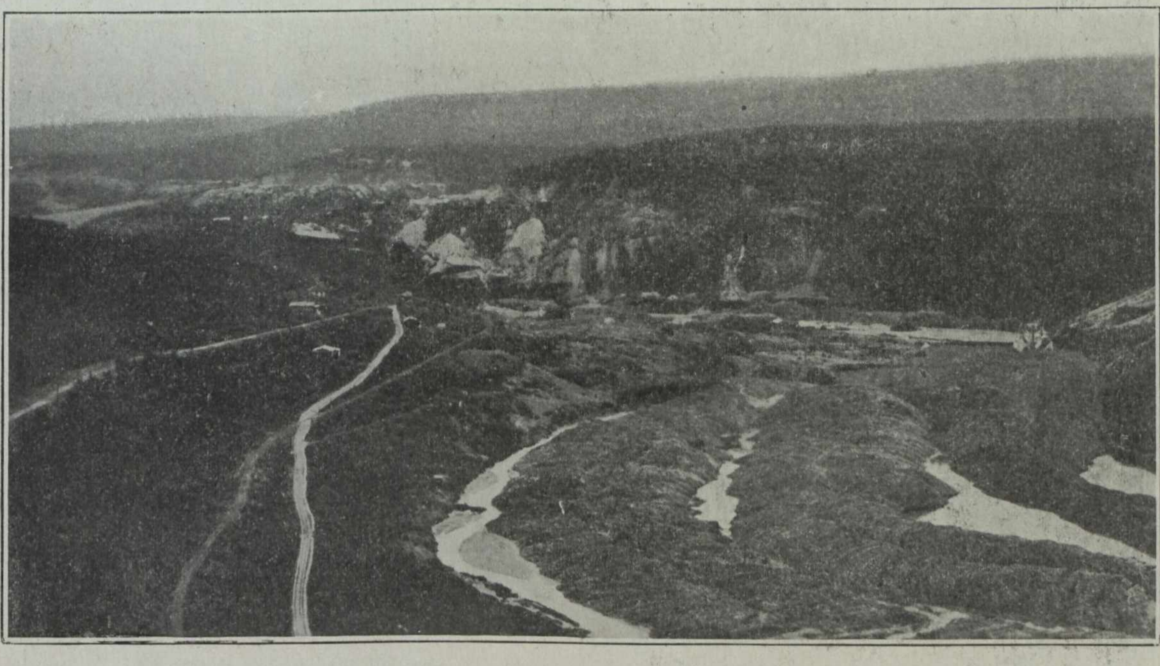
Even at a cost of 10 to 17 cents per square foot for thawing and 6 cents per cubic foot for dredging a fair profit remains, since much of the gravel is said to average 30 cents a cubic yard.

During a visit to a property operated by an individual miner we entered a shaft 38 feet deep, in gravel frozen to bed rock. The operator stated that the values ran about 60 cents per square foot of pay streak, the latter on this property being less than one foot thick, and the expenses of mining averaged about 45 cents per foot. It is therefore evident that much of this gravel could be dredged at good profit.

I believe that Mr. H. M. Payne, who has investigated the mining operations of this district, believes the hot water system of thawing more efficient than the steam. He claims there is more loss of heat by conducting the steam under the necessary pressure than there is in transporting water, and that latent heat is wasted. It is true that heat may be lost in transferring the steam from the boiler to the points, but the latent heat is always available for thawing purposes, and the steam has the advantage of not forming so much excess water which stands in pools, and which in cold weather freezes near the place it is set free.

When first introduced the dredges only operated for a short period during the summer months, but with improved facilities for the prevention of freezing they expect soon to be able to operate, at least nine months of the year.

The gold production.—The output of gold this year is said to be around $5,000,000, and it would appear that this should continue nearly constant or even increase for some years. The Yukon Gold Company (the Guggenheim interests) has installed a hydraulicking system in which the water is conducted about 75 miles by ditch, flume and pipe, and used in working the extensive de-

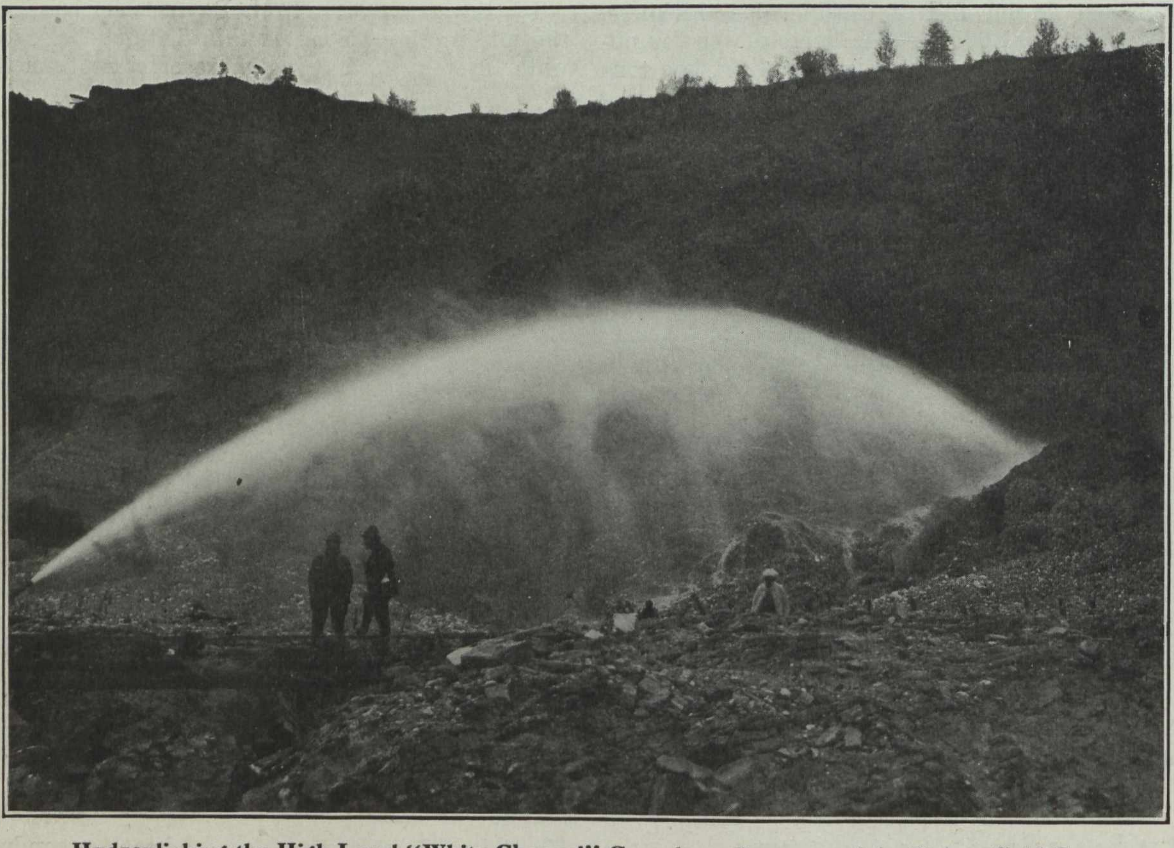


Bonanza Creek, Klondike. At Extreme Right is One of the Dredges of the Yukon Gold Co.

posits of "White Channel" gravels on Bonanza Creek and elsewhere. This company also has a number of dredges in operation, and the Granville Mining Company, which has acquired large holdings on Dominion and Sulphur creeks, has only begun operations. The Boyle Concession Company estimates that with their annual capacity of about 7,000,000 cubic yards their holdings should contain a supply of workable gravel sufficient for 20 years. Only one quartz mine seems to be in operation, and from the small size of most of the veins, or the barrenness of the large ones, one cannot take a very hopeful view of the quartz mining problem, although no one could fail to sympathize with the prospector, who, on first investigation, thinks "The Dome" should carry the quartz veins which have supplied all these rich streams with gold. Practically all the rich streams head in this mountain, but the gold seems to have come from innumerable small veins of quartz, which almost everywhere cut the sericite schists.

From these observations there is reason to believe that Dawson City will for a long time remain an important distributing centre for mining operations in Central Yukon and Alaska.

It would not be just to close this account of the C8 excursion without expressing appreciation of the kindness and courtesy of the officers of the mines which were visited, the officers of the Congress, and of the work of the geologists who have worked in these distant and difficult fields, especially the splendid work of Mr. R. G. McConnell which was found to be accurate and thorough in detail as well as in the larger structures and principles.



Hydraulicking the High Level "White Channel" Gravels on Property of the Yukon Gold Co., Bonanza Creek, Klondike

CEMENT.

Materials used in the manufacture of cement in Canada include marls, limestones, clays and blast furnace slag. The occurrence of cement materials is so widespread and abundant in all parts of the country that the question of their utilization is largely economic, being dependent upon the market for the product, the comparative availability of suitable raw materials in different localities, the cost of fuel, and the transportation facilities.

There are at present 24 completed cement plants in Canada, with a total daily capacity of about 28,800 barrels, besides several plants in course of construction. The total production in 1912 was 7,132,732 barrels, valued at $9,106,556, and in addition 1,434,413 barrels were imported.

CORUNDUM.

In spite of the large increase in late years in the manufacture and consumption of artificial abrasives, such as carborundum, alundum, etc., natural corundum is still preferred for certain purposes, and the Canadian deposits of this mineral yield practically the entire supply. In 1912 the production amounted to 1,960 tons, valued at $239,091.

The corundum mines are situated in the eastern portion of the Province of Ontario, in the townships of Carlow and Raglan, and mining operations have been in progress since 1900. At present mining is being conducted solely by one corporation—the Manufacturers Corundum Company—who have acquired the mines and mills formerly operated by the Ontario Corundum Company, in Carlow, and the Canadian Corundum Company, in Raglan.

THE CHISANA (SHUSHANNA) GOLD DISTRICT*

By D. D. Cairnes.

Throughout a small area within Chisana district, Alaska, not exceeding 10 or 12 square miles in extent, rich gold-bearing gravels have been found, but what the adjoining territory may contain is as yet problematical. The geological formations and other general characteristics appear to persist, however, to the eastward well into Canadian territory, 30 to 40 miles distant, and it is quite possible that further valuable deposits of placer gold may be found within this belt, not only in Alaska but in Yukon as well. The district is difficult to reach and, due to the northern latitude, conditions are extremely severe on those not properly equipped or unaccustomed to the climatic and other conditions there prevailing.

The original discovery in Chisana district, generally known as the James discovery, is located 30 miles west of the International boundary line, at about latitude 62 degs. 10 mins. N. and longitude 141 degs. 55 mins. W. The gold-bearing belt lies along the southern edge of the Nutzotin mountains, and within 25 miles of the northern slopes of the snow and ice-capped Wrangell mountains which include several peaks exceeding 12,000 feet above sea-level, the highest of which—Mount Sanford—rises to a height of 16,200 feet above the sea. The Chisana gold deposits, situated as they are near the head waters of the White and Tanana rivers, are in a district which is very difficult to reach and may be considered one of the least accessible portions of Alaska.

Five main routes to Chisana are available, two of which may be considered as Alaskan, and the remaining three as Yukon routes. The two Alaskan routes are respectively by way of the Copper river and Northwestern Railway, and the Tanana river.

By the railway route, the railway is followed from tide water at Cordova to McCarty, a point near the northern end of the railway line, 191 miles from Cordova. Thence this route proceeds either over the Skolai or Chitistove passes to Russell glacier at the head of White river. The valley of White river is then generally followed to Solo creek, whence the trail proceeds northward to the gold fields. From McCarty to the James discovery is about 10 days' travel for pack horses, the route by the Chitistove pass being somewhat shorter but more dangerous than that by the Skolai pass. Either route is both difficult and dangerous, and is available only during a few weeks in the summer.

By the Tanana River route, the distance from Fairbanks to the mouth of Chathenda creek (also known as Johnson creek) which is a tributary of Chisana river, is about 350 miles. Over this part of the route it is claimed that small power boats will be able to reach within 50 or 75 miles of Chathenda creek. For the remaining portion of the 350 miles, poling boats may be employed. This route is very long, arduous, and difficult, and in any case will only be followed by persons already at Fairbanks or some nearby portion of central Alaska, it being altogether an impossible route for persons residing outside Alaska.

All three of the Canadian routes proceed from tidewater to Skagway, over the White Pass and Yukon Railway to Whitehorse, a distance of 110 miles. From Whitehorse, the routes diverge and may be named the Kluane, Coffee Creek, and White River routes, respectively.

The Kluane follows the wagon road from Whitehorse westward to the upper end of Lake Kluane, a distance of 143 miles, and proceeds thence by trail via Canyon City to Chisana, a distance of 170 miles. In winter the route from Kluane to Canyon City is shortened about 25 miles due to the fact that it is possible to travel from the upper end of Lake Kluane practically the entire length of the lake on the ice, instead of having to follow around the southern end and western side of the lake. From Lake Kluane to Canyon City, no trail has as yet been constructed, although one will in all probability soon be built. Quite a number of persons have travelled this route, however, although to those unacquainted with the district the portion of the journey from Lake Kluane to Canyon City is somewhat difficult. From Canyon City to Chisana, the route is well defined, and for part of the distance a good trail has been constructed.

By the Coffee Creek route, Lewes and Yukon rivers are followed from Whitehorse to the mouth of Coffee creek on Yukon river. Coffee creek is 350 miles from Whitehorse, and 110 miles from Dawson by river. Commodious steamers ply regularly between Whitehorse and Dawson during the summer months, it being now possible to catch a steamer going either up or down stream almost any day during the season. From Coffee creek a good government trail has been constructed to Canyon City, and a branch of this trail is being constructed to the mouth of Snag creek on White river, distances from Coffee creek of 120 and 95 miles respectively. The distances from Canyon City and Snag creek to the discovery are 50 and 75 miles, respectively. Government trails have been constructed from Snag creek and Canyon City westward to the international boundary or to within about 35 miles of the James discovery. The trip from Coffee creek to the James discovery via Canyon City can be made with pack horses in summer in 10 or 11 days, without unduly exercising the pack animals.

The White River route follows up White river from its mouth to Snag creek, a distance of 115 miles, and thence the trail to the gold fields is followed a further distance of 75 miles. The mouth of White river is 381 miles from Whitehorse, and 80 miles from Dawson by river. White river is navigable for power craft for about 90 miles from the mouth, and one especially designed gasoline boat is reported to have reached Snag creek in four days, from the mouth of the river.

The three Canadian routes are all available throughout the entire year, but travelling and freighting is much easier, quicker, and cheaper in winter when sleds may be employed, than in summer when it is customary to use poling boats or pack horses, except in cases where men pack on their own backs or pack by dogs. It is difficult to say which of the three Canadian routes is best. Special circumstances will decide in each case.

But little was known concerning the particular locality in which the Chisana gold-bearing gravels have been discovered, until this past summer, but geological work had been performed in adjoining territory on practically all sides of the district. Between 1891 and 1902, C. W. Hayes, Alfred H. Brooks, Oscar Rohn,

*From a report made by Dr. Cairnes to the Geological Survey.

Frank S. Schrader, and others, made reconnaissance surveys in adjoining portions of Alaska and Yukon. During the summers of 1904 and 1905, R. G. McConnell, of the Canadian Geological Survey, explored the Kluane district and the territory along certain of the headwater tributaries of White river. In 1908, Messrs. Moffit and Knopf, of the United States Geological Survey, mapped and explored the Nabesna-White River district immediately adjoining the Chisana. Thus, although no detailed information concerning this exact area was available previous to the time of the strike, a great amount of general information was available and the adjoining district on the Canadian side of the boundary line had been considered for some years to be one of exceptional promise, and would have already been investigated, geologically, except for a series of unavoidable delays. The writer was accordingly appointed to investigate the adjoining White River district during the past season, and reached there before the stampede commenced. The directors of the Canadian and United States Geological Surveys at Ottawa and Washington respectively, are forwarding all the information that is available concerning Chisana and the adjoining districts to all requesting such.

Chisana district, along the east side of Chisana river, and the creeks in which the gold has been found, are tributary to this stream which has given the district its name. The name Chisana appears in all the older authentic maps published by the various United States government departments and the name "Shushanna" which has recently appeared in the press so frequently, is merely a corruption of Chisana. All records filed in the district and all authentic documents spell the name C-h-i-s-a-n-a.

The district is mountainous, but immediately adjoining the gold-bearing creeks is not rugged, being characteristically undulatory in character. The mountains immediately to the north, however, in which these creeks head, are quite rugged and rise to elevations of 9,000 to 10,000 feet above sea-level, the James discovery being about 5,000 feet above the sea. All the higher elevations including the main gold-bearing creeks, are above timber line, the closest timber being along the valley bottom of Chathenda creek distant 3 or 4 miles from the James discovery.

The geological formation is dominantly sedimentary, and consists of dark grey to black shales and slates which are extensively invaded by basic volcanics which occur prevailingly in the form of dykes less than 100 feet in thickness. The strata of the prominent, easterly-trending range in which the gold-bearing creeks head, and which are undoubtedly the source of the placer gold, have been very highly mineralized as a result of this igneous invasion and have a general bright red appearance throughout, due to leaching and oxidation of the contained iron-ore minerals.

No evidence of glaciation was detected in the district, which partly accounts for the presence of the gold. Had the district been glaciated, the water-sorted accumulations of gold in the gravels would have become scattered through enormous masses of unsorted material and would thus have been lost.

Gold is believed to have been first discovered in Chisana district about May 3, 1913, by William E. James and Peter Nelson, of Dawson, both of whom with a third partner, Frederick Best, had spent the previous winter prospecting in White River district. A story is current to the effect that an Indian named "Joe" first found the gold and told James of the discovery. Mr. James has denied this, stating that all the Indian showed him was a quartz vein on Chathenda creek which contained free gold, and that he later found the placer gold himself. The partners, James and Nelson, commenced sluicing on Discovery claim on Little Eldorado creek on July 4 and by August 2 had obtained about $9,000 from this claim, an average of about $300 per man for each 8 hours of work performed. It had been impossible up to that time to employ men in the district, and the work performed had practically all been done by the owners who, in addition, had to devote a considerable portion of their time to looking after other extensive interests in the vicinity. When the writer left the district on August 4, Discovery claim on Little Eldorado was the only claim from which any considerable amount of gold had been obtained. Since that time, however, from information obtained from what are thought to be quite reliable sources, it appears that a number of other properties have become important producers.

The creek gravels are not frozen in summer, as they are not covered by muck or moss, but the bench gravels are frozen in most places throughout the entire year. A number of the present streams have comparatively recently formed canyon-like valleys, and in places the material of the older stream channels is quite apparent and the gravels they contain constitute the main bench gravels of the district. From these gravels it is possible the bulk of the gold will be obtained, either from the old channels themselves directly, or from the present stream channels where these cut the older gravels. In such places the gold originally in the older gravels is now concentrated in the gravels of the present intersecting streams.

The creek gravels are very easily worked, being in most places less than 4 feet in thickness, and not over 100 feet in width, and they constitute typical prospectors' diggings, as a minimum of equipment, time, and labour are required to obtain the gold.

A small area not exceeding 12 square miles is known to contain important deposits of placer gold, but what the surrounding country may contain is as yet problematical. Recently a strike was made at the mouth of Chathenda creek which is reported to be rich; if so, this discovery adds considerably to the area known to be valuable. The geological formation and general conditions persist eastward well into Canadian territory 30 to 50 miles distant, and it is hoped that the gravels there may also prove to be rich in gold. In fact, Messrs. James, Nelson, and Best claim they found pay in Frying Pan creek in Yukon territory in the course of their operations last winter, but say they were forced to stop work as the water came in so rapidly in each case when they reached bedrock, that the pits or shafts had to be abandoned.

Several thousand men went into Chisana district this summer before the freeze-up, but with rare exceptions they were prepared to remain only a few days and departed, so that possibly at no one time were there more than 300 to 400 persons in the vicinity. Quite a number have now returned to the district with large outfits and are prepared to spend the winter prospecting and getting ready for work in the spring. A considerable number of cabins are being built, a post office and mail service is being established, and negotiations are under way for installing wireless telegraphy in the new camp. Royal Northwest Mounted Police have been stationed along the Canadian routes, and roadhouses have been built or are being built on White river at its mouth, at the mouth of Donjek river, and at the mouth of Snag creek. The Customs authorities of both the United States and Canada have also mutually agreed to waive the duty on all goods going into Chisana district from either country for a period of one year. It is expected by spring, therefore, that there will be plenty of provisions and ordinary outfits available in the camp, although prices will naturally be high. All provisions have been worth at least one dollar per pound all season anywhere in the vicinity of Chisana district.

Since early in August, repeated warnings to prospectors and others have been made in the press, against going into this district this fall without good outfits, and otherwise being prepared to spend the winter in the field if necessary. Practically all the known valuable ground was located by August 1, since when there was no possibility of being able to stampede into the district, locate quickly, and return. All persons going into Chisana since August 1 should be prepared to do bona fide prospecting, and persons so prepared are quite liable to make important discoveries quite outside the area at present considered valuable.

Already a number of men have lost their lives during the stampede. Some were drowned in the dangerous rivers of that northern country, some met with fatal accidents crossing the Skolai or Chitistone passes, and others became lost and starved to death. Practically all the fatalities would have been avoided if all those going into the district had been properly outfitted.

THE METAL COBALT AND ITS ALLOYS

By H. T. Kalmus

(Continued from December 15 issue.)

Tensile Strength and Compressive Strength of Metallic Cobalt.

For each of these determinations the extensibility or ultimate elongation has been measured.

The numerical values for tensile and compressive strength of the pure metal cobalt have as yet not been determined to the same degree of accuracy as they have been for certain of the cobalt alloys. About 5 pounds of metallic cobalt is reduced from the oxide at a time, and a set of observations of the properties of the pure metal made with it. Then it is alloyed with a small percentage of aluminium, chromium, iron, etc., as the case may be, and a series of alloys made and studied with increasing content of the second metal. In this way each batch of cobalt yields a large number of sets of measurements of the properties of its alloys, with but a singular set for the pure metal.

The mean of 15 compression and tensile strength measurements shows these constants for pure cast cobalt to be extremely high. Until a complete publication of these data is made no specific figures will be given, but it is not improbable from the work thus far that the tensile and compressive strengths of pure cast cobalt are higher than the corresponding strengths of any of the ordinary pure metals.

As far as possible strength tests will ultimately be made on rolled and drawn pieces as well as on castings, both for the pure metals and for the alloys.

Electroplating Metallic Cobalt.

A series of experiments was performed on the electro-deposition of metallic cobalt to compare it with that of nickel. A variety of electrolytes were used and the effect of varying current densities and electromotive-forces studied. In a general way cobalt may be plated from an alkaline solution in very much the same way that nickel is commonly plated. A current density of 15 milliamperes per square centimetre, or lower, gives a brighter and more uniform deposit than current densities higher than this value.

In general it may be said from the results thus far obtained that cobalt may readily be plated, yielding a surface very similar to that of nickel, but somewhat tougher, more silvery in appearance, and more non-corrosive. We have plated nickel-cobalt alloys which appear to be extremely tough and which, therefore, are of commercial interest to the electrotyper. The writer has considered this matter carefully with some of the large electroplating concerns, and arrangements are being made to have tests made on a commercial basis.

Cobalt Chromium Alloys.

Certain alloys of cobalt and chromium are known to be extremely hard and certain of them to be extremely acid resisting. About 20 cobalt chromium alloys were prepared in an electric crucible furnace of the carbon plate resistor type. This furnace could be maintained at any temperature from 1,000° C. to 1,800° C. and absorbs up to 25 KW. Weighed amounts of cobalt and chromium were charged into the furnace in a graphite crucible lined with alundum cement. After the metals were melted and well mixed, these alloys were allowed to soak for about one-half hour at a temperature of 50° to 100° C. above their melting point. From this temperature the melts were poured both into sand and iron moulds. In general the lower the temperature of pouring above the melting point the freer the alloy from occluded gases. Neither skim gates nor risers were found to be necessary with these cobalt-chromium alloys, and sound bars 1 foot in length and 1 square inch in section were readily cast, using a very little manganese as a degasifier.

While the alloys of this series thus far made and tested are not as good as those being made at present, so that it is early to draw definite conclusions, nevertheless, the indications are that these alloys will suffer from their lack of ability to yield to heat treatment. The tools thus far made compare favourably with the best untreated tool steels, but as yet they do not lend themselves to heat treatment and do not compare favourably with the best tempered tools or with good self-hardening steels.

Aluminum-Cobalt Alloys, and Aluminum-Cobalt-Copper Alloys.

In discussing the requirements of the market with some of the larger foundrymen, the writer has repeatedly had it emphasized to him that there is an urgent need in many quarters, particularly among automobile manufacturers, of an alloy of aluminum which shall not be very much heavier than the present alloys largely used, but which shall have increased tensile strength, and which shall not be subject to the same degree of shrinkage in casting.

I note 53 alloys of aluminum, principally copper-aluminum alloys, which are at present in use; easily 90 per cent. of all the castings of this series used in automobile construction are of the composition aluminum 92 per cent., copper 8 per cent. This particular alloy has a tensile strength of about 20,000 pounds per square inch, and shrinks badly in casting.

The tensile strength of the light casting alloys of aluminum is tremendously influenced by the size of the constituent crystals, that is, "by the closeness of the grain." For any given composition the finer the grain that can be produced the stronger the metal. The closeness of the grain of these alloys is greatly affected by: (a) Small additions of other elements. (b) The volume and dimensions of the casting. (c) The temperature and heat conductivity of the mould. (d) The temperature at which the metal is poured into the mould.

The extreme industrial importance of these alloys, as well as the fact that certain preliminary experiments made it appear that satisfactory results might be expected, has caused us to undertake the investigation of the effect of adding various proportions of cobalt to aluminum and to copper-aluminum alloys. Since commencing this work a German patent, by W. Borchers and Herman Schirmeister, Aachen, which was issued in January, 1912, has come to hand. We are finding, in keeping with this patent, that additions of from 8-10 per cent. of cobalt, and in the neighbourhood of 1 per cent. of tungsten or of molybdenum, yield alloys which are more readily worked and finished, and which are more non-corrosive than pure aluminum.

Beyond this patent there seems to be nothing in the literature pertaining to this series, but, in any event, the factors which determine the ultimate valuable properties of such an alloy are so numerous that there is offered a most promising field for a great variety of investigations.

Starting with pure aluminum, alloys are being prepared with increasing percentages of cobalt, and as well, a great variety of aluminum cobalt-copper alloys are being cast and studied. The effect of both tungsten and molybdenum in small percentages is also being tried. Determinations are being made under the various headings enumerated under cobalt-chromium alloys.

Great difficulty has been experienced in obtaining these castings free from occluded gases, and it is only during the last weeks, after pouring some 100 castings, that the technique has become sufficiently well in hand to promise representative results. Consequently a report of the numerical constants of this series will be deferred until later, at which time the entire series will be treated in an independent publication.

Non-corrosive Alloys.

Apart from the cobalt-chromium alloys, the acid resisting properties of which have already been noted under the heading "Cobalt-Chromium Alloys," there are certain cobalt-tin alloys and cobalt-copper-tin alloys which are extremely passive. Alloys containing 80 per cent. to 95 per cent. copper, 12 per cent. to 3 per cent. tin, 8 per cent. to 2 per cent. cobalt, have been and are being prepared, and passivity tests made.

During the progress of the experiments on cobalt-tin alloys, a paper has come to my attention entitled "Die Erhohung der chemischen Widerstandsfahigheit mechanisch noch gut bearbeitbarer, fur Konstruktionszwecke verwendbarer Legierungen," by Otto Barth, Metallurgie 1912, page 216, in which the author discusses alloys containing cobalt and tin in the ratio of 4 to 6 as being particularly non-corrosive. The series of cobalt-copper-tin alloys with small additions of other elements are being studied in some detail. The alloy 40 per cent. Co and 60 per cent. Sn, without further addition, was prepared and found to be practically insoluble in all concentrations of nitric acid. However, this particular alloy is so brittle that it is worthless for most purposes. We are experimenting to better the working properties of this alloy without too greatly diminishing its passivity.

The writer has had a number of inquiries from prominent chemists and engineers with regard to these non-corrosive alloys, and a study of their properties in chemical reagents other than acids is being planned.

Magnetic Alloys.

One of the first matters considered upon the establishment of this laboratory was the possibility of preparing alloys of cobalt and iron which should have a greater magnetic permeability than the best iron now in use for electromagnetic apparatus. The discovery of such an alloy, having working properties capable of rendering its use possible, either for the construction of electro-magnetic machinery or of small measuring instruments, would, of course, be of tremendous importance.

Our experiments indicate that the alloy of such proportions as to yield the compound FE_2Co, has a magnetic permeability about 10 per cent. greater than that of the best magnetic soft iron. Due to the difficulties of obtaining a suitable pure iron for experimenal purposes, and due to delays in obtaining certain auxiliary apparatus, fuller observations on these cobalt-iron magnetic alloys, such as to establish their permeability, have not yet been made. This work will be completed in the near future, and a corresponding independent publication made.

From Atlin comes information of expectations of a much higher total value of gold produced in 1913 than in any other year since 1907. The returns will include lode as well as placer gold.

In Nelson division, among others the Silver King and Molly Gibson mines, both operated by the Consolidated Mining and Smelting Co., are making a good showing. News from Ymir tells of improved conditions at both the Dundee and Yankee Girl mines.

The British Columbia Copper Co. is continuing its activities in several camps in Boundary and Similkameen districts, and reports published tell of substantially large deposits of ore opened by development work of this year.

Additions being made to plant at the Iron Mask mine, near Kamloops, include electric motors, generators, etc. The electric current will be transmitted over a line from the power station of the City of Kamloops, the intention being to use electric power for driving most of the machinery.

In Portland Canal district, excellent progress has been made in driving the long adit of the Portland Canal Tunnels, Ltd. At about 2,300 ft. in the rock being passed through is freely mineralized, and indications of ore not far ahead are stated to be favourable.

OXYGEN BREATHING APPARATUS

The Controversy of the Injector vs. the Non-Injector Types.

By F. W. Gray.

English and French mining literature has contained much within the past twelve months, having to do with the comparative merits of oxygen breathing apparatus of the injector type and those of the non-injector type. Particular interest has been taken in what has practically amounted to a controversy since Dr. Cadman reported on the death of Mr. Painter at Caeduke Colliery, who succumbed while wearing a Draeger apparatus in irrespirable air. Dr. Cadman found two minute punctures in the regenerator cartridge, and gave his opinion that death was due to carbon monoxide being sucked into the circulating air of the apparatus from the outside. Dr. Cadman further expressed the opinion that an injector apparatus, possessing as it does a zone of negative pressure, "Is always liable to leakage and it would be in the interests of safety if the apparatus were made to give positive pressure only, so that any small leaks which must inevitably occur, will pass gas from the inside to the outside of the apparatus."

Dr. Forstmann's Paper Reassuring—As Dr. Cadman's strictures cast grave reflections upon the safety of breathing apparatus of the injector type, and as a preponderatingly great proportion of the breathing apparatus actually in use is of this type, particularly in Germany, Austria and in North America, any record of authoritative tests bearing directly upon the controverted points is of interest. In the issue of "Gluckauf" of 27th September last there were published two papers read before the Second International Congress on Rescue Work and the Prevention of Accidents, which was convened at Vienna this year. A full translation of one of these papers, that written by Dr. Forstmann, is published in this issue of the "Journal," and contains information that will reassure the users of injector-type apparatus. The second paper, by Bergassessor Grahn, a recognized authority on breathing apparatus, states that the manufacturers of the standard German types of breathing apparatus—"with a view to removing all possible objections to the use of injectors in rescue apparatus arising out of the possibility of poisonous gas being drawn in by suction originating from negative pressure inside the apparatus, had adopted means to ensure positive pressure throughout the apparatus."

Apparatus Should be Tested.—It would seem from Dr. Forstmann's experiments, that too great importance has been laid upon the possible dangers of leaks, either in apparatus of the injector or the non-injector type. An apparatus with a leak, no matter how infinitesimal, is a defective apparatus, and it is not clear why Dr. Cadman should consider that small leaks "must inevitably occur." Dr. Forstmann contends that before a leak can become dangerous it must be of a diameter that could not escape detection by proper testing, and there lies the whole point of the matter.

Every modern standard oxygen breathing apparatus on the market to-day is an example of ingenious mechanism. Ignoring in this particular consideration the liquid-air apparatus, all the accepted breathing apparatus of to-day use compressed oxygen, in conjunction with alkali regenerators for the elimination of carbon-dioxide, and they vary but in details of design. It may be said that as mechanical devices they approach perfection. It is to the chemist that we must look for radical improvements in the future breathing apparatus rather than to the mechanic. Breathing apparatus of the types now on the market have done good work, have enabled things to be done which before their advent would have been impossible, and which even to-day are not sufficiently apprehended or appreciated. But these same apparatus, as before emphasized, are mechanical devices depending on nice adjustments. They must be used with care and judgment, and with a due appreciation of their limitations as well as their possibilities. The sportsman who hunts big game sees that his guns and cartridges are in good order, the aviator does not attempt flight until he has looked to his flying machine, nor the diver descend until he has inspected his diving suit and appliances. In like manner the wearer of a breathing apparatus in irrespirable gases knows that his life depends upon the efficiency of that apparatus, and it should not be used without previous testing. Nothing is so likely to bring breathing apparatus into disrepute as the idea that they can be stored for months and years, and then brought out and used, sometimes by inexperienced men. No mechanical device yet invented will allow of such treatment, and in this respect breathing apparatus is not different from a watch, a gun or a motor car. This point has not been sufficiently recognized by makers of apparatus, nor by paternal governments. Makers of apparatus have oftentimes been more anxious to sell their goods, or to criticize those of their rivals, than to point out the dangers of improper use; and governments have enacted laws making the provision of breathing apparatus compulsory, forgetting sometimes, it is to be feared, the necessity for the subsequent inspection and care of the prescribed apparatus. Breathing apparatus should be in the charge of a competent skilled instructor, who should inspect and test all apparatus before use. In passing, it may be remarked that the instructor should not wear the apparatus himself, nor place himself in a position of danger, but should remain at the base to see that his men are properly equipped. If it is not considered possible to have a competent man to take charge of breathing apparatus it is far better to be without them. No person should be allowed to use a breathing apparatus under dangerous conditions underground—no matter if he be an official—unless he has had proper practice in its use, and is thoroughly acquainted with the mechanism of the apparatus. It is time that mine owners and governments realized that the use of breathing apparatus under dangerous conditions is work for a specialist, and not for the untrained man, even though the untrained user be a man of position and intelligence.

An inspection of the apparatus now installed at stations in America, and maybe elsewhere, would reveal that a great deal of the equipment is defective. The apparatus are probably stored in a hot and arid place, exposed to sunlight and great alternations of temperature, attended to by incompetent persons, or entirely neglected, and when required for use, more likely to prove a danger than a help.

In commenting on the possibilities of leaks, Dr. Forstmann pertinently remarks: "Of course, where apparatus is not kept in good order, and if the proper tests are not applied before use, the life of the wearer may be placed in danger. In such a case, however, there are **many other possibilities of danger, at least as important.**

One cannot help thinking that a great deal that has been said and written in the controversy on injector types versus non-injector types has been influenced by the bias of the makers and users of the rival methods, and that the importance of this point has been overstated. But what has not been overstated, and may have been deliberately concealed is that breathing apparatus require expert care and attention before use, and trained men to use them. If these conditions were always fulfilled we should hear less of leaks and of fatalities among the users of breathing apparatus.

Chief Use is to Fight Fire.—A point in Dr. Forstmann's article is his evident understanding that the chief service of breathing apparatus is in the fighting of mine fires. As an able editorial in the "Colliery Guardian"—reprinted in this Journal—recently pointed out all the recent disastrous explosions in coal mines have been accompanied by outbreaks of fire—the Senghenydd explosion being the last example—and the use of breathing apparatus in combatting fire underground is a going back to first principles. German mining engineers were among the first to see the advantages of self-contained oxygen breathing apparatus in subduing underground fires, and the idea of using them for saving human life was not prominently brought before the public eye until the spectacular journey of the Shamrock Rescue Corps from Herne in Westphalia to Courrieres, after the explosion that took such an unexampled toll of life. The use of the word "rescue" in connection with breathing apparatus is largely a misnomer, and is responsible for much misunderstanding of the true functions of these devices.

To Sum Up.—Breathing apparatus are an essential part of the equipment of every modern colliery, and have in many instances proved themselves to be of great utility, but, like every other part of mine equipment, they must receive proper care and inspection, must be taken seriously and not regarded as a rare show or a fad, and must be used under the same discipline and with the same sense of responsibility, as say, the ventilating fan, or the man-hoisting shaft.

OXYGEN BREATHING APPARATUS WITH AND WITHOUT INJECTORS*

By Bergassessor Dr. Ing. Forstmann, of Essen.

(Translated by F. W. Gray, from "Glückauf," Sept. 27, 1913.)

At a meeting of the South Staffordshire & Warwickshire Institute of Mining Engineers, held December 16th, 1912, Professor Cadman, of the University of Birmingham, pointed out that in breathing apparatus using injectors negative pressure existed, and consequently, if leaks were present, the outer atmosphere might gain admission. In his opinion this presented a source of danger to the wearer of such breathing apparatus, and made it necessary to replace all injector breathing apparatus by apparatus without injectors. This expression of opinion has led to a lively exchange of views in the English and French technical periodicals, and a closer examination of the question appears desirable.

The injector in breathing apparatus was introduced in 1901 by Fire Director Giersberg. Its chief advantages are the following:

The air in the apparatus circulates of itself—without lung movement—thereby sparing the lungs, and increasing the working capacity of the wearer. With the automatic air circulation the addition of regenerator cartridges became possible and more perfect elimination of CO_2, which again favourably influenced the capacity of the wearer for work.

It may properly be urged that the injector by setting up a negative pressure in the apparatus might induce the entrance of outer air through leaks. This possibility was not considered as of a serious nature, and was outweighed by the considerable advantages of the injector. It was also found possible, shortly after the introduction of the injector, to obtain a better testing of the whole apparatus by the use of the depression meter. Moreover, it was believed that a danger which presented itself only occasionally might best be met by exercising the greatest care to have apparatus in good condition, and by a thorough instruction and education of the rescue corps.

Since 1901 thousands of apparatus have been manufactured with injectors, and used in actual practice, without, up to the present any confirmation of Professor Cadman's fears.

Figures 1 to 4 are diagrammatic sketches of the types of apparatus now in use and manufactured by the Draeger and the Westfalia Companies.

In a few types of apparatus (Fleuss, Tissot) using oxygen, the injector is not employed. As an example of such an apparatus, Fig. 5 gives the scheme of the newest model of the Fleuss apparatus, manufactured by Siebe Gorman & Co., which possesses great resemblance to the old Shamrock type.

Although the objections which Professor Cadman has urged against the injector have been long recognized in Germany and Austria, and not regarded as being fatal, yet his discussion of the matter, has led me to make further researches.

The first question that arises is what extent of incoming outer air is dangerous to the wearer of a breathing apparatus. According to the figures given by several authorities the inhalation of 1.1 litres of carbon-monoxide is sufficient to fully saturate the blood, causing death, and unconsciousness supervenes after inhalation of 0.55 litres. From numerous experiments carried out by the Berggewerkschaftskasse in Bochum it has been established that the highest percentage of carbon-monoxide noticed in fire-gases is 0.6 per cent. In the voluminous researches undertaken in Upper Silesia fire-gases were found to contain 0.1-1 per cent. carbon-monoxide, and only in exceptional cases was the greater

*A paper read before Section VI. of the Second International Congress on Rescue Work and the Prevention of Accidents, held in Vienna, 1913.

proportion of 3 per cent. observed. Similar results have been published in Austrian papers. When over 1 per cent. of monoxide is present the case falls under the category of gases escaping from a sealed-off fire area.

From these numerous observations it may be deduced

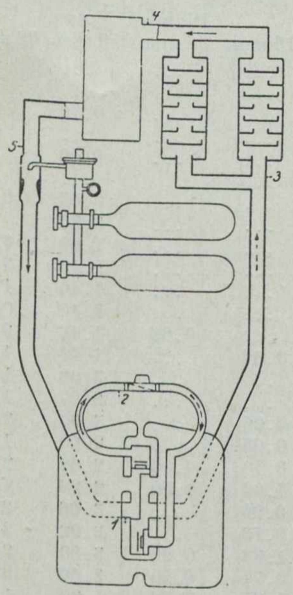


**Fig. No. 1—
Draeger Apparatus,
Model 1904-09.**

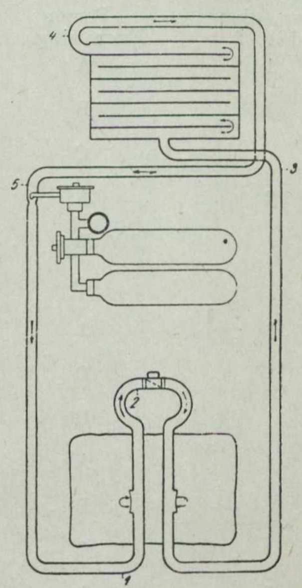


**Fig. No. 2—
Westfalia Apparatus,
Model 1908**

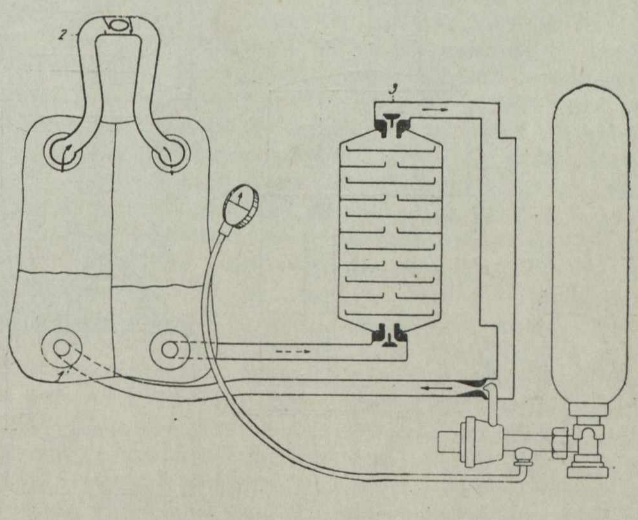
that in actual practice in fire-fighting and rescue work not more than 1 per cent. of monoxide will be encountered. (Professor Cadman always reckons on a monoxide percentage of 5 per cent.) If the fire-gases contain 1 per cent. monoxide, with a leak in the apparatus allowing the entrance of ½ litre of the outer air in one minute, then in two hours sufficient monoxide will have entered the apparatus to overcome the wearer. If the leak is larger than this, unconsciousness will, of course, follow more rapidly. With a smaller percentage of monoxide the danger is naturally less. The question, therefore is, how large must the leak be to admit so much of the outer air, and can such a leak remain unnoticed?

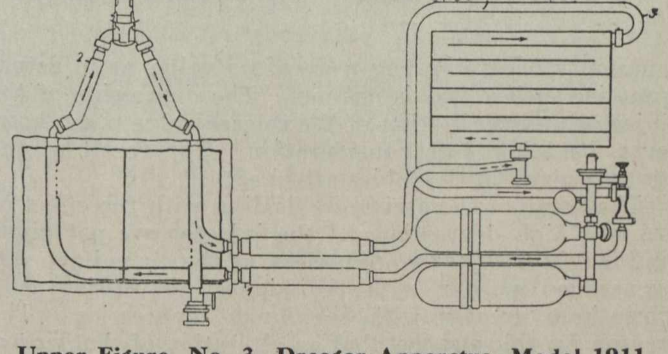
Professor Cadman does not give details of his experiments. He seems to have reckoned the volume of the incoming outer air from the extent of the negative pressure existing in the apparatus. But, as every test shows, the pressure in an apparatus in use varies constantly. It does not depend on whether the wearer breathes in or out, but on how strongly he breathes. Therefore every reading is inexact, and one can name almost any figure. As, moreover, first negative and then positive pressure rules, the volume of air actually entering cannot be decided in this way.

In order to obtain accurate results I had made for the experiments a small volume meter (see Fig. 6) holding about five litres. To eliminate frictional resistances as far as possible the pulley from which the bell and counterweight is supended was strongly constructed and provided with ball bearings. This made it possible to balance the bell so nicely that it sank on the least emission of air. A table of weights was used during the experiments which showed the correct weight of the bell in every position, the weight being thereby completely eliminated from the calculations. Small pieces of lead, weighing about 10 g. were employed, and according as the bell sank, they were removed from the counterweight. The connecting tubes between the meter and the apparatus under test holder was so delicately adjusted that it responded to the least alteration of pressure.

A number of points were selected for testing the several types of apparatus, the order being as shown in Figs. 1 to 4. In the older types of the Draeger and Westfalia apparatus five points were selected, in the newer types three points, and in the Fleuss apparatus two points only were chosen. In the four injector types the measuring points are numbered consecutively in the direction of the air circulation, commencing from the injector. The two first points lie between the injector and the mouth, therefore in a part of the air passage in which the injector acts as a blower, so that positive pressure must exist here. The other parts are in the region of suction, or negative pressure. In the two old types (Figs. 1 and 2) three points were chosen in the negative zone (Points 3-5) and in the newer types (Figs. 3 and 4) only one point (3), was taken, this last-named point (3) corresponding to point 4 in the older types. Points 3 and 5 in the older types can be neglected as at 3 only a little air is under negative pressure and the suction at 5 does not materially vary from that at 4.

In the Fleuss apparatus (Fig. 5) point 1 lies between the breathing bag and the inhalation valve, and point 2 between the valve and the mouth.



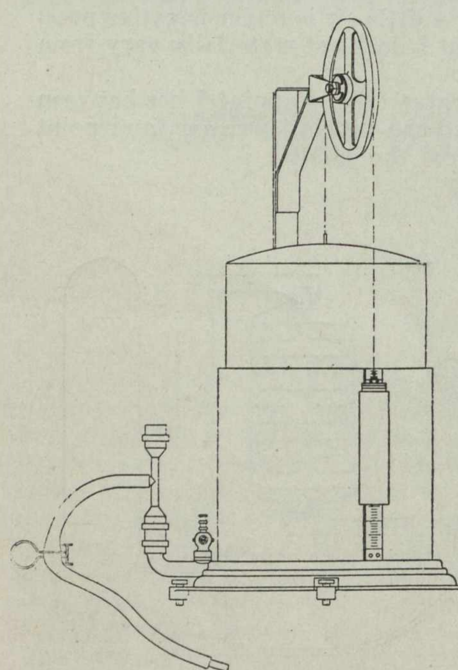


**Upper Figure, No. 3—Draeger Apparatus, Model 1911
Lower Figure, No. 4—Westfalia Apparatus, Model 1912.**

In order to experiment with openings of varying size, short connecting pieces with circular openings of 5, 2 and 1 mm. were used. Measurements were taken with apparatus at work and at rest. The last-named trials were not difficult and were, as a rule, extended over four minutes in order to obtain a reliable average.

The measurements during work were more difficult to obtain. After several futile trials a continuous run was chosen as the only possibility. This had the advantage of giving a more uniform effort, and a stronger one, than exercise at the usual apparatus for measuring work performance. At first it was attempted to extend the run over two minutes. This proved rather too strenuous for the persons under test, and the run was usually limited to a duration of one and a half minutes. The experiments were conducted on three persons, in one case on two persons, and were invariably repeated in order to obtain a reliable average.

Preliminary experiments with the depression meter had established that the negative pressure existing in breathing apparatus when worn by different persons varied somewhat. Also a great deal depends on whether the breathing bag is filled with air or not. The setting of the blow-off or release valve, and, in a lesser degree, the depression of the injector, were influencing factors, and had much to do with determining the volume of incoming air through a given leak. However, the experiments with



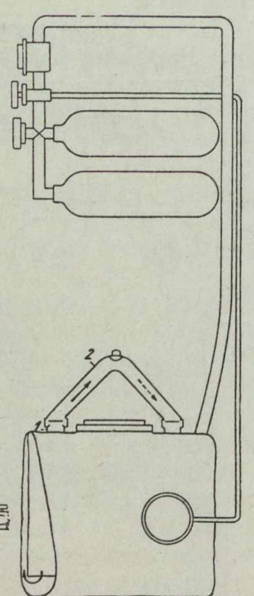


Fig 6—Air Volume Meter. **Fig. 5—Fleuss Apparatus.**

an empty breathing bag were of no value, as in actual practice such a case is not met. The depression of the injector and the setting of the release valve must, however, be taken into consideration. The result of the tests is given in the tables attached.

The results of experiments dealing with the effect of various high depressions of the injector are not given in the tables. They were useless, as the air volume was sometimes greater with the highest depression, and sometimes greater with the lowest depression. The reason for this may be, that an alteration of the depression is followed by an alteration of the volume of the circulating air in the apparatus, and a difference in the depression of 225 mm.—measurements were made at 90 and 115 mm.—was not able to exercise any appreciable effect.

Table 1 illustrates the effect of the adjustment of the release valve. Settings of 16 and 36 mm. were selected. The results showed plainly that with a low set release valve considerably more outer air obtained entrance.

TABLE 1.—Effect of the Setting of the Blow-off Valve on the Volume of Air Entering From Outside.

Depression of the Injector 115 Millimetres. Leak of 5 Millimetres.

Point on apparatus where test was taken Fig. 2.	Person Exercising.	Volume of air entering in one minute. Resting. Blow-off Valve. 16 mm.	Resting. 36 mm.	After Run. 16 mm.	After Run. 36 mm.
1	A	...	...	...	...
		...	...	...	...
	B	...	...	0.10	...
		...	...	...	...
	C	...	...	0.10	...
		...	...	...	...
2	A	...	...	0.67	0.26
		...	...	0.80	...
	B	...	...	1.00	0.67
		...	...	1.13	0.40
	C	...	...	1.40	1.06
		...	...	1.40	0.86
3	A	...	0.06	1.46	0.86
		0.06	...	1.40	1.53
	B	...	...	3.00	1.67
		...	...	2.27	1.73
	C	0.06	...	3.00	2.06
		0.05	...	2.60	1.80
4	A	0.70	0.06	2.00	2.00
		1.07	0.50	2.26	1.73
	B	0.26	...	3.66	2.73
		0.73	...	3.90	3.20
	C	1.33	0.20	3.80	2.40
		0.77	0.20	3.60	2.47
5	A	1.65	0.52	1.80	1.86
		1.00	0.37	2.00	1.40
	B	1.13	0.20	3.52	2.73
		1.66	0.07	3.52	3.90
	C	1.60	0.90	3.00	1.73
		1.40	0.92	3.60	2.67

The results given in this Table will not bear comparison with the more extended tests, as they were merely preliminary, and not carried out under the same conditions as the chief tests. In the preliminary tests no valve was provided on the holder of the volumemeter.

TABLE 2.—Westfalia Apparatus—Model 1908. Air Entering per Minute.

Depression of the Injector 115 Millimetres. Setting of the Blow-off Valve 36 Millimetres.

Point on apparatus where test was taken (Fig 2).	Person Exercising	Resting. Size of Leak. 5 mm.	Resting. 2 mm.	Resting. 1 mm.	After Run. 5 mm.	After Run. 2 mm.	After Run. 1 mm.
1	A	0.23	...	...	0.33	...	...
		0.35	...	...	0.33	...	...
	B	...	...	...	0.33	...	...
		...	...	...	0.33	...	...
	C	...	...	...	0.60	...	...
		0.10	...	...	0.40	...	...
2	A	0.10	...	...	2.66	...	...
		1.40	...	...	2.86	...	...
	B	1.17	...	...	2.86	...	...
		1.30	...	...	3.51	0.10	...
	C	0.57	...	...	2.53	0.40	...
		0.70	...	...	2.53	0.26	...
3	A	0.21	...	...	2.00	0.10	...
		1.46	...	...	2.00	0.13	...
	B	1.26	...	...	2.67	0.26	...
		1.60	...	...	3.51	0.36	...
	C	1.35	...	...	2.53	0.30	...
		1.76	...	...	2.13	0.33	...
4	A	0.73	...	...	2.40	0.26	0.16
		1.60	...	...	2.40	0.40	0.10
	B	1.26	...	...	3.15	0.53	0.16
		1.60	...	...	3.52	0.63	0.20
	C	1.46	...	...	2.93	0.46	0.03
		1.76	0.16	...	3.52	0.46	0.03
5	A	0.90	...	...	2.80	0.33	0.06
		1.17	...	...	2.66	0.46	0.10
	B	1.35	0.12	...	3.15	0.60	0.16
		2.10	0.10	...	4.40	0.56	0.23
	C	1.95	0.07	...	2.80	0.46	0.16
		1.76	0.11	...	2.93	0.40	0.06

TABLE 3.—Draeger Apparatus—Model 1904/09. Air Entering per Minute.

Depression of the Injector 120 Millimetres. Setting of the Blow-off Valve 40 Millimetres.

Point on apparatus where test was taken (Fig. 1).	Person Exercising	Resting. Size of Leak. 5 mm.	2 mm.	1 mm.	After Run. 5 mm.	2 mm.	1 mm.
1	A	0.12	...	...	0.46	...	...
		0.22	...	...	0.60	...	...
	B	0.40	...	...	0.80	...	...
		0.55	...	...	1.63	...	...
		0.57	...	...	0.93	...	...
		0.32	...	...	1.46	...	...
2	A	1.05	...	...	2.72	0.26	...
		0.72	...	...	2.66	0.26	0.13
	B	0.52	...	...	2.46	0.06	...
		1.17	...	...	3.52	...	...
	C	0.50	...	...	2.93	0.33	0.13
		1.05	...	...	3.52	0.40	...
3	A	0.30	...	...	0.66	...	...
		0.45	...	...	0.86	0.20	...
	B	0.62	...	...	1.13	0.13	...
		1.02	...	...	2.33	...	...
	C	0.50	...	...	1.00	...	...
		0.70	...	...	1.00	...	...
4	A	1.10	0.28	...	2.00	0.80	...
		1.60	...	...	2.40	0.46	0.13
	B	1.46	...	...	2.93	0.33	...
		1.95	...	...	3.52	0.46	0.06
	C	1.46	...	...	2.93	0.40	0.13
		1.76	...	...	2.93	0.46	0.16
5	A	0.95	0.38	...	2.00	0.60	0.13
		1.47	0.12	...	2.80	0.73	0.20
	B	1.76	0.05	...	3.52	0.53	...
		1.95	0.07	...	3.52	0.46	0.13
	C	1.46	0.07	...	2.93	0.86	0.10
		1.35	0.20	...	3.52	0.73	0.16

TABLE 4.—Draeger Apparatus, Model 1911. Air Entering per Minute.

Depression of the Injector 100 Millimetres. Setting of the Blow-off Valve 40 Millimetres.

Point on apparatus where test was taken (Fig. 3).	Person Exercising	Resting. Size of Leak. 5 mm.	2 mm.	1 mm.	After Run. 5 mm.	2 mm.	1 mm.
1	A	...	...	...	...	...	...
		...	...	...	...	...	...
	B	...	...	...	0.53	...	...
		0.07	...	...	0.26	...	...
	C	...	...	...	...	...	...
		...	...	...	0.20	...	...
2	A	...	...	...	1.00	0.20	...
		...	...	...	0.80	0.06	0.13
	B	0.87	...	...	2.40	0.60	0.20
		1.25	...	...	1.86	0.20	0.46
	C	0.50	...	...	2.26	0.33	0.13
		0.45	...	...	2.26	0.20	0.13
3	A	0.32	0.12	...	0.20	0.26	...
		0.20	0.15	...	0.50	0.20	...
	B	0.50	0.05	...	1.66	0.26	...
		0.67	...	...	0.80	0.26	...
	C	0.15	0.10	...	0.80	0.20	...
		0.55	...	...	0.73	0.20	...

TABLE 5.—Westfalia Apparatus, Model 1912. Air Entering per Minute.

Depression of the Injector 110 Millimetres. Setting of Blow-off Valve 18 Millimetres.

Point on apparatus where test (Fig. 4).	Person Exercising	Resting. Size of Leak. 5 mm.	2 mm.	1 mm.	After Run. 5 mm.	2 mm.	1 mm.
1	A	0.08	...	...	0.27	...	...
		0.07	...	...	0.13	...	...
	C	0.20	...	...	0.33	...	...
		0.32	...	...	0.33	...	...
2	A	0.80	...	...	1.80	0.07	...
		1.25	...	...	2.80	0.07	...
	C	1.33	0.10	...	2.53	0.33	...
		1.33	...	...	2.40	0.33	...
3	A	0.90	0.08	...	1.70	0.20	0.07
		1.30	...	...	2.33	0.20	...
	C	2.20	0.42	...	2.93	0.60	...
		2.20	0.20	...	2.73	0.73	0.13

Note.—Person "B" was taken sick and is not included.

TABLE 6.—Fleuss Apparatus. Air Entering per Minute.

Point on apparatus where test was taken (Fig. 5).	Person Exercising	Resting. Size of Leak. 5 mm.	2 mm.	1 mm.	After Run. 5 mm.	2 mm.	1 mm.
1	A	0.62	...	...	1.30	...	...
		0.92	...	...	0.90	...	...
	B	0.92	...	...	2.13	...	...
		1.10	...	...	2.53	...	...
	C	0.85	...	...	2.80	...	...
		0.75	...	...	2.40	...	...
2	A	1.40	...	...	6.50	0.57	...
		1.60	...	...	5.00	0.33	...
	B	1.76	...	...	4.40	0.73	...
		1.76	...	...	4.40	0.73	...
	C	1.76	...	...	4.40	1.33	...
		1.46	...	...	5.86	0.80	...

Tables 2 to 5 show the results of the measurements on the Westfalia and Draeger apparatus. It is at once seen that the latest models of both these firms show better results in regard to admission of outer air than the old models, although the old types give no occasion for criticism.

Under strenuous effort and with an opening of one millimetre diameter considerably less than ½ litre of outer air gains entrance into the apparatus. With an opening of 2 mm. diameter, if no work is performed, the volume of incoming air is even less. Under conditions of strenuous work and in some parts of the apparatus the volume of indrawn air can be greater than ½ litre; with an opening of 5 mm. diameter, without work, it is considerably greater than the critical volume of ½ litre. In order to properly value the meaning of these experiments it must be remembered that no person can perform for any length of time such strenuous work as was possible in the short duration of the tests. After a period of hard work rest must follow. It may, therefore, be assumed that in an extended period of use the incoming air would be about the mean of that registered under conditions of work and under conditions of rest. But this mean with an opening of 2 mm. is less than half a litre per minute. It can only exceed this figure at point 5, just in front of the injector. This point is so protected, however, that the presence of a leak is unthinkable. Therefore a leak, corresponding to a hole of 2 mm. diameter, would not be dangerous in the presence of carbon-monoxide, as unconsciousness only supervenes when for two hours more than half a litre of outer air is taken into the apparatus having a monoxide content of one per cent. Further, a higher percentage of carbon-dioxide in fire-gases cannot be dangerous, as the regenerators of the Westfalia and the Draeger apparatus are so adequately designed that they could absorb the carbon-dioxide which such a leak would admit without shortening their normal duration. At the highest they would only be required to deal with 6 to 7 litres, as up to the present the highest recorded percentage of carbon-dioxide in fire-gases has been 12 per cent.

Of course a greater leak than 2 mm. diameter would endanger the life of the wearer of an apparatus in the presence of an atmosphere holding a high percentage of monoxide. Such a leak can be detected with ease, and a leak of 2 mm. cannot remain undetected if proper tests are applied before an apparatus is taken out for use, for with a leak of 2 mm. the negative pressure will drop from 15 to 20 mm., and with greater leaks correspondingly more quickly. For example, a 5 mm. leak will cause a drop of almost half, that is, from 50 to 60 mm. Such a difference must speedily be detected if the depression meter is used for testing. The leak would also be quickly noticed if the apparatus be tested by blowing through it, as prescribed by rule in the Ruhr district.

On the ground of these tests the conclusion we must arrive at is that Professor Cadman has greatly exaggerated the possible danger, and that the usual prescribed tests are sufficient to avoid any dangers that may arise through leaks in an apparatus. Of course, where apparatus is not carefully kept in good order, and if the proper tests are not applied before use, the life of the wearer may be placed in danger. In such a case, however, there are many other possibilities of danger, at least as important. Professor Cadman's conclusions that injector apparatus should be displaced altogether in favour of non-injector apparatus is not sustained. Moreover, Professor Cadman has overlooked the fact that in apparatus without injectors the outer air may gain entrance. In the only apparatus without injector to which I have had access, the Fleuss, according to my experiments (see Table 6) a leak of 2 mm. and of 5 mm. diameter at point 2 (See Fig. 5) under work conditions will admit more outer air than under similar circumstances and at the same testing points in the injector apparatus.

THE CONSOLIDATED MINING AND SMELTING CO. OF CANADA

The report of the Consolidated Mining and Smelting Co., of Canada, Ltd., for the period of fifteen months ending Sept. 13, 1913, has been issued.

The report of the President, Mr. W. D. Matthews, says:

The net profit, after deducting $146,019.30 for development, and $193,256.06 for depreciation, amounts to $998,367.14, out of which three dividends (a total of 8 per cent.), amounting to $464,352 have been paid, leaving a balance of $534,015.14, which, added to the balance at the credit of the Profit and Loss Account as shown last year, makes a total of $1,717,650.49 at the credit of that account.

During the year the Property Account has been increased by the sum of $232,113.73, the following properties having been acquired: The Monte Christo, Iron Horse, Abe Lincoln, and Virginia claims, adjoining the company's Rossland properties, the No. 1 group and the Highland group at Ainsworth, and the Ottawa mine at Springer creek, Slocan district. An interest in the Silver King group of mines at Nelson has also been acquired, and an agreement has been entered into to operate the property.

The plants at the various properties have been well maintained, and alterations and improvements have been made at the smelter to take care of the increased tonnage of ore, and also to reduce cost of operating.

Mr. R. H. Stewart, general manager, says, in part:

Operations for the fifteen months show a net profit of $998,367.14, after writing off $193,256.06 for depreciation on plant and equipment, and $146,019.30 for development, and charging to Profit and Loss Account $598,239.96 expended during the period in the development of our properties. Increase in plant account for the fifteen months, deducting depreciation, sales of plant and sundry fire losses, amounted to $103,071.82. Increase in property account, less development written off, $232,113.73. Expenditures on property account included completion of the purchase of the Fort Steel Mining and Smelting Company's stock and bonds; the purchase of sundry mineral claims adjoining the company's properties in Rossland; the purchase of an outstanding interest in the Achilles and Florence fractions, part of the Molly Gibson group; completion of the purchase and development of the No. 1 and Highland groups at Ainsworth; the purchase of the Ottawa group of mineral claims near Slocan City, and expenditure on development of various claims, which the company has had under option.

The amount due to banks for borrowed capital is $197,970.44.

Average quotations for metals for the fifteen months are as follows: London Lead £18 19s. 7d. as compared with £15,593 during the previous year; New York silver 60.993 cents as compared with 56.355 cents; electrolytic copper 16.113 cents as compared with 13.942 cents.

The total tonnage smelted at Trail was 407,124 tons, having a gross value of $8,335,668.00; showing an increase in the average monthly tonnage smelted over last year of about 2,400 tons.

The company's mines in Rossland show an encouraging increase in the amount of ore developed, a considerable part of this increase being due to tonnage developed in the Le Roi.

Development in depth from the War Eagle mine continues to prove encouraging, a large body of ore, of good grade, having been opened up on the 14th level. A cross-cut from the Centre Star shaft is now being driven, to reach this vein at a depth of three hundred feet below this 14th level, and should reach the vein early next year.

Development in the Le Roi mine has been satisfactory in finding new ore.

A dispute regarding the rights to mine certain veins apexing near the north boundary of the Le Roi, where it adjoins the property of the Le Roi No. 2, was settled by an agreement between the two companies, involving an exchange of certain parts of the properties of both companies and the substitution of definite planes for extralateral rights. This agreement should do away with any cause for disputes of this nature with the Le Roi No. 2 Company in future.

At Kimberley, development of the Sullivan group has been satisfactory in opening up new ore, and the mine should continue to produce for a good many years to come.

At Moyie a small tonage has been shipped from the St. Eugene mine, but no large bodies of new ore have been discovered.

The Molly Gibson mine was closed down for about six months last winter, owing to snowslides, which carried away a considerable part of the tramway. The tramway has been repaired and development is proceeding satisfactorily. The cross-cut tunnel mentioned in last year's report, has opened up considerable new ore, much of it of very good grade, and the mine looks better than ever before. Owing to its situation development is necessarily slow, but the mine should, in time, be a producer of considerable profit.

At Sandon there have been no new developments in the Richmond Eureka group, which still continues to produce a small tonnage.

At Ainsworth the No. 1 mine has been producing ore comparatively steadily, and developing with favourable results. The Highland group is also being developed with fairly satisfactory results. This mine has also commenced producing, and results are favourable. The Maestro, Libby, Banker, and Tiger properties adjoining, or close to the Highland and No. 1 groups, and which the company has under option, have developed to a small extent and some ore has been produced under lease.

At Salmo the Silver Dollar mine, which the company has had under option, has not been developed to any extent, owing to labour difficulties.

At Boundary Falls the No. 7 mine was operated for a part of the year to supply silicious ore, which was at that time lacking at the smelter.

In the Phoenix camp no work was done.

New Properties.—At Slocan City the Ottawa mine was purchased at a low figure, and a small amount of development has opened up a shoot of high grade ore, which will probably prove profitable.

At Silverton the company has under bond the Lucky Thought mine, on which some development has been done, but so far without very definite results.

A small amount of money was spent in developing a group of claims on the Coast, but the option was dropped as the property did not appear to be sufficiently promising.

At Nelson the property of the Silver King Mines, Limited, has been operated. This property includes the Silver King and surrounding claims, and formerly produced a large amount of silver-copper ore, but has been closed down for some years. Development has been carried on and some shipments made, but so far with no very definite results.

Improvements.—The total charge to construction account includes amounts taken into account on account of plant or properties purchased during the period, amounting in all to $64,400.00.

Besides this the principal expenditures have been about as follows:

In Rossland in connection with experimental work on concentration, which has been carried on at the Le Roi experimental mill; and the installation of an electric motor at one of the Le Roi compressors (made necessary on account of shortage of compressed air, due to increase of production and development in the company's mines in Rossland).

The head-works at the War Eagle mine were destroyed by fire during the year, and insurance to the amount of $22,000.00 was received therefor. The loss of these head-works did not, however, interfere with operations to any extent, owing to the fact that the War Eagle shaft was being used mainly for the movement of men and supplies, the ore being hoisted through the Centre Star shaft.

The assay office at the Centre Star mine was also partially destroyed and was replaced by a new one more conveniently located.

At Ainsworth were installed an aerial tramway from the No. 1 mine to the lake (length about 9,000 feet); also a small compressor plant.

At the Highland mine a small water-operated air compressor at the Highland mill and an air-line from the mill to the mine have been installed.

At Kimberley, the principal improvements were further accommodations for the men, and general equipment required for increased production and for further development.

At Trail the principal improvements have been alterations in the machine and blacksmith shops, and the transfer of machinery for these shops from the old Le Roi plant; the re-building of one of the copper furnaces and increasing its length to thirty-five feet; preparation for installation of a new lead furnace, and for re-building the lead furnaces; preparations for the installation of a new blower and of cranes for handling material in the blast furnace building; re-building of the Heberlein plant to reduce costs of operation and to take care of increased tonnage of lead ores; including the installation of a crane for handling the Heberlein pots, and of a 24 x 36 jaw crusher and grab bucket for handling sinter, and the purchase of additional Heberlein pots; the purchase of additional electric locomotives; of two Wedge roasters to take care of increased tonnage of lead ores; the installation of a gas-producer for the Dwight and Lloyd roasters, to replace firing with gasoline.

General Conditions.—There has been considerable improvement in mining throughout the Kootenay district. Customs ores received amounted to 97,823 tons for the fifteen months, as compared with 47,257 tons in the previous year. Considerable new ore is reported as having been discovered and a number of new properties have been on the list of shippers, some of them properties that have been idle for a number of years.

Management.—The properties and departments of the company have been in charge of the following gentlemen:

Mr. S. G. Blaylock, assistant general manager; T. W. Bingay, comptroller; James Buchanan, superintendent of smelter; M. H. Sullivan, assistant superintendent of smelter; J. F. Miller, superintendent of refinery; M. E. Purcell, superintendent Centre Star group of mines; E. G. Montgomery, assistant superintendent; F. S. Peters, superintendent Le Roi mine; C. H. McDougall, St. Eugene and Sullivan mines; K. B. Carruthers, Molly Gibson mine; W. A. Cameron, Slocan Lake properties; W. M. Archibald, J. M. Turnbull, and A. W. Davis, mining engineers.

FELDSPAR.

This mineral is employed at the present time almost entirely in the pottery industry (where, in a finely ground form, it is mixed with the clay to act as a flux), or in the enamelling of cooking and similar utensils. Attempts are being made also to utilize the mineral as a source of potash, of which it contains as high as 14 per cent.

Feldspar has been mined in Canada since the year 1890, and the present average annual production is 12,000 tons. Practically the whole of the output is exported to the United States, where it is consumed in the New Jersey and Ohio potteries. Almost the entire production of Canadian feldspar is derived from the Province of Ontario—the principal mines being located in the county of Frontenac, about twenty miles north of the town of Kingston on the St. Lawrence River. A few small deposits also have been worked in the Parry Sound district, in the vicinity of the Muskoka Lakes. Formerly feldspar was mined to some extent also in the Province of Quebec—the deposits being located in Ottawa County. No development of these properties has taken place during recent years—the distance from the United States factories rendering mining unprofitable. One mine in this region yields a remarkably pure white feldspar, which is in demand for the manufacture of artificial teeth.

SMELTING THE COBALT SILVER ORES

By A. A. Cole.

(Continued from December 1 issue.)

Canadian Copper Company's Cobalt Plant.

The Cobalt plant of the Canadian Copper Company is situated at Copper Cliff, about ¼ mile south of the large copper-nickel smelting plant of the same company.

The works were designed to smelt and treat ores and concentrates from the Cobalt silver district, and have been in operation since December, 1905. This Cobalt plant is to be closed down permanently as soon as the values now on hand are recovered.

Treatment.—The ore is first crushed, ground in a ball mill to 30 mesh, and one-tenth cut out by a Synder sampler. Sampling is completed by coning and quartering. The first quartering divides the sample into two parts, which are worked down as two independent samples. The ore is charged with suitable fluxes in a 30 in. x 72 in. blast furnace, having a capacity of 25 to 30 tons per 24 hours. Limestone from Michigan is used as a basic flux, and low grade Cobalt ore when an acid flux is required.

Products of the blast furnaces are:

1. Silver.
2. Speiss.
3. Fumes containing flue dust, crude arsenic.
4. Slag.

1. The silver button represents an extraction of about 75 per cent. of the silver in the ore charged, and assays about 850 fine. The silver is charged into an oil-fired refining furnace, with a capacity of 30,000 ounces refined silver, which brings the grade up to 980 fine. It is shipped in bars to the Balbach Smelting and Refining Company, of Newark, N.J., for refining, and sold in New York.

The slag from the refining furnace is a revert to the blast furnace.

2. Speiss: The following is an analysis made of a sample of speiss taken over a month's run:

Silver 900 ounces per ton. Arsenic 24 per cent. Cobalt 27 per cent., Nickel 9 per cent., Copper 2 per cent., Sulphur 6 per cent., Iron 20 per cent.

The speiss is ground to 30 mesh, mixed with 20 per cent. salt and roasted in eight mechanically worked Edwards reverberatory roasters, fitted with water-cooled rabbles. Each roaster has a capacity of 2,400 lbs. per 24 hours.

The product or chloridized speiss is taken to the wet house where it is treated in cylinders with water, which dissolves the soluble salts of cobalt, nickel and copper. Solution is decanted and the copper precipitated on iron. The cobalt and nickel are then precipitated as hydroxides by a solution of soda carbonate, converted to oxides in an oil-fired furnace, ground in a pebble mill, and barrelled for shipment. An approximate assay of this material is as follows:

Silver 15 ounces per ton. Arsenic .3 per cent., Cobalt 40 per cent., Nickel 3 per cent.

Nickel runs lower than the usual proportion of nickel to cobalt for the reason that it is less easily converted to a soluble salt by the above treatment than cobalt.

The treatment of the speiss is continued with four covers of hyposulphite of soda solution which eliminates all the silver except 20 to 30 ounces per ton. The silver is precipitated from solution as a sulphide by treatment with a saturated sodium nitrate and 10 per cent. sodium carbonate, heated to redness in an oil-fired roasting furnace, transferred to leaching tanks where it is leached with hot water. This leaves a spongy mass of metallic silver with a small quantity of cobalt and nickel that has not been changed to the soluble state. The spongy mass which contains from 60 per cent. to 65 per cent. silver is added to the bath in the silver refining furnace.

The residues from the first hyposulphite leaching are mixed with quartz and smelted in a blast furnace for the elimination of the iron. The resultant products are:

(a) Slag.
(b) Speiss.
(c) Flue dust and crude arsenic.

(a) The slag, which contains 15 ounces silver per ton, 10 per cent. cobalt, and less than 1 per cent. nickel, is smelted with other high silver slags with pyrite from Capelton, Que.

(b) The speiss from this second smelting has the following approximate composition:

Silver 300 ounces per ton, Arsenic 25 per cent. to 30 per cent., Cobalt 35 per cent., Nickel 25 per cent., with a little sulphur when arsenic is low, Iron 3.5 per cent., Copper 2 per cent.

This speiss is treated as the first speiss up to the time when the first residue leaves the cylinder in the wet house. It then contains about 20 per cent. arsenic, and after mixing with 20 per cent. sodium nitrate and 10 per cent. sodium carbonate, it is given an oxidizing roast in a hand-rabbled reverberatory furnace. This transforms the arsenic to sodium arsenate which is leached out with hot water and discarded. The residue after drying has the following approximate composition:

Silver 20 to 30 ounces per ton, Arsenic .3 per cent. to .7 per cent., Cobalt 35 per cent. to 37 per cent., Nickel 23 per cent. to 25 per cent., Copper 3 per cent., Iron 5 per cent.

Payment is received for the silver in the above product, as well as for the cobalt and nickel oxides.

3. The arsenic from the blast furnace and roasting furnaces is collected in flues and recharged into an arsenic refining furnace. The residue is a clinker high in silver which is returned to the blast furnace. The final product is a refined white arsenic which contains 99.98 per cent. Arsenious Oxide (As_2O_3) with about .3 ounces of silver per ton.

4. The slag from the blast furnace is rejected except when it is found to run over 10 ounces silver per ton, in which case it forms a revert to the smelter.

Power is supplied from the company's plant at High Falls, 14 miles from the smelter. The Cobalt plant requires from 200 to 300 horse power. Eighty men are employed in this plant, working 12-hour shifts.

The following statement shows the ore treated and the production of the Cobalt plant of the Canadian Copper Company since the commencement of operations.

Operations of Canadian Copper Co.'s Cobalt Plant.

Year.	Ore treated. Lbs.	Silver. Fine ozs.	Cobalt.* Lbs.	Nickel.* Lbs.	White Arsenic. Lbs.
1906	1,767,692.5	1,282,692.78	9,021	3,987	....
1907	4,560,627.5	3,829,542.82	331,151	138,427	510,622
1908	9,857,072.5	8,551,582.07	464,171	268,140	942,827
1909	10,651,189.5	8,779,014.55	690,737	463,588	1,242,722
1910	9,792,511.0	8,696,624,87	346,483	260,756	843,619
1911	6,744,108.0	6,584,102.46	238,684	234,323	680,074
1912	3,667,301.0	3,523,207.80	223,163	209,330	476,156
	47,040,502.0	41,246,767.35	2,303,410	1,578,551	4,696,020

*These figures represent the metallic nickel and cobalt contained in crude oxides in which form they are shipped.

Canada Refining and Smelting Co., Ltd.

The plant of the Canada Refining and Smelting Company is located on property owned by the company, consisting of about 11 acres, situated in the southern part of the town of Orillia, Ont., and adjacent to the Grand Trunk, Canadian Pacific, and Canadian Northern Railways.

Construction was started on the 1st September, 1910, and smelting commenced on the 20th February, 1911.

The plant is designed for the treatment of silver ores from Cobalt, and has a capacity of about 13 tons daily. It produces refined silver, white arsenic, and the mixed oxides of cobalt and nickel.

Treatment.—The crushing and sampling of the ore is done at Cobalt by Campbell and Deyell, samplers and assayers, before shipment to the smelter. The ore is first smelted in an Allis-Chalmers 48 in. circular shaft furnace, which produces:

1. Silver.
2. Speiss (argentiferous).
3. Fumes containing arsenic, silver, etc.
4. Slag.

I. The silver button which represents a silver extraction of about 80 per cent. and assays about 900 fine, is refined in a cupel furnace up to 996 fine and shipped. There are two of these refining furnaces each with a capacity of 70,000 ounces to a charge. The slag from the refining furnace reverts to the blast furnace. Limestone and iron ore are used as fluxes when required, the limestone coming from Longford Quarry, 9 miles distant from the smelter, and the iron ore from Midland, Ont.

2. The speiss is ground, roasted, reground, and sent to the Cobalt house. Here it is treated chemically and most of the metals, except the silver ore, are dissolved. The impure silver-bearing mud is separated from the liquor in filter presses and recharged in the cupola furnace.

The iron, arsenic and copper are first precipitated from the liquor and finally the cobalt and nickel are precipitated together as carbonates. The mixed carbonates are heated in a hearth furnace and converted to oxides, w'ich after grinding are barrelled and shipped. The oxides assay about 40 per cent. cobalt and 25 per cent. nickel.

3. The arsenic fumes from the shaft and coasting furnaces are caught in the impure arsenic bag house, from which the arsenic is taken and treated in resubliming furnaces, where silver is retained in the residue and the arsenic drawn off and caught in the clean bag house, from which it is taken, ground and barrelled for commerce.

4. The slag from the blast furnace is discarded except when the silver contained makes it worth retreating, in which case it is recharged in the blast furnace.

About 300 horse power is required by the plant. This is supplied by the town of Orillia at the rate of $18.40 for a 24-hour service per horse power per year, from a hydro-electric installation 18 miles distant from the town.

The number of men employed at the works will average about 80.

Since the commencement of operations, to December 31st, 1912, ore treated and production has been as follows:

Operations of Canada Refining and Smelting Co.

	Ore Treated, Lbs.	Silver, Fine, Ozs.	Cobalt and Nickel Oxides Lbs.	Value.	Arsenic Lbs.	Value.
1911	1,635,488	1,719,743	10,825	$1,796.67	None	None
1912	3,324,545	3,303,641	79,640	13,477.78	250,088	$6,639.69

STORAGE AND MEASURING POCKETS AT NEGAUNEE MINE*

By S. R. Elliott.

In order to be able to handle rapidly two grades of ore and rock at No. 3 shaft, Negaunee mine, three compartment storage pockets were put in. The general plan and dimensions of these are shown in the accompanying drawings. From the centre compartment it is possible to load into either skip. If the grade of the larger tonnage is handled through this compartment, and a little care is used to keep a reserve in the pocket, it will never be necessary to run either skip up empty in order to continue to hoist from either of the other compartments. This may occur with a two compartment pocket if the grades of ore hoisted are of different proportions. With the exception of the front, which is made of wood, the entire pocket is concrete.

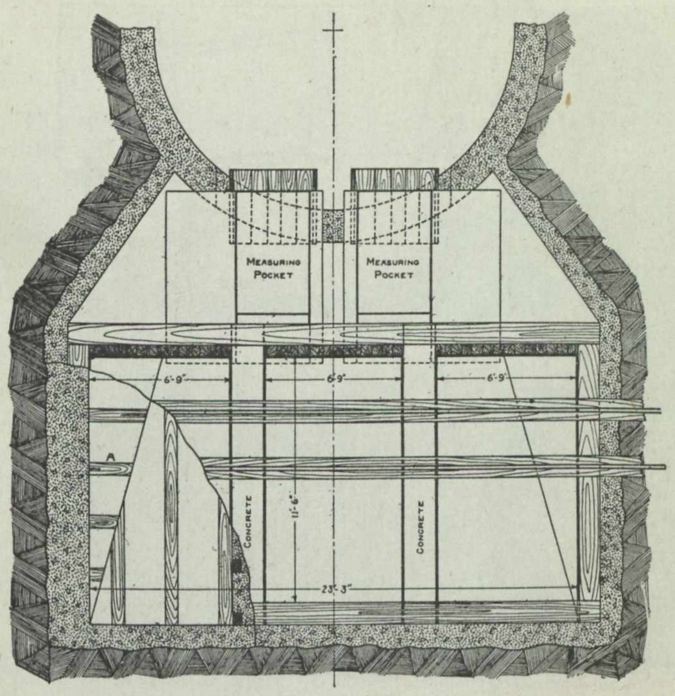
The sides are lined with plates, those in the lower part being one-half inch thick, while those in the upper are only one-quarter inch. The long dimensions of these plates extend horizontally instead of vertically, the object being to gradually decrease the thickness from the bottom, where there is the most wear, to the top where they would last for a great length of time. At intervals of 2 ft. 6 in. on the sides there are 5x7 timbers, to which the plates are bolted. These plates serve as forms behind which the concrete is dumped. As a rule, plates in pockets wear rapidly, due to the fact that they are not on a perfectly solid foundation. They buckle and in a short time ore gets behind them and they are shoved out of position. Plates in a concrete pocket are expected to last until they are completely worn out.

Some means had to be provided for the replacing of the plates when worn out. As the concrete completely fills the space back of the plates, it would be impossible to reach the nuts of the bolts, so the countersunk heads of the bolts were made like the head of a screw. Before dumping in the concrete the threads were well covered with grease to keep it from sticking, and after it had set for a sufficient length of time, so that there was no chance of the nuts turning, every bolt was loosened with a large screw driver and tightened again. When the plates were out the bolts can be removed and other plates put in position, the same nuts being used as many times as necessary, as they are firmly imbedded in the concrete.

Head Works, Negaunee Mine

The bottoms of the pockets are made out of two thicknesses of 3 in. hardwood plank, spiked to 5 x 7 in. timbers, placed at intervals of 2 ft. 6 in. Behind these

*Extract from paper entitled "Method of Raising, Sinking and Concreting, No. 3 Shaft, Negaunee Mine," presented at Houghton meeting of L. S. M. I., August, 1912. Photos by R. E. Hore.

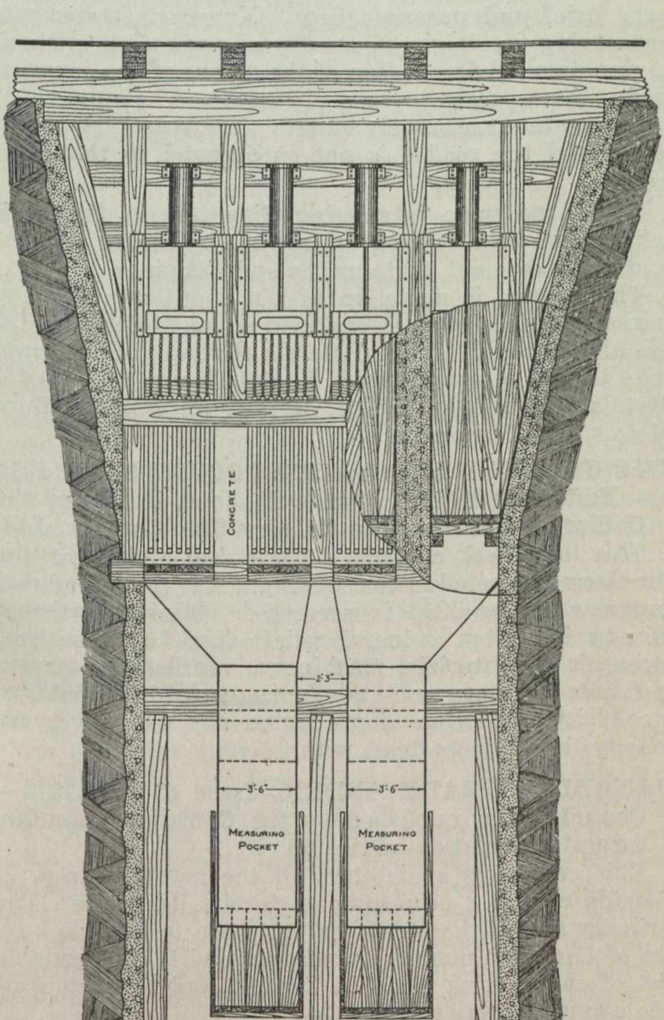


Storage and Measuring Pockets, Negaunee Mine.
(Plan)

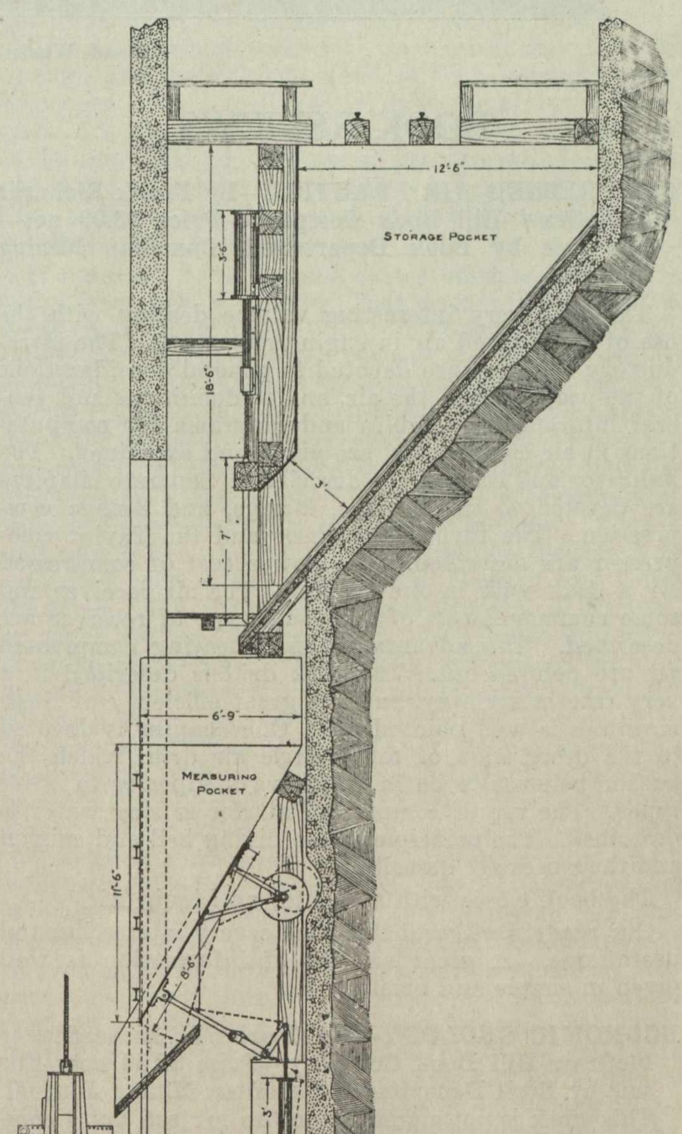
planks concrete was also dumped. When the upper planks wear out they will be removed and replaced by others.

Measuring Pockets.

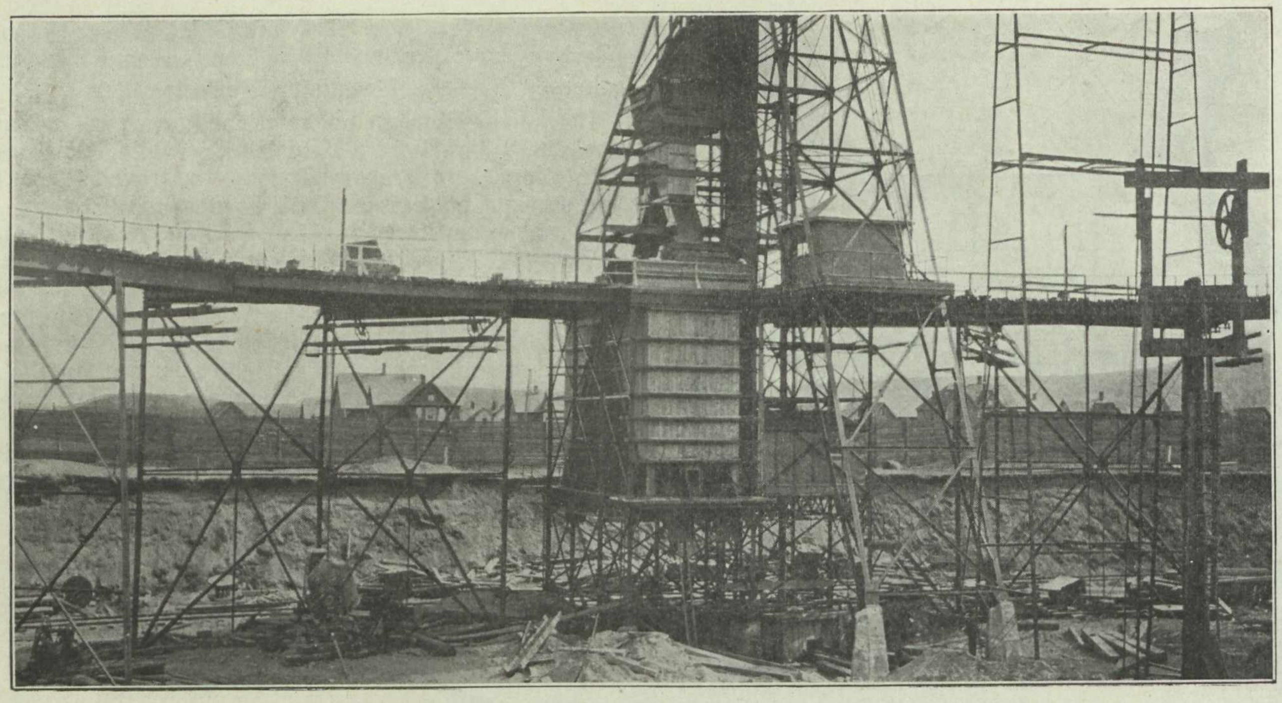
Below the storage pockets there are two measuring pockets, which hold a skip load. While the skips are in motion the operator has time to draw the ore from the storage pockets and fill a measuring pocket. As soon as the empty skip is in position, it can be immediately filled by simply tripping a lever. One great disadvantage in the common style of measuring pocket is that the door opens towards the skips. If, for any reason, the operator fails to close the door before giving the signal to hoist, it will be torn out by the skip, causing great delay and damage. In order to avoid this possibility, and to make the operation as near "fool-proof" as possible, the pockets were designed with the doors opening away from the shaft. The ore falls on a slide from which it runs into the skips. The doors are made of two thicknesses of one-half inch plate, strongly braced by angle iron. They are counterweighted, closed and opened by small air cylinders. These have been found to work most satisfactorily and very rapid loading is possible.



Storage and Measuring Pockets, Negaunee Mine.
(Front Elevation)



Storage and Measuring Pockets, Negaunee Mine.
(Side Elevation)



Head Works, Negaunee Mine.

BOOK REVIEWS

COMPRESSED AIR PRACTICE—By Frank Richards —McGraw Hill Book Company—Price $3.00 net— For sale by Book Department, Canadian Mining Journal.

This is a very interesting volume dealing with the use of compressed air in engineering work. The introductory chapters are devoted to general considerations of the properties of the air, and to definitions and general information. Tables and diagrams for computations in air compression are given and explained. The indicator and its uses are described. Separate chapters are devoted to single stage, 2-stage, and 3-stage compression. The turbo compressor and the Taylor compressor are described. The power cost of compressed air is dealt with in one chapter. The air receiver and some common faults of the usual type of receiver are described. The advantages of re-heating compressed air are pointed out. The rock drill is described in a very interesting way, and the great efficiency of these machines is well pointed out. One chapter is devoted to the description of the electric air drill, which the author believes to be in many ways superior to other types. The use of compressed air for raising water is described. The principle of the diving bell and caisson and their uses are described.

The book closes with a chapter on Liquid Air.

Our readers will find this book a very interesting and useful one. A great amount of information is well given in simple and brief form.

ECONOMIC GEOLOGY—By Charles H. Richardson— McGraw Hill Book Company—Price $2.50 net—For sale by Book Department, Canadian Mining Journal.

This work is not a treatise on the subject, but a compilation of notes used in connection with a series of lectures. For the students for whom it is written, it will doubtless be very useful. It is doubtful, however, whether the work will find other fields of usefulness.

The description of many important ore deposits is very brief and unsatisfactory. Numerous statements concerning the origin of ore deposits are made without giving detailed description of the nature of the deposits, and without presenting any argument. The opinions of many writers are merely stated. The reasoning is not given and the reader is not encouraged to think for himself.

There are some interesting diagrams in the book which have been taken from reports by earlier writers, and a few original photographs and drawings.

The volume is made up of ten chapters. Ore Deposits; Origin of Ore Deposits; Precious Metals; Useful Metals (Group 1); Useful Metals (Group 2, Sub-Group A); Useful Metals (Group 2, Sub-Group B); Useful Metals (Group 3); Useful Metals (Group 4); Rare Metals, and Economics.

THE COLLIERY MANAGER'S POCKET BOOK, 1914 —Edited by Hubert Greenwell, Joint Editor of the Colliery Guardian—The Colliery Guardian Co., Ltd.

This little book contains a great deal of information for those interested in coal mining. A review of mining progress during 1913 is presented. Mining statistics, mining institutes, miners' relief fund, examinations, strength of materials, machinery, ventilation, surveying, uses of rescue and ambulance, general regulations, electricity, valuation, depreciation and explosives are among the subjects dealt with.

CANADIAN TRADE INDEX—Issue of 1913-1915— Compiled and published by the Canadian Manufacturers' Association—Price $3.

This volume is a directory of the manufacturers in Canada classified according to the articles made. The primary aim of the publishers has been to provide buyers of Canadian manufactured goods with a dependable list of the articles made in Canada, and the names of the manufacturers making them.

In addition to the very complete index which forms the major part of the volume, there is considerable useful general information. The book should prove to be very useful to buyers of all classes of manufactured articles.

THE MODERN ROCK DRILL*

By W. L. Saunders.

The mining drill at the present time is a machine which weighs from 60 to 150 lbs. It is largely a one-man machine, though under many conditions of work it is still best to add a helper. The percussive or piston type still holds its supremacy for heavy work, even in mines where large stopes are encountered, as, for instance, at the Homestake, but this percussive drill is now a machine which safely withstands pressures of from 100 to 110 lbs. and its weight has been considerably reduced because of changes made in both design and material. This type of drill now used in the stopes at the Homestake weighs 137 lbs. unmounted, and mounted on column with arm about 375 lbs. Its work is chiefly in down-holes. Each part of the machine represents a study in material. The metal itself and the treatment it receives in the shops are both regulated in accordance with the work that each particular part has to perform. All our knowledge of metallurgy is taken advantage of in the construction of the drill. The cast iron is not ordinary cast iron. It resembles it only in that the metal is cast. The composition is made up to suit rock-drill service and the metal is treated with special reference to the work it is to do. The steel is not common steel, but it is alloyed to suit each particular part. It receives a hot, crude oil bath and it goes through many processes before it is finally coupled up with the other parts into a complete drill. Special metal and special treatment are not confined to the piston or percussive type, but they apply equally to the hammer type. In fact, it was because of the necessity for lighter weight and greater strength in the hammer type that the study of the metallurgy of the rock drill was initiated and carried to a successful issue.

The first great improvement made in the piston or percussive type has been in the metal used, and this has resulted in greater strength, greater durability, and a lighter weight of machine for higher pressures. There has also been a change in design, which in the main has been confined to the valve motion. The chief aim of the designer has been to get greater speed. This means a greater number of blows, and in order to do this valves have been provided which open and close quickly and which have large ports. It is obvious that, other things being equal, a piston type of drill of large piston area will do more work than the same type of drill with a smaller area. The larger machine, which drills more, is handicapped by its weight, and when the net efficiency is figured up it has been found that it sometimes pays to get less drilling capacity with a machine which is more readily handled. Here the question of upkeep is introduced, because generally speaking the heavy type of machine costs less for repairs than the lighter type. The designer, taking all these things into consideration, has sought to increase the diameter of the piston so as to provide the drilling capacity of the heavy type with a machine of considerably less size and weight. This has in a measure been accomplished by the use of superior material and a design which shortens the piston, putting the extra bearing into the front head, where it is lighter. Through the use of a type of valve known as the butterfly a quick opening of large area is provided, thus increasing the number of strokes and thereby bringing up the drilling capacity. This has been done with no increase in air consumption that is not compensated for by increased drilling power.

Air consumption in rock drills is much misunderstood. Assuming that the piston and valves are tight, in other words, where there is no leakage, air consumption is usually dependent upon the number of strokes delivered. It is assumed, of course, that a constant diameter and length of stroke are used and that the pressure is uniform. It is plain that if we are able to utilize air or steam at 100 lbs. gauge pressure for the full length of stroke when a percussive drill delivers its blow we are going to get the best results in drilling capacity; that is, we are going to get the hardest blow that is commensurate with the diameter, length of stroke, and pressure of the machine. If this blow is too hard, that is, if it breaks the steel, destroys the bit, or creates a condition where the drill is unmanageable on its mounting, then we have the alternative of reducing the size of the machine and in this way getting lighter weight, which is always desirable when it is consistent with the other conditions. We all know that the class of rock usually determines whether or not we are striking too hard a blow, but assuming that the class of rock is uniform, or that it is determined and understood, the engineer is obviously justified in providing a drill which will strike the hardest blow that the machine and the rock will stand without destructive consequences. We see, therefore, how important it is to start with a machine which has a valve motion and ports so designed that the full power pressure will follow the piston the full stroke until the blow is delivered. Having this condition, as light a machine should be used as will stand up to the work.

It naturally occurs to one that a quick-opening valve and a large port will bring about greater speed, but the question is asked, is not this condition wasteful in air consumption on the return or back stroke? It will be generally admitted that it pays to get the blow, but why should the same conditions that give us the blow obtain when the piston returns for another stroke? There are two reasons why this is advantageous. One is, that the pull-back on a piston type of rock drill is sometimes of as great importance in the long run as the blow. A weak pull-back reduces the speed of the machine, causing it to come back more slowly than it went forward, and it has the further disadvantage that holes that are not straight, or which are out of round, and where seams and other irregularities are encountered, will act to retard the steel during its reciprocations. This considerably reduces the efficiency of the machine, not only because it cuts down the number of blows delivered, but because it weakens the strength of blow. The steel is held back in its effort to reach the full stroke and a laboured blow, with sometimes a shorter stroke, is the result. Now it is quite true that in good, clean, hard rock, without seams, and where holes are drilled to reasonable depths, it might pay to save air on the return stroke. As a matter of fact, this is always done in a piston drill because the diameter of the rod must be subtracted from the piston area. The percussive piston type of drill is naturally a compounded machine which hits a harder blow forward than backward, because it has the full piston area at one end and a reduced area at the other. It is not a difficult matter to regulate this to any degree desired by increasing or decreasing the size of the piston rod or by increasing or decreasing the valve and port areas on one end of the stroke and not on the other. But every attempt to compound a piston type of drill by putting a pressure in front of the piston is a mistake. Just in proportion as a pres-

*Extract from paper presented at Butte meeting, A.I.M.E., August, 1913.

sure is introduced in the front end it would cushion or restrict the force of blow, and in doing this, as has been previously pointed out, we make it necessary to increase the weight of the machine in order to get the effective maximum blow. It is, therefore, a very dangerous expedient in the design of piston drills to attempt to compound the stroke. Reduced air consumption is easily effected at the sacrifice of efficiency. Air at 100 lbs. is delivered to a percussive drill at a cost that varies from 40c. to $2 per day. To save 25 per cent. of this is all that compounding could reasonably be expected to accomplish, and this at the maximum is only 50c. a day. Experienced engineers will have no difficulty in seeing that there are many ways underground by which this and larger amounts may be lost through a machine which must inevitably be weakened in certain other directions in order to effect a small saving in air economy. Under most conditions of service it pays to conserve labour and upkeep expenses, giving first consideration to those things which cost most. A small reduction in drilling capacity, or a few idle hours, means an expense which will easily run in excess of any possible saving in air.

The hammer type of drill is a natural air saver, and it is in the design and construction of this type that air economies may be effected safely and without sacrifice. The hammer drill is essentially a machine for mines. It represents the evolution of the rock drill from the piece of steel struck by a hammer through the various stages of percussive machines back again to the hammer-driven blow upon the steel, the difference being only that the blow is a rapid power blow. A hammer drill is economical in air consumption because, in the first place, it reciprocates a light plunger which weighs only a few pounds, while with the piston drill not only must the heavy piston be thrown backward and forward at high speed, but it carries with it the steel and bit. In hammer drills the power is utilized, not in overcoming the inertia of a heavy body, but in compensating for that inertia through the high speed of a light body. A heavy mass moving slowly may give the same impact of blow as a light mass moving rapidly. The effective work done at the bottom of the hole is represented by the weight multiplied by the velocity. The same effect may be produced by subtracting from the weight and adding to the velocity, or vice versa. In a piston or percussive drill, velocity is limited, while in a hammer drill it is practically unlimited, and here is where the great possibilities of hammer drills have come in.

We must always bear in mind in comparing piston and hammer drills that the piston drill is handicapped by the load of the piston and steel, which has a certain inertia difficult to overcome in our efforts to reach high speed. The stroke is necessarily short, and as the hole gets deeper this handicap of weight is increased by longer steels, so that we are driven to high air pressures in order to get high speed. High air pressures naturally cost more money than low air pressures, and, as has been shown, if we attempt to save air by compounding we limit the capacity of the drill to force itself through difficult places. In holes at or near the horizontal there is always an added disadvantage in a percussive type of drill, due to the steel dragging in the hole. This will take place even in a clean, straight, round hole. The steel sags, and in sagging, and during the process of rotation, there is considerable friction loss within the hole. All this leads us to high pressures, which is only another expression for greater power. It is safe to say that the piston type of drill has reached its limit when we consider capacity as a limitation when rating efficiency. In down-hole service, especially for deep holes and in soft rocks, piston drills will always be useful. The pumping action of the bit serves to agitate the material at the bottom, especially when mixed with water, and in this way the hole is kept more or less clean under the bit.

The study of rock-drill economics has led the mechanical engineer into the hammer-drill field as one which offered the greater possibilities. The problem was to do more work and with a lighter machine. The next consideration was to accomplish this with a reduced labour and power cost. All of these conditions have been met and, as subsequent figures will show, extraordinary results have been obtained which have materially reduced the cost of excavating rock and ore. We have seen that the process has been one of return to primitive methods. In other words, we have done what is most natural, and that which conforms closest to the laws of Nature is invariably best. The natural way to drill rock is to strike a piece of steel with a hammer. The only reason why the miner does not continue to do things in this way is because he cannot strike a sufficient number of blows. Just in proportion as he uses a heavier hammer does he reduce the number of blows that he is able to maintain and with the lighter hammer he is brought to an absolute limit. It would seem that the first thought of the engineer would have been to follow the old miner by building a rock drill on the hammer type. He may have thought of this, but the problem proved to be a very difficult one. The first difficulty was to get material that would stand up against this rapid-fire system. Then came the question of rotation, which was not easy to accomplish with a machine of the hammer design. Of equal importance was the question of keeping the bottom of the hole clean, because the bit being practically stationary at the bottom, the cuttings from the hole would pack between the edges of the bit and the bottom of the hole and prevent further progress. Jets of steam, of air, and of water were used to discharge the cuttings. Steam has many disadvantages, air is expensive and it creates dust, while water is, in the first place, difficult to introduce into the bottom of the hole, its mixture with parts of the drill results in wear and tear, and to use much water is a disadvantage and an expense in underground work. Up-hole work offers less difficulties for hammer-drill service than any other. The cuttings drop by gravity out of the hole and the only disadvantage is dust. Horizontal hole work is that which is most difficult, while with down-holes water thrown into the hole always serves a useful purpose. A mixture of air and water has solved most of the problems arising from the use of hammer drills in mines. This is known as the Leyner system. Air is always available and is readily conducted in the hole, using either live or exhaust air. Where this air is commingled with water it discharges the cuttings from the bottom of the hole without blowing them away in the form of dust, but by simply reducing them to a puddle condition with enough water only to create a moderate stream, which discharges the cuttings through the orifice of the hole. This keeps the bit cool, there is enough puff to the air to remove the chips, and a long experience under all conditions of service has demonstrated conclusively that a mixture of air and water is more effective in cleaning the hole than even a large stream of water alone. In fact, air is the ideal thing to use, and it would be used alone were it not for the dust, so that the present system introduces only enough water to lay the dust. In doing this we effect economies by using only a small amount of water mixed with air from the exhaust.

The pneumatic tool, especially the type known as the riveter, illustrates the mechanical principles involved in the hammer drill. It is likely that the perfection of the pneumatic tool led to the perfection of the hammer drill. A riveter combines an extraordinary amount of power.

Its efficiency is very high because the hammer speed is high, and the machine is light and easily handled. Its use in steel and iron construction is now universal. Air consumption in a tool of this nature is low in proportion to the work it does, because the thing reciprocated by the air is so light that it is easy to get high speed without sacrificing power to overcome inertia. In other words, there is a closer relation between the air pressure and the speed of hammer, with the resultant effective blow.

A point not to be lost sight of is that the rapid reciprocation of a flying piston, as in a hammer drill, is very much more easily mounted or held by an abutment than where we have a reciprocating action of a heavy weight, as in the case of a piston drill. The reasons for this are obvious. High speed of a light hammer takes the place of slow speed of a heavy hammer. One is like the rapid reciprocations of a hand hammer, the other the ponderous swing of a sledge. So great an effect is obtained by this rapid, light blow that it has been found practicable to reduce the weight to a figure considerably under 100 lbs. in a machine which in drilling capacity compares favourably with a piston drill of two or three times the weight. In this light machine, material alone has not enabled us to cut down the weight, but the light rapidly moving piston design, with the quick-opening valve, is of equal importance. It would surprise a drill runner of 10 years ago to learn that hammer drills are used to-day in hard rock, putting in holes 10 and 15 ft. in depth without even mounting the drill, it being held in the hand of the operator. Of equal importance in tunnel driving is the fact that by the use of hammer drills the equivalent of heavy machines is placed in the headings mounted upon a light horizontal bar, this bar being easily handled by a few men, yet it affords abutment enough to resist the jar, because the jar has been reduced to a minimum. Heavy upright columns, carriages, and other forms of support were made necessary because of the ponderous pulsations of the piston drill. To be able to use a light bar, placed horizontally, is of the greatest importance in tunnel driving because it affords an opportunity to begin drilling quickly after a blast and before the muck has been cleared away from the bottom of the heading. This has been referred to in detail in the paper of D. W. Brunton, Notes on the Laramie Tunnel.

An effort has been made in the foregoing statements to analyze and give reasons for a condition in rock-drill service which is now in practical operation.

A hammer drill is the modern progressive miner. It has practically done away with hand drilling and in doing this it has largely increased the field of service. There is no longer any question about the fact that it pays to use power drills in all classes of mining. It is now entirely a question of adapting the system of mining to these light, efficient, handy perforators. In August, 1912, there was held at Calumet, Mich., what is perhaps the last contest between hand and power drilling. A three-man double-jack team of the best drillers in the copper country was pitted for a money prize against a small hammer drill of the Butterfly type. This machine was operated by one man. The drilling was in a block of Cape Ann granite, 60 in. thick. The three-man drilling team started with a 1¼-in. bit and finished with a ⅞-in. bit. The one man with the Butterfly (this is a light hand hammer drill, of the usual plugger type, weighing about 40 lbs.) used a 2-in. starter and finished with a 1¼-in. bit. It required 14 min. for the machine to drill entirely through the block (60 in.), while the hammer-and-drill squad put in a 49-in. hole in the same time. The machine did 20 per cent. more work with one-third the labour cost. As a matter of fact, no such rate of hand drilling as was shown by the three-man squad could be maintained over a working shift, while there is no reason why the machine drill should not keep up its speed indefinitely.

ANNUAL REPORT OF THE GRANBY CONSOLIDATED CO.

The annual report of the Granby Consolidated Mining, Smelting and Power Co., Ltd., for its fiscal year ended June 30, 1913, was made public at the annual general meeting of shareholders, held in New York City, on October 7. It shows an operating profit of $1,214,599, or a little more than $8 a share on its 150,000 issued shares. This compares with net earnings of $583,379 for the fiscal year to June 30, 1912, during which year, however, mines and smeltery were idle four months, besides having during three months of smelting operations the higher cost of Pennsylvania coke when none was obtainable from Crowsnest collieries.

Figures showing production and average prices of metals, and gross receipts for same, follow, with figures in brackets for the immediately preceding fiscal year for purpose of comparison: Copper produced, 22,688,614 lbs. (13,231,121 lbs); silver, 324,336 ozs. (225,305 ozs.); gold, 47.266 ozs. (33.932 ozs.). Gross receipts for products, $4,782.691 ($2.874.760). Average prices of metals were: Copper, $0.1604 a lb. ($0.1558); silver, $0.6118 an oz. ($0.5906); gold, $20 an oz. ($20).

The year's net earnings available for dividends were reduced to the extent of $80,665 by fixed charges, which represent the interest on its $1,500,000 of bonds issued last May, and by $829 charged to depreciation, says the Boston Commercial. Its final net earnings per share, therefore, amounted to $7.55, and its surplus above dividends for the year was $683,149.

In the year to June 30, 1912, Granby Co. charged $979,461 to its Hidden Creek mines investment, that amount having been expended out of its treasury surplus. In 1913 no charge was made to its Hidden Creek investment, its expenditures on the equipment of its new property having been paid for with the proceeds of its bond sale. The actual investment at the Hidden Creek property the past year amounted to $1,958,724; altogether this property and its equipment represents an expenditure by the company of $2,038,185 to the end of the last fiscal year.

On June 30, 1913, the company had a surplus of cash and liquid assets over current liabilities of $2,587,924, which Mr. Geo. L. Walker calculates equals $17.25 a share of its stock.

President William H. Nichols says: "The ore reserves at the mines at Phoenix have not been fully maintained, being now reduced to 5.613,000 tons and the recoveries are reduced to 17.68 lbs. of copper per ton of ore. The cost per ton of ore was the lowest in the history of the company.

"At the Hidden Creek mines, Anyox, Observatory inlet, the ore reserves have been materially increased, the estimates now being 7,759,000 tons, carrying 2.2 per cent. of copper, which is regarded as ample advance provision for the 2,000-ton smelter now approaching completion. It is confidently expected that smelting will be commenced early in the new year."

Last year's directors were re-elected, and at the organization meeting the former officers were reappointed with the exception that Mr. F. M. Sylvester was made general manager, succeeding Mr. Jay P. Graves, who remains a vice-president of the company.

PERSONAL AND GENERAL

Mr. John R. Rutherford has resigned his position on the engineering staff of the Hollinger Gold Mines, Porcupine, Ont., to accept a position as superintendent at the Motherlode Gold Mine, Sheep Creek, British Columbia.

Graduates of the Michigan College of Mines who are located in the Cobalt district will meet at Haileybury on January 3 for the purpose of organizing an M. C. M. club.

Mr. C. A. Foster has returned from England, where he was successful in interesting capitalists in the Kirkland lake district, Ontario.

Mr. J. B. Tyrrell has returned from England.

Mr. Charles Fergie has been elected president of the Intercolonial Coal Co., succeeding Mr. D. Forbes Angus.

Mr. J. A. Dresser, manager lands department, Algoma Central and Hudson Bay Railway, announces that 2,000 square miles of the company's land are now open for public prospecting.

The Canadian General Electric Co. has issued a bulletin describing storage battery industrial and mining locomotives.

A meeting of the Toronto branch of the Canadian Mining Institute was held on December 13. The next regular meeting will be held on January 10.

The Smart Turner Machine Co., Limited, Hamilton, Ont., are supplying Messrs. Armstrong, Whitworth, of Canada, Ltd., Longueuil, Que., with one of their Duplex pumps.

The Toronto branch of the Canadian H. W. Johns-Manville Co., Limited, announces its removal to more spacious quarters at No. 19 Front street east. This new store and warehouse has a floor area of approximately 35,000 square feet, and is situated in the heart of the wholesale district.

COAL MINE ACCIDENTS IN THE UNITED STATES

The lack of comparable and accurate statistics of coal mine accidents in the United States has led the Bureau of Mines to collect such data, and the results of these investigations have been compiled by Mr. F. W. Horton, in Bulletin No. 69, entitled "Coal Mine Accidents in the United States and Foreign Countries," which has just been issued. This report shows that during 1912, 2,360 men were killed in the coal mines in the United States, as compared with 2,719 for 1911, and that the fatality rate was lowered from 3.73 in 1911, to 3.15 per 1,000 men employed in 1912. The report contains statistical information concerning the production, the number of men employed and the number of men killed in each State since 1896. From 1896 to 1907 the number of men killed per 1,000 employed gradually increased with only slight fluctuation, the number killed per 1,000,000 short tons also increased, but the rate fluctuated over a wider range.

During this twelve-year period through 1907, the increase in the death rate was accompanied by an enormous increase in the production of coal. In 1896 the output was 191,986,000 tons, and in 1907 it was 480,363,000 tons, an increase of over 150 per cent. In 1896 each man employed produced 2.64 tons coal per day, whereas in 1907 the daily production of each man was 3.06 tons, an increase of 16 per cent. Since 1907 there has been a marked decrease in the number of fatalities at the coal mines.

This general improvement has been brought about by a combination of causes, the principal one of which has been more efficient and effective mine inspection on the part of the State Mining Departments and the State mine inspectors throughout the country, supplemented by greater care on the part of both operators and the miners. The investigative and educational work of the Bureau of Mines has kept both the operator and the miner alive to the various dangers connected with coal mining, and has shown what precautions should be taken to avoid these dangers. As a result of these educational features, mining companies are organizing safety committees; providing emergency hospitals, training men in first aid and rescue work, so that in case of a disaster they are equipped to cope with any ordinary accident.

The fatality rates in a number of countries covering a period of ten years, 1901 to 1910, inclusive, are as follows:

Great Britain, 1.36 per 1,000 men employed; Germany, 2.11; France, 1.69; Belgium, 1.02; Japan, 2.92; Austria, 1.04; India, 0.96; New South Wales, 1.74; Nova Scotia, 2.65, while the rate for the United States was 3.74. The low fatality rates in some countries may be accounted for largely by reason of the fact that coal mine inspection has been in operation much longer than in the United States. In Great Britain the coal mine accident statistics have been collected, published and studied since 1851; France, 1853; Austria, 1875; Germany, 1852; and Belgium, 1831.

A chronological list of the more disastrous coal mine accidents in the United States shows that 275 accidents have occurred since 1839, in which five or more men were killed at one time, representing a total of 6,777 fatalities. Of these accidents there were 135 that killed from 5 to 9 men each, a total of 859; 82 that killed from 10 to 24 men each, a total of 1,237; 25 that killed from 25 to 49 men each, a total of 870; 18 that killed from 50 to 99 men each, a total of 1,221; 11 that killed from 100 to 199 men each, a total of 1,534; 3 that killed from 200 to 299 men each, a total of 695, and 1 that killed 361 men.

Of these larger disasters gas and coal dust explosions caused 183 accidents and 5,111 deaths, or over three-fourths of the total number of men killed. The next greatest number of deaths were from mine fires, which caused the loss of 1,082 lives, or over 15 per cent. of the total number killed, by 33 separate accidents. It may thus be seen that accidents from gas and coal dust explosions and mine fires account for more than 90 per cent. of the total number of men killed in these large accidents, although falls of roof, pillars and wall claim nearly 50 per cent. of the total fatalities.

ORE AND FUEL TESTING PLANTS.

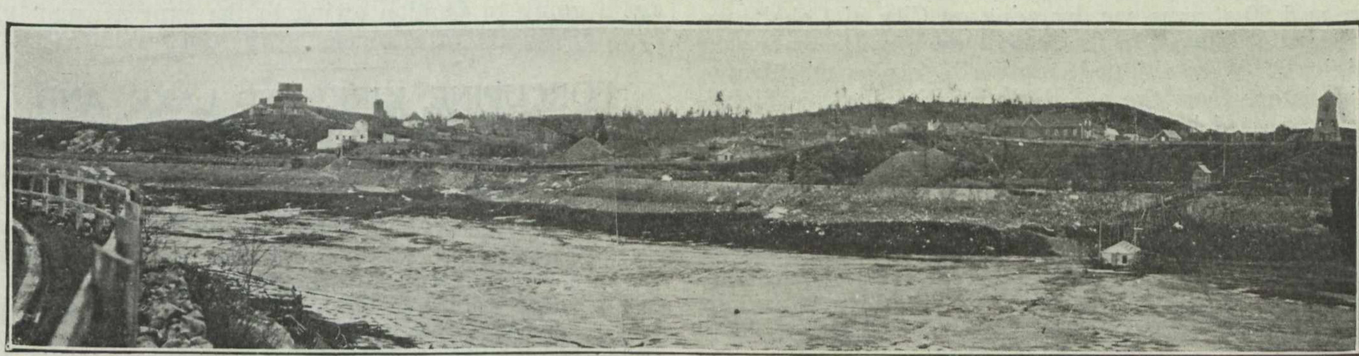
The Mines Branch of the Department of Mines has installed at Ottawa a modern and well equipped laboratory—The Dominion of Canada Ore Dressing and Metallurgical Laboratory—for the purpose of experimental concentration and metallurgical tests with Canadian ores and minerals.

There are also ore testing plants at the principal mining schools in Canada, including the Nova Scotia Technical School, Halifax, N.S.; the University of McGill, Montreal; Kingston School of Mines, Queen's University, Kingston; and the University of Toronto, Toronto, Ont.

SPECIAL CORRESPONDENCE

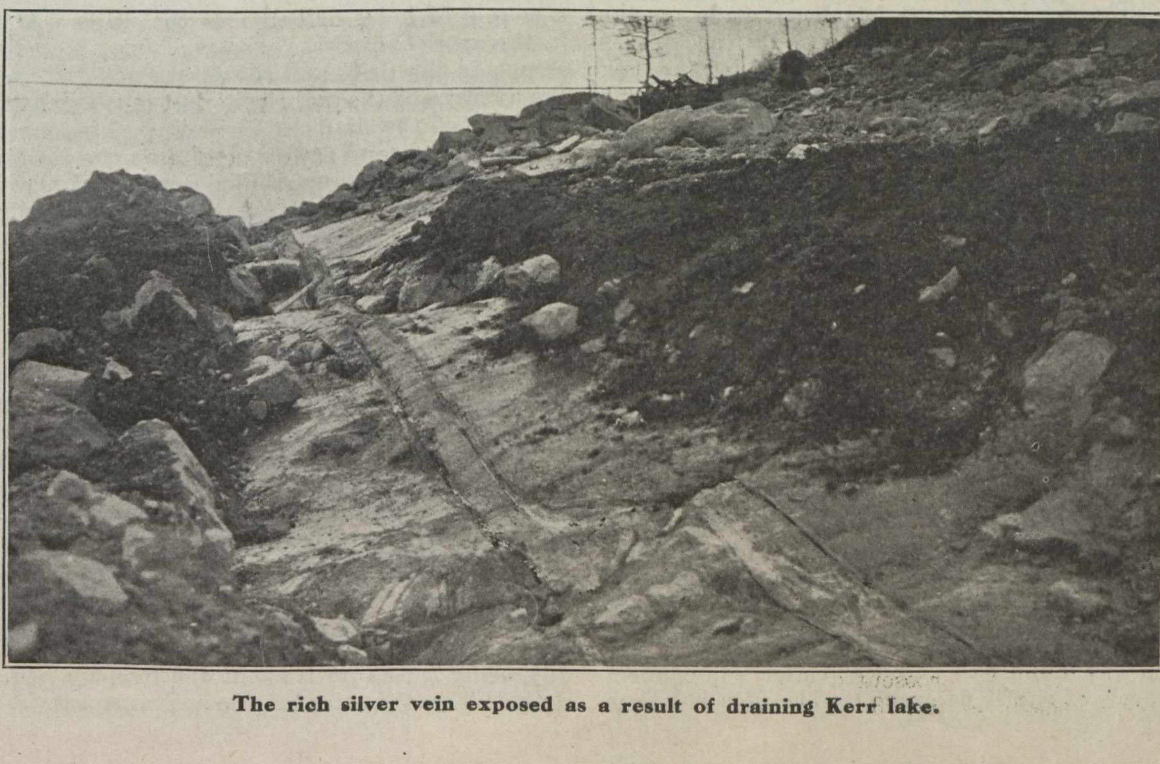
COBALT, GOWGANDA AND ELK LAKE

To Drain Cobalt Lake.—Interests antagonistic to the draining of Cobalt lake have been reconciled to the scheme and there was little opposition before Mining Commissioner Godson at the hearing at Haileybury. A preliminary hearing was held in Toronto and most of the claims of the mining companies concerned were met and dealt with. At the last moment the Cobalt Board of Trade found that they will be put to heavy expense to construct sewers and other works necessary to take care of the sewage, which is now flowing into Cobalt lake. An agreement had been entered into with the town council of Cobalt, but this did not define the rights of the town in the matter and did not provide for a right of water for the sewer on the Cobalt Lake property. As a concession to the sentiment that was aroused another agreement was drawn up defining the rights of the town, it being conceded that the town would have to pay the cost of the sewers in return for the revenue to be derived from the ore tax on the Cobalt lake when it comes within the boundaries of the corporation of the town of Cobalt. There are a few other small claims yet to be satisfied, but, in the main, the way seems clear for the draining of the lake early next spring.



Kerr lake basin after removal of the water.
Caribou Cobalt (Drummond) buildings at left, Kerr Lake Co's property and pumping plant at right.

McKinley-Darragh-Savage.—The production for the month of November from the McKinley-Darragh and the Savage mines amounted to 187,800, as compared with 192,749 oz. in the preceding month. Of this the Savage contributed 58,008 oz., of which 42,000 was high grade and the remainder concentrates from the dump and development. The shoot of high grade ore found last month at the 140-ft. level of the Savage proved to be 60 ft. long. In the bottom of the winze 8 ft. below the level the vein is 2 in. wide of two thousand ounce ore.



The rich silver vein exposed as a result of draining Kerr lake.

Heavy low grade shipments from several mines, notably the Cobalt Townsite, in the month of November raised the gross tonnage from the camp higher than for any month in the past two years with the single exception of December of last year. The total shipments reached the figure of 2,170.10 tons from 15 mines.

The new Northern Customs mill is now dropping stamps and will take over the entire contract of the La Rose from the Cobalt Townsite mill before the new year. To construct and finish a mill in so short a time has broken all records in Eastern Canada at least. At the old Northern Customs mill, now the possession of the Cobalt Townsite, 100 stamps are treating Townsite ore and 20 stamps are dropping on City of Cobalt ore.

Right of Way.—In the second week in December the Right of Way shipped another car of concentrates. This is ore from the old Right of Way dump which is being treated in the Colonial mill.

The bullion shipments for the year have now passed the $5,000,000 mark. The Nipissing has produced more than two-thirds of the total.

Pan Silver.—More stock is being offered by the Pan Silver Mining Company in order to carry on development. At the annual meeting in Haileybury it was decided to issue 350,000 shares of treasury stock at 10 cents a share in order to carry on development on the property.

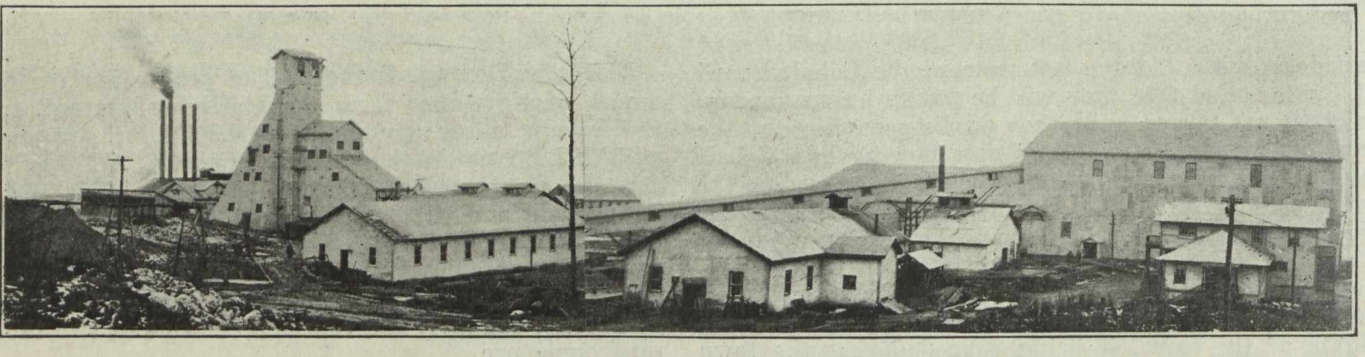
drifted on for 95 ft. The present west face shows but little vein and no values. The vein in the east face assays two thousand ounces over a width of one and a half inches. The average for the 95 ft. is about 1,500 oz. over one inch.

The hydraulicking operations have been discontinued for the season. All the work that is to be done on Nipissing property tributary to Cobalt lake has been done, and next spring the water will be taken from Peterson lake and will flow back into that lake.

The high grade mill treated 173 tons and shipped 516,857 ozs. of refined silver. The low grade mill treated 6,334 tons. The bullion from the Nipissing is again going to London owing to the express company having brought rates almost to the old level.

PORCUPINE, KIRKLAND LAKE, AND HARRICANAW

Hollinger.—Within the past month the Hollinger has done some very effective exploration with the diamond drill. In the face of the main vein at the 200-ft. level there has not been much ore for some time. As drills were so badly needed in other parts of the mine this face was left standing without much effort being made to pick up the extension, if there were extension. Recently one of the diamond drills which the Hollinger keeps for exploration work was set up in the drift and



Hollinger mine buildings and mill, Timmins, Ont.

a couple of holes drilled into the walls. About 20 ft. in the extension of the vein was cut. It has now been struck in the drift and shows ore not quite as wide as the average of the main vein, but much richer in grade. The use of the diamond drill in picking up extension of veins has been very successful on the Hollinger. The development of the subsidiary veins of the Hollinger has now reached a point where they are yielding a good portion of the daily tonnage of ore going to the mill. This accounts for the decrease in grade of the ore in the past two months. The smaller veins of the Hollinger are of lower grade than the No. 2, and it is therefore seen that the bigger the proportion of the ore that comes from their development the lower the grade to a certain point. At the present time the power plant of the Hollinger is not adequate for the growing needs of it and the Dixon. Another plant of a permanent nature has been planned and will be proceeded with at once. When this is finished it will take care of the Hollinger power needs for some time to come.

Dome.—Good progress is being made with the addition to the Dome mill, and it is expected that the first crushing of ore can be undertaken in April. As the returns made monthly now show the tonnage is gradually being raised until about 460 tons are being treated daily. The objective of the management is to mill a

Beaver.—The final payment has been made on the Beaver Auxiliary property at Elk lake by the Beaver Consolidated Company. A lack of water at the Elk lake prospect has handicapped development for some time; but a small lake in the neighborhood has now been dammed and the difficulty has been overcome.

At Gowganda the people refuse to be satisfied with the concession promised by the T. & N. O. Railway Commission in the way of a motor car service and an efficient telephone line. The Board of Trade passed a resolution asking for the extension of the railroad.

Nipissing.—During the month of November the Nipissing mined ore of an estimated net value of $159,220 and shipped from Nipissing and Customs ore an estimated net value of $367,153. At shaft 73 a crosscut at the fourth level continues to encounter extensions of branch veins showing at the third level. One was cut in October and two in November. Those found in November have widths of from one to two inches and assay two thousand ounces. These veins are within a few feet of the Keewatin contact. It is expected that they will increase in width and values when drifting is done on the conglomerate side.

A new vein was discovered at the third level of 64 shaft. This was found by a crosscut which will connect the third levels of shafts 64 and 73. The vein has been thousand tons per day with the enlarged mill, but it is not expected that this end will be obtained until the whole of the eighty stamps have been dropping for some time.

Dome Lake.—It is reported that no time will be lost in starting up again at the Dome lake under the new management. The Timiskaming and Hudson Bay will inaugurate a vigorous development policy on the property they have just acquired.

North Thompson.—The Hamilton and Ehrlich interests on the North Thompson have two diamond drills at work and are sinking the old shaft. The vein, as it is being opened up, looks very promising. The Vipond, the adjoining property, is again being sampled, this time it is understood by the Hamilton and Ehrlich group.

Jupiter.—The bond issue of $50.000 on the Jupiter has all been subscribed by shareholders so that there is no necessity for an appeal to the outside public. The bonds are repayable in August of next year. The money so raised is to be used in paying off company obligations.

Kirkland Lake Proprietary, Ltd.—It is now announced that while in London, Mr. C. A. Foster succeeded in organizing the Kirkland Lake Proprietary, Ltd., a company capitalized at $1,000,000. This company will take over and operate claims in the Kirkland lake area. As Mr. Foster has a controlling interest in most of the best prospects in the new goldfields the new company will have no difficulty in securing prospects to take over and operate. The first prospect to be publicly announced as taken over is the Teck-Hughes gold mines, in which the Great Northern silver mines had a controlling interest. The English company has purchased 50,000 shares of treasury stock of this company and has an option on more of it. There will be no change whatever in the mine management. There is now a prospect of ample development money for the Kirkland lake field.

Harricanaw.—Interest in the Harricanaw field in Northern Quebec has been revived by the good surface ore found on the Sullivan claim. The vein on the Sullivan property has been opened up for several hundred feet and it is 5 ft. wide. A shaft has been put down 10 ft. and good assays have been obtained from sampling at the bottom of the test pit. The Sullivan claim is at Keniwisik lake, about 55 miles south of the Transcontinental Railway.

Wettlaufer.—After sinking two shafts to a depth of 50 ft. and doing some surface work, the Wettlaufer interests of Buffalo have decided to abandon operations on their veteran claims in Hoyle township, in the Porcupine district. The surface showing was promising, but values decreased as the shafts were sunk.

BRITISH COLUMBIA

BOUNDARY.

Phoenix.—The British Columbia Copper Co. has taken under option of purchase a mineral claim adjoining the Wellington group from which during recent years much oxidized ore was extracted and shipped to the smeltery at Greenwood. Prospecting work has been commenced to determine whether or not sufficient ore can be found to make it worth while resuming mining operations in this part of the camp. The Granby Consolidated Co. is reported to be diamond drilling on the Snowshoe property, formerly worked under lease by the Consolidated Mining and Smelting Co. Work on a small scale has been resumed on the Bay and Tip Top claims, west of Phoenix toward Greenwood. Gold-silver ore occurs on these claims, but production from them has not been of much importance in the past.

Greenwood.—The British Columbia Copper Co. is exploring ground at the south end of its Mother Lode property, in Deadwood camp, using a diamond drill. Indications are reported to be favourable to ore being found here. The Granby Consolidated Co. is stated to have bonded the Big Copper property, in Copper camp, five or six miles west of Greenwood, and to have commenced diamond drilling on it.

The Jewel 15-stamp mill has been operated continuously for the last five months, crushing and successfully treating monthly about 1,400 tons of gold-quartz. The Jewel-Denero Mines, Ltd., is about to sink the main shaft, now down 330 ft., to a greater depth with the object of opening another level at 100 ft. below the present lowest working. The mill plant was remodeled during the first half of this year. Since completion of the changes, about the end of June, there has not been any difficulty experienced in operating the mill.

"YARDAGE" DISPUTE AT COAL CREEK AND MICHEL*

It may be remembered that at the conclusion, in November, 1911, of the prolonged dispute between the members of the Western Coal Operators' Association and their employees, being members of the United Mine Workers' Association, it was agreed as from November 17, 1911, to March 31, 1915, that any dispute arising during the life of the agreement should be referred in writing (if not settled otherwise) "to the Commissioner of the Western Coal Operators' Association and the President of District No. 18, United Mine Workers of America, for settlement," these parties to select, if necessary, an independent chairman as third member, and, if a chairman being necessary, these parties were unable to appoint one by joint agreement, then an independent chairman to be named by the Minister of Labour. "The decision of the committee thus constituted shall be," says the agreement, "binding upon both parties."

Some time since a difference existing between the Crowsnest Past Coal Company, Limited, and its employees, with reference generally to the interpretation to be placed upon the term "yardage," and, the other members of the committee being unable to agree on an independent chairman, the Minister of Labour was requested to name a chairman. The Minister accordingly named Mr. James Muir, K.C., Calgary. The dispute has now been dealt with by the committee and has been formally passed upon. The Department has received during the month a copy of the decision reached, the same bearing the signatures of Mr. James Muir, chairman, and Mr. W. F. McNeill Commissioner of the Western Coal Operators' Association.

The decision of the committee was rendered in the following terms:—

This is an application of certain miners asking to be allowed what is known as "yardage," and on the 25th of March, 1913, the question came before myself as Chairman, appointed by the Minister of Labour, and Mr. Stubbs, representing the United Mine Workers, and Mr. McNeill, representing the Western Coal Operators' Association. After considerable discussion it was agreed by all parties that the consideration of this question should stand adjourned, and in the

*From Labour Gazette, November, 1913

meantime Mr. McNeill and Mr. Stubbs should each file with me a brief or memorandum showing the grounds of their respective contentions.

On the 31st of said month of March, Mr. McNeill filed his argument, and on the 22nd September, ult., I received the argument put in by Mr. J. E. Smith, the delay of the latter argument being explained from the fact that in the meantime Mr. Stubbs had resigned from the position of President and Mr. Smith had succeeded him.

By the agreement between the Mine Workers and the Coal Operators, dated November 17th, 1911, provisions are made with great minuteness as to the charges to be made for the different mining operations under the different conditions existing in the various mines covered by that agreement, and among these provisions are what is known as "yardage."

In the mines belonging to the Crowsnest Pass Coal Company to which the mines in question belong, there are some sixteen provisions under the heading of "yardage" in all of which under this heading are included the following:—

(a) Levels and parallels.

(b) Crosscuts between levels.

(c) Room crosscuts no tracks,

and for these divisions of "yardage," different prices are allowed to miners in the different mines, and in two cases under that head the widths are given, and I may here notice that in the case of mines belonging to the International Coal & Coke Company, Limited, under the heading "yardage," divisions are made with prices and particulars differing from those in the first mentioned company. I would here note that this agreement which is to continue in force until the 31st of March, 1915, has apparently been prepared with great care and particularity, and no doubt in arriving at the different provisions fixed by this agreement concessions and compromises must have been made by both parties and the agreement having been reached under these circumstances it must have been intended during the time it was to be in force to settle the different questions as to prices for work done by miners as well as other matters so that any dispute arising between the parties interested should be governed by the agreement referred to.

At the first and only meeting held on the 25th March last, it was stated and it was not disputed, that the claim made by the miners here in dispute did not come within the terms of any of the sub-divisions of what is known as "yardage."

I have carefully read the arguments put in by Mr. Smith and Mr. McNeill, respectively, and I gather from Mr. Smith's argument that the meaning to be placed upon the provisions respecting "yardage" are to be extended from their ordinary meaning by reason of certain customs which support his contentions, and he, in support of this among other things, refers me to certain adjudications on this question of "yardage," the construction for which he contends was allowed, but I notice that these adjudications took place before the date of the agreement in question, therefore, it was a matter which had been in dispute before the agreement was entered into.

It is not contended but that apt words might have been used in the provisions respecting "yardage" which would have met the cases now in question and thus prevented any question being raised as to their meaning, and the fact that this same question had been a matter of dispute before the agreement leads me to the conclusion that for some reason or other it was not intended that claims for "yardage" should be extended beyond the provisions specially mentioned under that heading.

I may further say that in the discussion which took place on the 25th of March last, it was admitted by both parties that when this work was done by the miners in question, no agreement was made, nor has since been made, that the miners should be paid for their said work under the heading of "yardage," I must hold that both the mine workers and the mine operators understood or must be held to have understood that the rate of payment for this work in dispute was to be governed by the agreement hereinbefore referred to.

I may further say that I feel that it would be a serious matter and might endanger the rights of all parties if where express provisions are made these provisions are to be either extended or limited by doubtful interpretations put upon the words where the words used specify the particulars which in this case come under the head of "yardage."

I agree with Mr. McNeill in his conclusion that the miners' claims for "yardage" do not come within the terms of the written agreement referred to and should not be allowed, and I so find and award.

Dated at Calgary, Alberta, this 14th day of October, A.D. 1913.

(Sgd). JAMES MUIR,
Chairman.

I concur:
(Sgd.) W. F. McNEILL.

SULLIVAN ANGLE-COMPOUND AIR COMPRESSORS.

Angle-Compound engines have been used for many years under conditions demanding high speed, freedom from vibration and close economy, and some special air compressors of very large capacity have been built on the same principle. The Sullivan "Angle-Compound" may fairly claim, however, to be the only power-driven compressor of this design, now being manufactured in ordinary commercial sizes. In combination with other especial features, mentioned later in detail, the following marked advantages are obtained over compressors whose cylinders are in the same plane, as in the familiar duplex or cross-compound machines, whether horizontal or vertical.

The Angle-Compound design permits a very close balancing of reciprocating masses. The momentum of moving parts increases as the square of the rotative speed, and the matter of balancing is of larger economic importance for engines and compressors which are intended to run at comparatively high speed, than has generally been recognized. The perfect balance of the Angle-Compound compressor saves for useful work power otherwise wasted in friction and vibration. A coin will stand on edge on this machine when it is running at full load with the foundation bolt nuts removed. The compressor and motor will continue to run when unloaded for a minute and a quarter after the power has been shut off.

The output per unit of floor space has been increased —and this with an actual advance in accessibility of all parts and convenience of attention.

The small saving of floor space is accompanied by a reduction of strains on the foundation and the latter is of correspondingly small dimensions. No lining up beyond beveling need be done; no expensive or intricate problems in driving attachment need be solved, and hence installation cost, often a serious item in other compressor types, is always a small matter in this machine.

The Angle-Compound compressor may be connected by any usual method to the motor unit which may be located at either end of the compressor. It may be direct connected, by mounting a motor or water wheel on its crank shaft. A wide range in the size of the band wheel is permissible, to accommodate various sizes and speeds of motor pulleys. A change of form, type or size of driving means may be made more easily and cheaply than with any other design.

Refinement in every detail, making for increased efficiency and durability, has been achieved for this design, as shown in the detailed description in the following pages.

The intercooler used is of extra size, effective in action, durable and convenient to repair. The use of the outside walls of the cylinder water jackets for cooling the air is a valuable addition of water cooled area that would otherwise be wasted.

The lubrication system is superior to the usual forms. A self-contained gravity system for working parts, a force feed system for cylinders and valves and compression grease cups on the valve motion, make a combination that insures perfect lubrication at all speed, eliminates oil drip or splash on outside parts and requires no drip pans.

With increased speed, the question of adequate and reliable lubrication becomes of greatest importance. The well-known splash system for supplying oil to the working parts, while simple and reliable, is not suited to fast-running engines and compressors. The oil used in this system is contained in the main frame, from which the most conscientious manufacturer is unable to remove every vestige of moulding or core sand and the gritty scale on the surface of the castings which is eventually dissolved by the oil. Even if all grit were removed in the manufacture of the machine, the erecting man or operator cannot be relied upon to thoroughly clean out all cinders and grit accumulated in transit or during erection. The constant and violent agitation of the oil by the moving parts keeps grit or foreign substance in the oil in suspension and delivers it repeatedly through the bearings, where, even if the grit is not harsh enough to cause heating, it produces unnecessary wear.

The oil reservoir in the Angle-Compound compressor is in the bottom of the horizontal frame, but the oil level is maintained at such a height that the moving parts do not touch it. Any gritty matter, therefore, remains undisturbed at the bottom. On the outside of the frame is attached a small plunger pump, operated from the valve gear, with all of its working parts submerged in the oil. This pump forces the oil into an elevated reservoir, whence it is distributed through piping to the bearings. Adjustable sight feed connections are provided, through which the oil flows in generous streams. The pump has a capacity largely in excess of requirements so that positive lubrication is assured. The excess oil is returned to the bottom of the horizontal frame through an overflow.

A separate system of lubrication is provided for the air cylinders in the form of a positive multiple feed oil pump actuated by connections to the air valve gear. This pump has sight feeds, so that the flow of oil is at all times under the observation of the operator.

The outboard bearing supporting the end of the crank shaft is independently lubricated by a supply of oil contained in a well underneath the bearing, to which it is delivered by ring oilers.

That compactness and accessibility can be brought together in the same unit has been demonstrated in this machine. Notwithstanding its enclosed and neat appearance, all working parts are easy to inspect, adjust or remove.

A single crank pin takes the place of the usual two eccentrics used for driving the valve motion in duplex machines. No supporting brackets or intermediate rocker arms are required.

A balanced disc on the end of the crank shaft carries a crank pin, on which the connecting rods for the valve motion of both cylinders are hung. It is unnecessary to point out the obvious simplicity and the many advantages of this arrangement as compared with the usual two eccentrics and eccentric straps with their high rubbing speeds and inconvenience of adjustment.

Balancing of Reciprocating Forces.—The reciprocating parts of a high-speed steam engine or compressor offer problems in balancing extremely difficult of satisfactory solution. Opposing balancing weights attached to the crank produce uniform opposing centrifugal forces radially around the shaft, while the inertia forces set up by the motion of the reciprocating parts change constantly in intensity throughout a revolution in line with their motion. They are started from a point of rest at one end of the stroke accelerated to maximum speed about mid-stroke, retarded from this point and brought to rest at the end of the stroke. In accelerating the reciprocating parts force has to be applied to them from the crank, tending to oppose its rotation, and they become charged, so to speak, with potential energy due to their velocity. After their maximum velocity has been reached at mid-stroke, and retardation begins to take place, the energy absorbed during the first half of the stroke is given up during the latter half, producing a force tending to assist the crank in its rotation.

In compressors of slow or moderate rotative speed, say 150 r.p.m., the disturbing effects of these inertia forces are so small that they are readily absorbed by the mass of the entire machine, but as the inertia varies as the square of the speed, it will be seen that if it is attempted to run such a compressor at a speed of 225 r.p.m. the disturbing effects have been increased in the ratio of $\left(\frac{225}{150}\right)^2 = 2.25$

In other words, with a speed increase of 50 per cent., the disturbing forces produced by the reciprocating parts have increased 225 per cent.

The inertia of the reciprocating parts reaches a maximum at the ends of the stroke and is equal in value to the centrifugal force of a mass having the same weight as the combined weight of the piston rod, crosshead and connecting rod. As stated above, the effect at the ends of the stroke is equivalent to the centrifugal force of a revolving mass of the same weight as the reciprocating parts, and the horizontal vibrations may be entirely neutralized by attaching such an equivalent weight to the crank opposite the crank pin. If this be done, however, the opposing centrifugal force of the revolving weight will practically neutralize the inertia forces, but introduce a new set of vertical unbalanced forces, of equal intensity, tending to shake the shaft and engine up and down.

In horizontal single or duplex compressors it will be seen that good balancing is an impossibility, and the best that can be accomplished is a compromise, effected by attaching a centrifugal counter weight of less weight than that of the reciprocating parts, which will partially absorb their horizontal disturbing effects without introducing vertical unbalanced forces of injurious magnitude, leaving the bearings, frames and foundations to absorb the remainder.

In the Angle-Compound compressor the disturbing influences of the horizontal and the vertical members tend to offset or neutralize each other, the maximum unbalanced effects of the vertical parts being produced when those of the horizontal parts are at minimum value and vice versa.

The beneficial effects of reduction in forces tending to set up vibrations are manifold. One of the main obstacles to high rotative speed having been removed in this design, a smaller machine may be used for a given duty, provided it is designed with proper values and valve areas for its rated speed, thereby involving savings in original investment, space requirements and foundations.

The massive foundations necessary to absorb the unbalanced vibrations in other types are not required for the perfectly balanced Angle-Compound compressor, and it may be successfully operated in buildings where vibration is objectionable or on unstable or filled ground, where vibration would have a tendency to cause unequal settlement and throw the compressor out of alignment.

The heavy counterweight permitted by this design practically absorbs within the shaft itself all of the heavy inertia loads, which would otherwise have to be carried by the crank shaft bearings, and leaves these important elements of the compressor free to perform their proper function of carrying the load due to the air pressure on the pistons and to support the weight of the moving parts, thereby greatly reducing power losses due to friction, trouble with heated bearings, etc.

In addition to the elimination of inertia loads from the bearings a further benefit is gained by a more uniform distribution of the working pressures around the circumference of the crank shaft boxes. In the horizontal type of machine, the wear due to the influence of piston load is all on the sides of the boxes, while with the Angle-Compound type the piston load produces wear in both horizontal and vertical directions, with the result that the boxes require less adjustment, with the wear distributed over a greater surface, and both the shaft and boxes retain a more nearly cylindrical shape throughout their life, resulting in unusual freedom from pounding.

In the ordinary duplex design, the stresses due to piston load are applied to the ends of a crank shaft supported in bearings several feet apart, and as the piston loads, during certain parts of the revolution act in opposite directions, a twisting effect or couple is set up in a horizontal plane which must be resisted by the machine frame, the foundations or both. Any lack of rigidity in these elements disturbs the alignment and produces a tendency toward heated bearings and increased friction. In foundations for duplex compressors, which are necessarily of large horizontal dimensions, if any settlement occurs, it is bound to be unequal and the wide base or frame cannot be made stiff enough to resist the distorting forces of the settling foundation. The right-angle compressor foundation is short and narrow, and if settlement occurs, the foundation, in tilting from a level position, will move as a solid block or unit, and no distortion of the frame will result. Furthermore, the right angle frame is short, narrow and of great depth in comparison to its width, giving it a rigidity far in excess of that found in the broad and more flexible base supporting the duplex compressor.

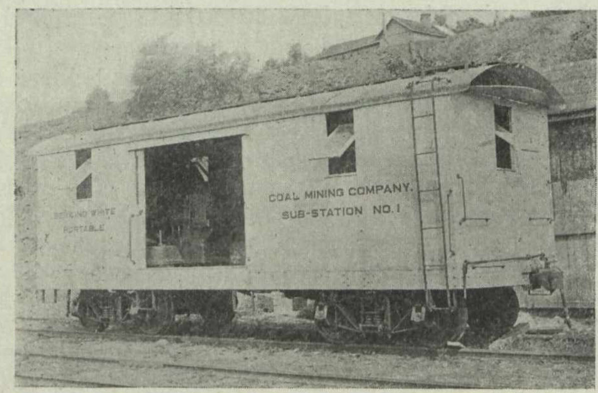
The unique arrangement of the cylinders in the Angle-Compound compressor permits the location of both connecting rods side by side on the same crank pin. This feature reduces the distance between the centre lines of the two cylinders from several feet in the duplex to the width of one connecting rod box in the Angle-Compound type, and practically eliminates the severe distorting forces previously referred to.

The crank shaft is supported in large bearings immediately on either side of the crank pin, so that the load imposed by both pistons is borne equallly by these bearings, without any tendency to rock or spring the shaft or main frame.

A PORTABLE SUB-STATION FOR A COAL MINE.

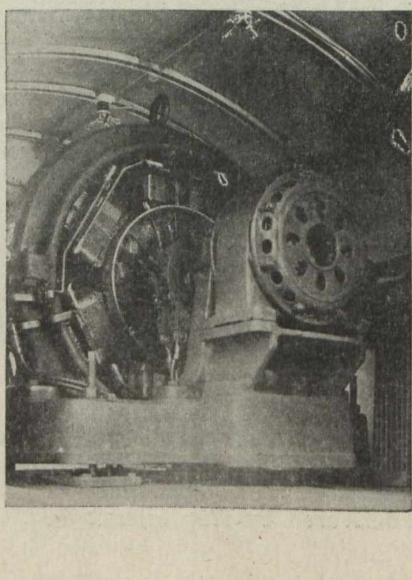
The Berwind-White Coal Mining Company, Windber, Pa., has recently added a 400 kilowatt Westinghouse portable sub-station to its equipment and is making a very interesting use of it.

A sub-station consists of apparatus for changing alternating current into direct current, and is generally necessary in mining work because direct current must be used for haulage in mines, but cannot be transmitted economically over long distances. Hence, when the



mine is located some distance away from the power station that serves it electric power can be transmitted more efficiently as alternating current at a high voltage and then transformed to direct current in the substation.

The Berwind-White Company is developing its outlying properties very rapidly and needs direct current at points where permanent sub-stations are not yet erected. In order to prevent delays in the development the use of a portable sub-station was decided on.



This sub-station has the same equipment that a permanent installation has; namely, transformers to step down to a moderate value the high voltage of the current received from the transmission line, a switchboard, and a rotary converter, which receives alternating current and delivers direct current. This apparatus is mounted in a car resembling an ordinary freight car.

When the work at a new development reaches the point where direct current is necessary the portable sub-station is hauled out to the workings, connected to the alternating current transmission system, and is started to work generating direct current. When the permanent sub-station is built the portable one becomes unnecessary and is taken to the next development.

A further use of this sub-station is to provide insurance against shut-downs. If accidents occur at any of the permanent sub-stations, the portable outfit is sent to carry the load until repairs are completed. One portable sub-station, therefore, is practically the equivalent of a duplicate set of apparatus at each permanent sub-station.

POWER EQUIPMENT FOR WINDSOR HOTEL.

The power equipment for the new Windsor Hotel, designed and installed under the supervision of Mr. Kelsch, consulting engineer, is more complete than usual because of the problems to be met. The power plant, which is in charge of Mr. Winkworth, chief engineer of the Windsor Hotel Co., is one of the most up-to-date isolated power plants in Canada. The main object of the power plant is to furnish light and heat to the hotel and power for the various motors used in the laundry, for ventilating fans, and in other parts of the hotel.

The steam equipment consists of three 200 h.p. Robb water tube boilers, each with a heating surface of 2,143 square feet. Two of the boilers are set in a battery and one is installed singly. The boilers, which are built for 175 pounds working pressure, are equipped with cotton blowers for burning anthracite screenings. This type of boiler consists of two horizontal cross drums with headers which are connected by a main bank of inclined tubes. The drums are connected by two rows of horizontal tubes, which complete the path of circulation for the water. At the extreme top, superheating tubes connect the drums so that the steam, which is separated in the front drum is thoroughly dried and slightly superheated when it enters the rear drum, from which it is piped to the engines.

This boiler is distinguished from other water tube boilers by the large throat area where the front header joins the front drum, giving a free and unrestricted passage for the large volume of water and steam passing from the main bank of inclined tubes into the drum. As the drums extend crosswise and the headers are as wide as the length of the drum, there is no contraction at the throat, as is necessary in many types where longitudinal drums are used.

Great flexibility is another feature of this new boiler, not only from the way it is placed in the setting on the supporting framework, but also because of the construction of the boiler itself. All the tube surfaces run in one direction and the plate surfaces in another, thus eliminating the strains caused in boilers where the longitudinal drums, headers, and tubes are connected rigidly together. A thoroughly modern design, this boiler has ample provision for cleaning, a hand-hole being placed in the header opposite each tube.

In the engine room of this power plant there are installed three Robb vertical compound engines, which are run non-condensing. Each engine is direct-connected to a 150 k.w. electric generator, made by the Canadian Westinghouse Co. These engines will operate the generators at 25 per cent. overload for two hours and 50 per cent. overload for one hour. With steam at 150 pounds pressure, they will carry the normal load at a speed of 425 r.p.m. These engines are entirely enclosed, so that working parts are protected from accident, and there is no danger of oil being thrown about the engine room. Every revolving and sliding part is automatically lubricated by a system which consists of a pump and distributing pipes, in which a pressure of from 10 to 20 pounds per square inch is maintained. Of the vertical type, these engines have many features which have been very successful in marine practice, and modified for stationary practice enable the engines to maintain the speed desired for direct connection.

A fuel testing station has been established by the Mines Branch at Ottawa, the Dominion of Canada Fuel Testing Plant, to demonstrate that peat could be economically utilized as a fuel for power purposes in a producer gas power plant, and to test the fuel and power producing values—on a commercial scale and in a commercial gas producer—of the bituminous coals of the extreme eastern and western provinces and of the lignites of Manitoba, Alberta and Saskatchewan.

A plant is also about to be erected by the Government of the Province of Saskatchewan at Estevan, for the purpose of assisting the development of the coal mining industry by testing the lignite coal of that district.

COBALT SHIPMENTS

The shipments for the week ending December 19 were again over one million pounds, including a car of high grade from the Casey Cobalt. The Nipissing shipped no less than five cars of cobalt residue from the high grade mill to England and the rise in the price of cobalt on the European market will make that mineral worth something to Cobalt mines in the future, perhaps. Of the six mines shipping two contributed low grade, namely, Nipissing and La Rose, the latter company also sending out a car of concentrates. The bullion shipments were well up to average, though of the three companies shipping, Nipissing alone ran over the 50,000 ounce mark. The Nipissing has now shipped in bullion over six million ounces.

The ore shipments from the Cobalt mines for the week ending December 19, were:

	High.	Low.	Lb.
Caribou Cobalt	59,960	......	59,960
Cobalt Lake	125,130	......	125,130
McKinley-Darragh	257,310	......	257,310
Nipissing	......	370,740	370,740
La Rose	86,680	60,000	166,680
Casey Cobalt	55,507	......	55,507
	584,587	450,740	1,035,327

The bullion shipments were:

	Bars.	Oz.	Value.
Nipissing	115	134,807.58	$77,851.38
Dominion Reduction	18	20,358.00	12,011.22
Penn-Can.	6	4,155.30	2,410.07
	139	159,320.88	$92,272.67

—Cobalt Nugget.

MARKETS

STOCK QUOTATIONS.

(Courtesy of J. P. Bickell & Co., Standard Bank Bldg., Toronto, Ont.)

Dec. 23, 1913.

New York Curb.

	Bid.	Ask.
Alaska Gold	21.37	21.62
British Copper	2.12	2.37
Braden Copper	7.00	7.12
California Oil	265.00	270.00
Chino Copper	38.12	38.37
Giroux Copper	.75	1.25
Green Can.	6.00	6.50
Miami Copper	21.12	21.25
Nevada Copper	15.12	15.25
Ohio Oil	145.00	146.00
Ray Cons. Copper	17.87	18.12
Standard Oil of N. Y.	177.00	178.00
Standard Oil of N. J.	400.00	402.00
Tonopah Mining	1.62	1.75
Tonopah Belmont	7.12	7.31
Tonopah Merger	.51	.52
Inspiration Copper	14.50	14.75
Goldfield Cons	1.37	1.43
Yukon Gold	2.00	2.12

Porcupine Stocks.

	Bid.	Ask.
Apex.	.00½	.01
Dome Extension	.06½	.07
Dome Lake	.23	.24
Dome Mines	14.80	15.10
Eldorado.	...	.01
Foley O'Brien	.15	.20
Hollinger.	16.90	17.20
Jupiter.	.06½	.07
McIntyre.	1.50	1.55
Moneta.	.02	.04
North Dome	...	.40
Northern Exploration	1.25	1.50
Pearl Lake	.09½	.09¾
Plenaurum.	...	.40
Porcupine Gold	.10¾	.11¼
Imperial.	.01½	.02
Porcupine Reserve	...	.06
Preston East Dome	.01	.02
Rea.	.15	.20
Standard.	...	.01
Swastika.	.04¾	.05
United.	...	.01
West Dome	.06	.10
Porcupine Crown	1.25	1.28
Teck Hughes	...	.28
Caribou.	.67	.71

Cobalt Stocks.

	Bid.	Ask.
Bailey.	.05	.05¼
Beaver.	.30½	.31
Buffalo.	1.75	1.80
Canadian.	...	.16
Chambers-Ferland.	.15½	.16
City of Cobalt	.30	.35
Cobalt Lake	.45	.53
Coniagas.	7.15	7.25
Crown Reserve	1.70	1.71
Foster.	.06	.08
Gifford.	.02¾	.03
Gould.	.02¾	.03
Great Northern	.09	.10
Hargraves.	.02	.03
Hudson Bay	67.00	71.00
Kerr Lake	4.45	4.50
La Rose	1.99	2.00
McKinley.	1.00	1.02
Nipissing.	7.90	7.95
Peterson Lake	.25½	.26
Right of Way	.04½	.06
Rochester.	.02	.03
Leaf.	.01	.02¼
Cochrane.	...	.40
Silver Queen	.04	.06
Timiskaming.	.13	.14
Trethewey.	.25	.30
Wettlaufer.	.06	.08
Seneca Superior	2.00	3.00

TORONTO MARKETS.

Dec. 23—(Quotations from Canada Metal Co., Toronto).
- Spelter, 5 cents per pound.
- Lead, 5½ cents per pound.
- Tin, 40 cents per pound
- Antimony, 8½ cents per pound.
- Copper, casting, 15½ cents per pound.
- Electrolytic, 15½ cents per pound.
- Ingot brass, 10 to 15 cents per pound.

Dec. 23—Pig Iron—(Quotations from Drummond, McCall & Co., Toronto.)
- Summerlee No. 1, $26.00 (f.o.b. Toronto).
- Summerlee No. 2, $25.00 (f.o.b. Toronto).

Dec. 23—Coal—(Quotations from Elias Rogers Co., Toronto).
- Anthracite, $8.25 per ton.
- Bituminous, lump, $5.25 per ton.

GENERAL MARKETS.

Dec. 19—Connellsville coke (f.o.b. ovens).
- Furnace coke, prompt, $1.75 per ton.
- Foundry coke, prompt, $2.50 to $2.75 per ton.

Dec. 19—Tin, straits, 37.15 cents.
- Copper, Prime Lake, 14.50 to 14.75 cents.
- Electrolytic copper, 14.12½ to 14.37½ cents.
- Copper wire, 15.50 cents.
- Lead, 4.00 cents.
- Spelter, 5.15 to 5.20 cents.
- Sheet zinc (f.o.b. smelter), 7.25 cents.
- Antimony, Cookson's, 7.40 to 7.50 cents.
- Aluminum, 18.50 to 19.00 cents.
- Nickel, 40.00 to 45.00 cents.
- Platinum, soft, $43.00 to $44.00 per ounce.
- Platinum, hard, 10 per cent., $46.00 to $47.50 per ounce.
- Platinum, hard, 20 per cent., $49.00 to $51.50 per ounce.
- Bismuth, $1.95 to $2.15 per pound.
- Quicksilver, $39.00 per 75-lb. flask.

SILVER PRICES.

	New York cents.	London pence.
Dec. 11.	57⅞	26¾
" 12.	58	26$\frac{13}{16}$
" 13.	58	26$\frac{13}{16}$
" 15.	57⅝	26⅝
" 16.	57⅝	26⅝
" 17.	57⅝	26$\frac{11}{16}$
" 18.	57¾	26$\frac{11}{16}$
" 19.	58	26$\frac{13}{16}$