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TWENTY-FOURTH YEAR OF PUBLICATION

The Canadian Mining Review

Established 1882

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CONTENTS.

Since the publication, in the July issue of the REVIEW, of a criticism of the flotation of the Nipissing mines, in Cobalt camp, the capital stock has been reduced from twelve millions to six millions. We think this was a wise change. We grant the Nipissing has made a very excellent showing, but six millions is a lot of money, and veins of rich silver ore have not always been remarkable for their permanence at great depth.

The REVIEW is not and never has been a party paper. It is perfectly immaterial to the mining industries of Canada which party is in power, either in the provinces or in the Dominion, so long as the mining law or laws are efficiently and honestly administered, and so long as there remains a disposition in the various governments to honestly advance the interests of the mining industry. In most cases the Government is well served, but it is notorious in Coleman that all official representatives of the Government are not above suspicion.

It is with much regret that we have to chronicle the devastation of the town of Haileybury by fire. On the night of August 20th, the greater part of the business section of Haileybury went up in smoke. The losses were fairly well covered by insurance, but, of course, will fall heavily upon the business men of that enterprising city. We are pleased to hear that most of those who were burned out will rebuild, showing that they have an unabated faith in Haileybury and its future. After all, most cities that amount to anything are either burned out or shaken up by earthquakes at some time or other.

The Geological Survey of the United States has published a volume on the methods and cost of gravel and placer mining in Alaska, written by Charles Wells Purington. The number of this Bulletin is 263, and all who are interested in placer

mining would do well to obtain a copy of it, as it gives a very detailed description of the methods in vogue not only in the American camps, but the camps on the Canadian side of the line. The pamphlet is well illustrated and the particulars furnished of the different appliances and methods are accurate and trustworthy.

Owing to the number of prospectors who are seeking their fortunes in Northern Quebec, the original report by Dr. Robert Bell on the geology of the basin of Nottaway River, published as Part K, Annual Report, Volume XIII., was exhausted and a large subsequent edition has been heavily drawn upon by persons who are interested in that northern country. This report, while not as full as could be wished, is a very useful one, and considering that Dr. Bell only had an opportunity to make a reconnaissance survey, it contains a vast amount of useful information.

A very instructive paper on turbine machinery was read by Mr. S. A. Everett at the last annual meeting of the South Wales Institute of Engineers, when it captured the Massey prize. Mr. Everett takes a very optimistic view of the future of the turbine. It seems, however, that the highest authorities believe that while the steam turbine is a success the possibility of the development of the gas turbine in the near future is not bright. Some have gone so far as to say that the possibility of producing a successful gas turbine was only likely, provided there be first a revolutionary scientific discovery. In other words, the materials at the command of the engineer do not seem applicable to the construction of a turbine to deal with so high a temperature.

According to an article by Mr. H. C. Hoover, contributed to the *Engineering and Mining Journal*, of New York, the decrease of returns from Westralia gold mining during 1905, amounting to some 28,000 ozs., was largely caused by the conditions of the Australian mining title. by which a leasehold is granted subject to measurement. One man must be employed continuously for every six acres; thus the prospector found it impossible to hold his ground. The fear of inability to so do drove the prospector from the field, and throttled the growth of the industry.

Now, the colony is free from a labor government, and much may be hoped for in consequence.

This, probably, contains a lesson that our legislature should take to heart. If it was possible to strangle the growth of a vigorous industry, in Westralia, it would be certainly an easy matter to kill off an infant industry in any of our Canadian provinces. Next to mineral deposits, common sense mining laws are required in order to make a country flourish from the mining point of view.

Mr. Jas. Ashworth, M.E., read a paper recently before the North of England Institute of Mining and Mechanical Engineers, giving the results of his observations on water-sprayed or damped air in coal mines. The Council has shown its recognition of the value of this paper by awarding Mr. Ashworth a prize of two guineas. The value of such recognition does not, of course, depend upon the money value of the reward, but because it is a public acknowledgment of good, conscientious, intelligent work. For years Mr. Ashworth has contended that water-sprayed and damped air in dusty coal mines is neither a preventative, nor yet a controller of the extension of an explosion from one part of a colliery to another, and, although public opinion was for a long time against it, it looks as though his arguments were meeting with much less opposition than formerly.

The curse of all the new mining camps is typhoid fever. In the army it is known as enteric, but, though the names are different, the disease is the same. There was a considerable amount of typhoid in the camps of Northern Ontario last summer, and there is likely to be a further outbreak this autumn—spring and autumn being the two worst seasons, as a rule. There seems only one safeguard—boiled water. If a man is careful to see that every drop of water that comes into his shack is boiled, he reduces to a minimum the chance of infection. Our own system—and we have passed scathless through several epidemics—is as follows: A bucket is kept for the purpose of bringing water from the creek or spring, and this, after being emptied into a large pot, or boiler, which stands on the stove, is placed outside the door of the shack. Every drop of water that is used, either for toilet or for household purposes, or for cooking, is first boiled. If this simple precaution be taken infection can only be acquired outside the shack, and when an epidemic of typhoid is going through a camp, the man who values his health should be very chary of either eating or drinking away from his own table.

A system, now becoming a favorite one in the Slocan, of working old properties under lease, is one that might have a wider application. Mr. Geo. Huston, Editor of the *Mining Standard* of Sandon, has published a very interesting account of this system in the *Mining Record*. He states that a number of old properties have been taken in

hand on low royalties. A few men club together, forming a syndicate, each man subscribing a certain amount and assessing himself at a small sum, monthly. In many cases the first assessment is one hundred dollars and the monthly dues ten dollars. This capital is managed solely by the investors, who keep close watch to see that all disbursements are for actual working expenses.

The labor is supplied by working miners, who go in on shares with the investors. Each party receives one-half the net profit, should there be any; the investing group paying for tools, outfits, powder and provisions, and allowing each miner one dollar a day. The miners are kept steadily at development, and any ore found is taken out by hired labor. A bank is selected to receive all moneys on account of the group and to make all payments, and to see to the equity of the division.

It appears to us that just such a plan would meet the needs of the small rich deposits that are likely to be found through Northern Quebec and Ontario. A few men drawing fair salaries can, by this system, get a run for their money, and stand a far better chance of receiving a good return than would be the case should they dabble in 5-cent and 10-cent stocks.

Most great inventions are simple, yet, surely, few can be simpler than that evolved by the clever managers of the De Beers diamond mines for saving the stones that pass through their hands. One of them noticed that oily substances, such as axle grease, or white or red lead, stuck to diamonds when they happened to come in contact with them. Hence, they argued, that diamonds should in turn adhere to grease. After a series of experiments it was ascertained that diamonds, alone, of all the minerals contained in the blue ground adhered to grease, the others drifting away as tailings with the water. The diamonds pass over a shaking table spread thickly with grease. The descending diamonds stick to the surface of the grease, while all the other minerals pass over it. Two tables are used, but only about one-third of one per cent. of the diamonds pass the first table, and those are found, with rare exceptions, upon the second table. Grease will catch rubies and sapphires and emeralds as well as diamonds, but it is not believed that it will cling to anything but a precious stone.

The grease which is used loses its power to retain diamonds after a few hours' work, when it is scraped off the tables, together with the diamonds adhering to it, placed in a kettle of finely perforated steel plates and steamed. The grease is used over and over again.

A modification of this method has been introduced still more recently by the Elmore Oil Process Company—but each really depends upon the affinity of gems for oleaginous substances.

A number of prospectors are now searching for diamonds in the northern parts of the Provinces of Quebec and Ontario, and these men all have frying-pans and abundance of grease derived from the mess pork they carry with them.

It may be possible that an ingenious man will make this hint of service in detecting the gems he is in search of.

MINING PROGRESS.

Each year sees improvements in the art of mining and metallurgy, so that ores that a few years ago were too poor to yield a profit in working, have now become available. One of the most notable metallurgical developments of recent years was the solution of the Broken Hill zinc problem, which resulted in the revival of the Broken Hill field. For many years tailings averaging 17 per cent. of zinc, 8 ozs. of silver, and 6 per cent. of lead, to the ton, were accumulated, until at length it was estimated that these old dump heaps contained some 6,500,000 tons of tailings. The wealth that was maintained in this immense accumulation tempted inventors so that some of the brightest brains were struggling to solve the problem, with the result that not one alone but many successful methods of treating these old tailings were discovered. These huge mounds have now but to be run through the treatment plant and zinc concentrates are obtained, which may be marketed or smelted. Unlike the great discovery of cyanide of potassium for the recovery of gold, the methods discovered for saving these zinc residues could not become monopolies. There were too many of them. Each successful inventor was forced to struggle with his competitors and to be contented with the smallest possible royalty. So the producers reaped the benefit—a benefit that was all the greater by reason of the high price of zinc, lead and silver.

The treatment problem having been solved, those companies which had dump heaps found they could sell them for large amounts of cash. After extraction of the zinc, the lead and silver become easily recoverable. The sulphur contents of the Broken Hill ores also assumed value in the form of sulphuric acid and superphosphates. Sulphuric acid is used for recovering the zinc in several processes and in the manufacture of superphosphates for manures. The following are the different processes for recovering the zinc in the Broken Hill ores:—The Sulman-Picard process of distillation of the zinc concentrates by treatment with ordinary bituminous coal; the magnetic separation process; the Potter and Delprat processes, in which sulphuric acid is used; the De Bavay carbonic acid gas process; and the Carmichael-Bradford desulphurizing process. All these processes are at work on the Barrier Range. It

may be pointed out that the importance of a cheap supply of sulphuric acid will create a demand on the part of innumerable new industries to which it is essential. The applications to which sulphuric acid can be put are so universal that it has been suggested that a nation's industrial progress may be roughly measured by its consumption.

The next in importance of the ore treatment processes is the extended introduction of the tube mill. At the Waihi mine three tube mills as auxiliaries to one of its batteries are crushing and treating some 30 per cent. more ore than was formerly reduced without tube mills; the El Oro in Mexico is extracting 16 per cent. more gold by the aid of tube mills, and the appliance is being extensively employed on the Witwatersrand. At Kalgoorlie the Wheeler pan has been pitted against the tube mill, with the result that on this particular ore the advantage is claimed to lie in favor of the former; but in the matter of initial cost—two pans being taken as equal to one 13 ft. tube mill—the advantage is distinctly with the pans. The estimated cost of two Wheeler pans is £290, whilst one tube mill is calculated to cost £633.

The method of re-treating the residue dumps of the Randt, as originally carried on by the Crown Reef Company, has been extended to other mines. As every Randt mine which has crushed since the industry started possesses greater or lesser accumulations of residues, the recovery of the small amount of gold left in these at a fractional cost means a substantial addition to revenues. Last year the Crown Reef Company secured from this source alone a profit equal to 17 per cent. on its issued capital. Some 70 to 90 per cent. of the gold contained in these residues, representing from 3s. to 6s. per ton, is being recovered by a simple process of atmospheric oxidization and leaching out the gold with water. The residue heaps may consequently be made a not unimportant new source of revenue to Randt mines.

The old tailings dumps throughout the world have been bought up by cyanide operators, until very few now exist. Practically all the old dumps on the Randt, Charters Towers, Victoria, West Australia, the United States of America, and Mexico are exhausted, having added millions of gold to the wealth of the world. Cyaniding is now, therefore, practically confined to the tailings and slimes as they come from the mill; and, with the use of tube mills, the intermediary product of tailings will be done away with, slimes only being left. There still remain very large old dump heaps of tailings from the silver mills; but, except in a few instances, the treatment of these has has not proved a commercial success, as the extraction of the silver values generally does not exceed 50 per cent. Of course, this does not apply where the tailings can be smelted. I, however, anticipate that these enormous piles of tailings in Mexico and other countries will become amenable, as the Broken Hill residues now are, to some process which will give a profitable rate of extraction. A fortune awaits the metallurgist who successfully tackles this problem.

Very considerable progress has been made in gold dredging, the simplest form of gold mining. In this case Nature has already done the mining by disintegrating the gold-bearing rocks and concentrating the gold into payable quantities in alluvial drift, so that it may be dredged up in an easily recoverable form. The introduction of this class of mining has made rapid strides during the past year, more particularly in the various South American territories, West Africa, Siberia, and the Western States of America. The experience gained in dredging methods and in dredge construction in New Zealand has been carried into other countries, and this phase of gold-mining presents the prospect of becoming more profitable than it has ever before been. In California the increased yield last year is mainly set down to dredging operations. No dredging area, unless it is a rich one, will stand a large capital. In New Zealand the vendor's and promoter's interests do not exceed one-fifth the total capitalization: the balance forms the cash working resources for equipping the property.

In the milling of ores the weight of the stamps has been increased to 1,350 lb. on the Randt, and in other cases to 1,500 lb. The tendency is by the use of preliminary ore breakers to feed a much smaller size of ore into the battery, and to run a much coarser grade out of the battery, leaving the auxiliary tube mills to complete the grinding to any degree of fineness required. In this way the duty of the stamps is very largely increased. The Wheeler pan is also coming into use as a subsidiary in fine grinding. In certain classes of ores dry grinding by roller mills, etc., has proved an economical success. More attention has been given to the re-crushing of concentrates, but either tube milling or the use of Wheeler pans get over this difficulty. Many additional mechanical contrivances for facilitating work have been introduced, such as the mechanical "mucker out," the steam shovel, various forms of ore conveyors, both over and under ground, the application of electrical energy for lighting, trolleying, hauling, pumping, crushing, and, in fact for all purposes where power is requisite. In this connection water power is being utilized as a generating force at great distances from the centre of application. Then there is the marvellous progress in the various systems of producer-gas plants, and the newer types of electrical pumps, which take up less room in the shaft, are less expensive than the old variety, and deal with immense quantities of water at a fractional cost. The progress of metallurgy has been equally great in the different thermo-electrical processes for the smelting of ores and the manufacture

of steel. In copper smelting, plants which were considered up to date five or six years ago have been so improved upon that it pays to scrap-heap them in order to use the latest appliances, giving better results at a great reduction in working costs. The more extended use of the filter press in the case of special ores has overcome treatment difficulties.

Advances have also to be recorded in the use of water-tube boilers, developments in the steam turbine, the standardization of mining machinery, the centralization of plant for a group of mines, the centralization of electrical power transmission, the provision of a central workshop for a group of mines and a central station for purchasing all the requisite supplies—such as foodstuffs, coal, timber, explosives, etc. On the Randt there has also been a tendency to enlarge the area under one management and so curtail administrative expenses, likewise to develop the enlarged area by fewer shafts, especially in the deeper level ground. I particularly notice the tendency in mining engineering to employ specialists, and, where there is such a variety of highly technical subjects to deal with, as in gold, silver, copper, tin, lead, zinc, etc. in all forms and combinations, the cheapest method in the end is to employ the best specialist on each subject under consideration. Reduction in treatment costs has made satisfactory progress during the year. The new and up-to-date methods for more economically handling and treating the ore are doing away with the uncertainty and chance which have in former times characterized the mining industry. Low grade ores, which a few years ago could not be mined at a profit, are now extensively worked, and treatment plants are being remodelled to meet the special requirements of each description of ore. Refractory ores which baffled the mining experts of a few years ago are now made to respond readily to treatment processes. Mining is, therefore, becoming more popular year by year. Where conducted on the honest, prudent and common sense lines recognized as requisite for success in other businesses, legitimate mining enterprise, under the guidance of well trained managers and engineers, is more profitable, on an average, than any other line of business.

Attention must be called to the fact that many of minently to the front during the past year, and continues to receive great attention—as it deservedly should in the process of placing mining upon a sound business basis. No ore ought to be considered to be in reserve unless blocked out on at least three sides, and the smaller the blocks are the more accurate will the estimates be.

I again draw attention to the fact that many of the goldfields of the world have either reached their zenith or entered the declining stage, whilst many mines have attained such great depth that their end can only be a matter of a few years. It is natural to expect the shares of such companies to decline in market value in proportion to the depth reached and the amount of gold taken out of the mine; but in practice this is seldom the case. So long as a mine yields 10 to 12 per cent. on the current quotation, that alone satisfies the average mining shareholder. There is too much inclination to consider mines as investments. This is particularly dangerous in cases where great depth has been attained, and the more so where the profit in the ore reserves is considerably below 60 per cent. of the market valuation of the company's capital. Of course, in cases where 60, 70, or 80 per cent. of the current market price is represented by profit in the ore in sight at the date of purchase, shares assume more the character of an investment, but even then a careful watch must be kept to see that the profit in the new ore developed is sufficient to replace that being crushed month by month. As this, however, is usually impossible—sufficient data being only given annually—the speculative element has to be reckoned with even in the limited number of first-class mines, authorities hold that no mines should be considered investments. They are speculations, and should be treated as such.

THE AMALGAMATION OF GOLD.

The bi-monthly bulletin of the American Institute of Mining Engineers for May, contains several articles of interest to mining men. The amalgamation of gold ores was the subject treated of by Thomas T. Read, and we understand this paper was also to be read during the July meeting in London. Its contents may be summarized as follows:—

1. Gold absorbs mercury, forming a solid solution which may contain as much as 13 atomic per cent. of mercury. Beyond this, an inter-metallic compound containing gold or mercury in solution (or a second solid solution) is formed, which contains 17.5 atomic per cent. of mercury. Ordinary amalgam, which is not in a state of equilibrium, consists of one or both of the foregoing, usually the former, mixed with an excess of mercury which coats the particles and causes them to cohere.

2. Amalgamation is a physical process, the chemical actions involved being chiefly inimical (excepting those purposely induced). The gold grains are wetted by the mercury and sink beneath the surface of the mercury film on the plates; this is facilitated by feeding mercury to the stamp, so that the grains may be thoroughly wetted before coming in contact with the plates. The disadvantages of this procedure have already been discussed. The surface-tension of the mercury draws the gold beneath the surface, and holds it against the plate. By diffusion into the metal of the plates the amalgam often becomes strongly adherent. Silver-plating is

useful, because it prevents the solution of the copper in the mercury, and, therefore, the harmful chemical reactions that result therefrom. Muntz metal plates exhibit the same effect, and, in addition, diffusion of amalgam into them is very slight, so that it is readily removed. Silvered-plates will hold a thicker film of mercury than plain copper, and plates coated with gold amalgam a thicker film than either. This assists the "catching" of the gold.

3. Variations in temperature make themselves felt in slight changes of a number of factors rather than large changes in any one. According to the relative importance of these factors in each case the total effect may vary. The most important undesirable effects of raising the temperature are the increased solubility of harmful salts, and a corresponding increase of the precipitation of base metals into the mercury; this both hinders its proper action and leads to its loss. Rise of temperature also diminishes the surface-tension and viscosity of the mercury, which allows it to be more readily "floured." The force with which the gold is drawn beneath the mercury and held against the plate is also decreased. On the other hand, by an increase in temperature the wetting of the gold by the mercury and the "catching" of it by the plates is facilitated, as is the coalescing of the globules of mercury.

4. Increase of temperature causes increased absorption of mercury by the gold and by the plates. Changes in temperature cause changes in all the foregoing factors. The retaining of a constant temperature is, therefore, most favorable to successful working. A comparatively low temperature is better where the influence of soluble salts in the ore has to be considered (which is usually the case); but when this may be neglected, as high a temperature as can economically be maintained, without variation, is most favorable to successful amalgamation.

THE UPPER STEWART RIVER, YUKON.

In the early eighties bar-mining was practised to some considerable extent on the lower portion of the Stewart river, but the upper waters of that river are practically unknown, except for such information as the Geological Survey has supplied through the medium of Mr. R. G. McConnell in 1900, and Mr. J. Keele, whose report on his explorations of last year is now being published.

That these upper waters do not traverse the desolate region one might suppose is plainly seen by a glance at Mr. Keele's report. He says "the long hours of daylight are favorable for abundant vegetation," and that trees—among which are spruce, balsam, poplar, and birch—grow to heights of nearly three thousand feet above the river. Wild fruits grow in great abundance and "the region offers a great field for the sportsman and explorer." Several species of bear are found in the region, wolves and wolverine, moose, mountain caribou and mountain sheep. Of the fur-bearing animals, there are lynx, fox, beaver, marten, otter and mink.

The part, however, of Mr. Keele's report that will be read with greatest interest is included in the paragraphs on economic geology. After describing the various rocks of the region, the author goes on to remark that "the bed-rock of all the productive placer ground in the Yukon Territory is of a similar character to the above," a hint which, to those prospectors who read between the lines may be of great value. Mr. Keele found gold "in the gravels of many of the small streams flowing over this area," but is naturally careful as to inciting false hopes and adds "whether there is sufficient gold to pay for mining can only be determined by the usual process of reaching bed-rock."

The physical features of the district make interesting reading. We learn that the "scenery is very fine and the mountains gain impressiveness from their situation in low, wide valleys, and their coloring is rich and varied. Some of the valley bottoms seen from a height have an extraordinary appearance, suggesting a mosaic floor in which the pattern is worked out by the bright surfaces of the countless ponds and the narrow dark-green land areas separating them."

SAFETY IN MINING.

The prevention of accidents in mining, is a matter that should be always under consideration by the mining engineer. The subject was, we think, well dealt with by Messrs. Donald Macaulay and Lewis G. Irving, in a recent paper contributed to the Journal of the Chemical, Metallurgical and Chemical Society of South Africa. Prevention is better than cure, and in the paper under consideration, the authors endeavor to point out the principal causes of loss of life through "gassing," and the means of avoiding it. The paper was, in part, as follows:

By the courtesy of the Acting Commissioner of Mines we have been permitted to examine the official reports of the fatal accidents due to "gassing," into which investigation was made by the mining inspectors, for the two years 1904 and 1905. We have gone through these returns very carefully, with a view to determining the general conditions under which these accidents happened.

Thirty separate fatal accidents occurred during that time. They involved the death of nine white men and thirty-one natives or coolies; and the serious "gassing" of some twenty-four others. Seventeen of these fatalities were clearly preventible. Returning to the working place too soon after blasting accounted for some, but only two white men were found culpable in this respect, and both lost their

lives; others were due to neglect on the part of the white miners to take proper measures to see that the working places were safe before setting the boys to work; others again to carelessness in the handling of explosives leading to their ignition. Twenty-three of the forty deaths were, broadly speaking, due to misadventure, but these included a considerable number due to mere ignorance, and a few where lack of supervision seemed certainly to be a contributing cause. A few were caused by exposure to fumes arising from blasting affecting those at work in neighboring parts of the mine.

Of the forty deaths the records point to nitrous fumes as having been the cause of death in seventeen cases, in at least eight of which the diagnosis is definitely stated to have been confirmed by post-mortem examination. All of these were characterized by the same clinical symptoms; no serious disability at the time of exposure, a latent interval frequently without apparent signs of anything being wrong, and then the onset several hours later of an acute and almost invariably fatal illness. Naturally enough in non-medical reports like these the symptoms of illness are not always detailed; where they are so in such cases they are those of the acute respiratory distress characteristic of poisoning by nitrous fumes. In the other twenty-three cases, on the other hand, carbon monoxide was apparently the predominant poison, although in a good many of these carbon dioxide was also present. "Gassing" from nitrous fumes and carbon monoxide conjointly appears to be rare, for reasons which will presently be stated, although it certainly may occur under special circumstances. Clinically the cases fall, with very few exceptions, into two quite distinct categories, poisoning by nitrous fumes and poisoning by carbon monoxide or by a mixture of the latter gas with carbon dioxide. It is of interest therefore to arrive at some conclusion as to the different circumstances under which these different types of "gassing" occur.

Let us take first those instances in which the explosive was ignited and burned, or burned and then exploded. During the period under review, there were five cases of this sort, causing in all six deaths, and in all but one of the latter "gassing" took the tpyical form of poisoning by nitrous fumes. This fact, however, must not be taken to indicate that there is no danger in these cases of poisoning by carbon monoxide, for it has, of course, been abundantly proved that when nitro-glycerine explosives are burned both CO and NO are evolved in large quantity. The result is rather due to the fact that people very naturally do not, as a rule, stay long enough in the neighborhood of burning explosives to run any great immediate risk of poisoning by carbonic oxide. There is a hasty stampede to a place of safety. In one of the six fatal cases, however, the post-mortem appearances seemed to point to a mixed poisoning, and during the present month a most striking and deplorable instance of this nature has occurred, resulting in the loss of fifteen lives. It is worthy of record.

A gang of thirty natives, under a white miner, were proceeding to their working place in a stope, The natives arrived first, some descended the stope, the others, fourteen in number, remained on the level above, in which, between them and the station, was the miner's dynamite box. The miner followed, and had reached his box and passed it, when immediately an alarm was raised; fifteen, perhaps twenty, pounds of gelatine dynamite contained in the box had become ignited, apparently, so far as the facts are obtainable through the carelessness of the miner. The boys in the level rushed towards the station, right into the fumes, and all collapsed at once and dropped within a short distance of the box, where their bodies, and that of the miner, were afterwards found. The natives in the stope below the level escaped. Exposure was thus immediate, and apparently death was equally so. The blood from three of these cases was examined in the Government Laboratory, In each case it was cherry red in color, and uncoagulated. It contained a high percentage of carbon monoxide, and the chemical evidence is stated to point also to an "oxide of nitrogen," as a contributory cause. Clearly, here, the proportion of these gases in the air at the moment, no doubt in conjunction with carbon dioxide also, was high enough to produce immediate unconsciousness and death, and the case may be regarded as one of mixed poisoning; although, probably, the proportion of CO by itself and of NO by itself may have quite well each been high enough to account for what happened.

In four instances in the reports of these two years, the examining mining inspector was inclined to think that the explosives had partially burned. In two of these, exposure to the gases did not occur till several hours afterwards; in each case a white man and a native lost their lives; in one instance, quite certainly, from carbon monoxide poisoning, for the bodies were found in a winze, with the candle of the white miner burning brightly beside them, and the post-mortem appearances corresponded; in the second, also, death was probably due from the same cause. In the other two instances, exposure was immediately or shortly after blasting, when "gassing" took the form of poisoning by nitrous fumes. The evidence on which the opinion of "partial burning" of the explosives having taken place is based is not in all these cases conclusive, but this need not concern us, since, so far as the relation between the conditions of exposure and the form of "gassing" which ensued is concerned, they fall quite into line with those which follow.

There remain, then, twenty-one instances in which "gassing" occurred after an apparently nor-

mal explosion, and in six of these it was due to poisoning by nitrous fumes. There were nine deaths and two recoveries. It is of interest to note that, in those where special investigation was made, no carbon monoxide was present in the blood. In one of these six instances there was no exposure to the fumes until two hours after blasting; in all others the exposure was immediately after the explosion had taken place.

One or two points are worth noting in respect to the circumstances under which poisoning by nitrous fumes occurs.

First, the exposure is typically immediately after blasting. Within an hour or so this special danger seems almost invariably to disappear, a fact which is, no doubt, due to the ready solubility of the gas concerned. Second, the duration of the exposure is often extremely brief. Third, it may occur at considerable distances from the actual seat of generation of the fumes, and the latter may affect one or two only out of a working party of several apparently equally exposed. Blasting in one portion of a mine may thus affect those working at the time in other portions, even at some little distance. It would appear from this that the amount of gas which may produce fatal poisoning may be very small. We have met with one case at least, as we stated in our last paper, where a white miner died from characteristic acute haemorrhage oedema of the lungs, without even having been aware that he had been "gassed" at all.

One of the most striking cases of "gassing" by nitrous fumes occurred in an accident which happened on one of the mines on the West Rand in May, 1905. It presents several features of interest which make it worth recording.

A box containing 30 lbs. of gelignite in a blind drive, eighty feet from the 10th level station, was observed to be burning. It exploded immediately after, causing 30 lbs. of blasting gelatine, twenty feet away, in another box, to explode also. A 6-gallon tin of paraffin at the station caught fire at the same time, and simultaneously the explosion broke a 6-in. air-pipe, allowing the compressed air to escape freely. A shift boss, two white miners and several coolies were at the station when the gelignite caught fire, and they immediately rushed into the drive on the opposite side of the shaft. The explosion and the flames overtook them, they were thrown down, burned and battered, and so severely that five coolies died later from their injuries. They lay there afterwards for a considerable time, but they were not "gassed." The bulk of the fumes seem to have mounted the shaft, and some passed along the 7th level, where the mine captain and a miner encountered them, 1,200 feet away from the seat of the explosion. They both felt the fumes, and the miner complained of feeling sick. He went to the surface, then returned underground, but had to go back. He died the same night of acute oedema of the lungs, the accident having occurred in the forenoon. None of the others were seriously affected by the fumes.

In the other fifteen instances (with nineteen deaths), also occurring after apparently normal explosions, poisoning appeared to have been due to carbon monoxide, with probably also in many cases, and certainly in some, an admixture of carbon dioxide. These accidents occurred in the dead ends of drives, in winzes or in rises, where air had been allowed to stagnate after blasting. In only one instance was there exposure immediately after the explosion; this was in a case where a white miner had recklesly returned with a native to the working face to blast the round very shortly after blasting the cut; both lost their lives. In another instance there was exposure half-an-hour after the explosion. In all other cases two hours or more had elapsed, in one as much as twenty-six hours. In several of the reports definite statements are made as to whether the candles of those affected, or their rescuers, burned in the usual way or not. Mention is made of this in eleven cases; it is a point which should invariably be particularly inquired into, although reliable evidence is not always to be had. In six cases the candles burned brightly, in one dimly, in four others they were extinguished, but in one of the latter instances three of the rescue party were afterwards rendered unconscious, although their candles by that time were burning perfectly well.

Clearly, it is difficult to accurately apportion the respective influence of carbon monoxide or carbon dioxide in many of these cases. It is probable, judging from the results of systematic analyses of mine air after blasting, that 2, 3, 4, or even as once happened in Mr. Mann's series, perhaps 7 per cent. of carbon dioxide may be present locally in the air after explosion, and while the smaller quantities mentioned would of course in themselves be insufficient to produce unconsciousness, they would unquestionably aggravate or accelerate the effects of any carbon monoxide present, especially in the presence of a decreased percentage of oxygen. On the other hand, even in cases where the candles of those affected burned as usual, and where the amount of carbon dioxide was therefore under 3 per cent., one reads of those affected being rendered unconscious "within a few minutes," and it is probable, therefore, that under such circumstances carbon monoxide was present in amounts perhaps approximating to 0.5 per cent. or more. These facts go to show that this gas is certainly frequently, and probably almost invariably, the predominant agent in producing a fatal issue under such circumstances. Unfortunately, spectroscopic examination of the blood of those affected was not frequently undertaken, but in the instances in this series in which

this was done the results were positive. Take for example such a case as the following: A miner blasted the face of his drive at 10.30, turned on the air and went to dinner. He stated that he warned his boys to wait till he came back. He returned two hours later and found one of the natives lying dead on the broken rock with his candle burning beside him, the compressed air being still on the "outbye" side of the broken ground. The laboratory report stated that the blood contained "a large percentage of carbon monoxide." It would be tedious to multiply instances, the general conclusion is plain enough. One further point, however, is worth noting, namely, that in none of these cases, where those affected were disabled or rendered unconscious at the time and recovered, did symptoms of superadded poisoning by nitrous fumes afterwards appear to supervene.

Several matters arising out of this particular group of cases deserve consideration. First, apart from cases of burning, carbon monoxide poisoning is, as we said, typically due to the stagnation of air in close places after blasting. It is, therefore, very necessary to prevent this by adequate ventilation, the more so as the cases we have quoted do not include the more numerous minor cases of "gassing," which are not reported to the inspectors, and which, although they do not contribute to the death-rate, do certainly contribute practical evidence as to the degree of vitiation of the working air. In all drives or winzes or rises, where development is being carried on some distance beyond the main air ways, ventilation other than the means ordinarily in use should be provided, in the form for example of the James' "water blast," which we shall describe in a moment, and of ventilation by pipes fitted with a reversible air jet, which can be used to propel air into the working places during the working time of the shift and extract it after blasting. These measures are recommended both in the English "Report on the Health of Cornish Miners," and in the "Report of the Western Australian Commission on the Ventilation and Sanitation of Mines." The latter contains a description of a simple arrangement of ventilating pipes in drives, designed to meet the difficulties of risk of injury from blasting.

In addition, any breach of the regulation regarding the proper examination of the working places by white gangers, prior to setting natives or coolies to work in them, should be severely punished.

Second.—One reads not infrequently of rescuers, working with misdirected heroism, being themselves "gassed," in one of these instances fatally so; one reads of deaths from inability to reach the affected persons in time, or from lack of skilled treatment on the spot after their extrication, facts which strongly accentuate the urgent necessity for the provision of effective rescue appliances, and for a more adequate knowledge on the part of mine officials and workmen of how to deal with cases of "gassing," on which we have already insisted.

Third.—We have noticed that in several instances it has been stated that boys have been set to shovel broken rock, and after working for some time, sometimes for several hours, have been overcome and found unconscious, or perhaps dead. There is no doubt that the broken rock tends to imprison the gases and that their subsequent liberation in shovelling may become dangerous in close places. And here again we see the necessity of more effective local ventilation, and of more continuous supervision on the part of the miners of work of this nature.

The question remains—are we to regard these cases of "gassing" as due to explosions which are exceptional in their nature, involving a partial burning of the explosives which does not normally take place? There is nothing wholly incredible in this supposition, for the number of cases of "gassing" is certainly small in proportion to the enormous quantities of explosives in use.

The origin of the explosives used in these cases of course differs considerably, and although the particular manufacture employed is not always specified in the official reports, it is clear that accidents may occur with one as much as with another. The composition of the explosives in local use also varies greatly, blasting gelatine, gelatine dynamite, and gelignite are all employed, and even of the gelignites, some of which are so named are as powerful as the ordinary standard of gelatine dynamite, while in others the active constituents form a rather smaller proportion than in the ordinary standard composition of gelignites.

One is left with two alternatives. Either the dangerous evolution of fumes of carbon monoxide and nitric oxide is due when it occurs to partial burning of the explosive, and this occurrence is exceptional, or even in normal explosions, the explosive decomposition is not theoretically perfect for the whole or part of the explosive, but commonly results in the production of varying quantities of these gases.

We have not as yet sufficient data to decide this question. We know how nitro-glycerine and nitrocotton behave when exploded and when burned, but as we do not yet accurately know what actually happens when these variously constituted nitroglycerine explosives are exploded under ordinary working conditions. It is very probable that under ordinary circumstances, especially with gelignites, the evolution of varying quantities of NO and CO is quite common, even when the shots are fired apparently quite satisfactorily. In other words, if perfection of explosion be defined as the production at the time of explosion of no deleterious gases other than CO_2, it is probable that under ordinary

working conditions an imperfect explosion is really not uncommon.

Mr. E. A. Mann has published in an appendix to the Western Australian Commission's Report the results of a careful series of experiments, undertaken with a view to determine the causes which might lead to the partial burning of explosives. This result, so far as his experience went, he did not find to be traceable to defects in the explosives themselves, there was no difference in different brands, and age up to two years made no difference either. He believed that careless storage of detonators, allowing of their deterioration, may be the cause in some cases, the only other cause revealed was burying the detonator too deeply in the charge, which may produce combustion through spitting of the fuse. The ordinary method of tamping he found to be sufficient, overcharging did not seem to affect the character of the fumes, and there was no obvious difference in results from the use of different sizes of detonators, which could be attributed to this factor alone. Nevertheless, all detonators should have full strength.

II.

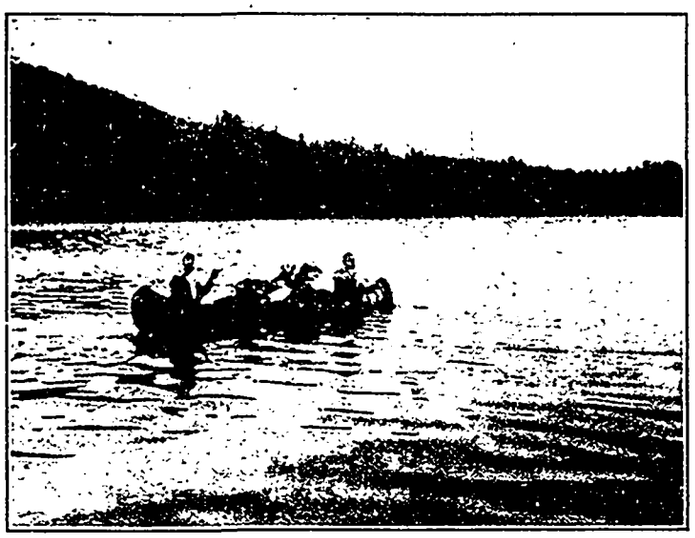
The gases which are formed from nitroglycerine explosives are important, not merely in occasionally producing "gassing," but in the constant influence they exercise in contributing to that vitiation of the general body of mine air by particulate and gaseous impurities, which is the most important cause of the unhealthiness of the miner's occupation.

Many of you will remember the great battle we had a couple of years ago in this Society, over the question of how far the vitiation of mine air by gaseous impurities contributed to the causation of the mortality amongst underground workers on the Rand, and to the production of "miners' phthisis." Mr. Heymann was the great protagonist of the "gaseous" view, and particularly of the theory that chronic carbon monoxide poisoning was probably the main causative factor involved. We ourselves, and the other medical men who took part in that enlivening discussion, held to the conclusion that dust was the chief primary factor in the production of the lung diseases of miners, although we agreed that constant dosage with sub-toxic quantities of carbon monoxide and nitrous fumes must also be reckoned as an important contributory factor in their causation. To this opinion we still adhere, while we admire the acumen of many of Mr. Heymann's contentions, and admit the force of some.

It is hardly necessary to resuscitate at much length that old discussion. It is to respiratory disease of a chronic type that the high occupational mortality of metalliferous miners all the world over is admittedly due, and there are three main factors which go to the causation of this respiratory disease. These are dust, infective processes, and gaseous impurities. And here we may say a word regarding the use of the term, "miners' phthisis." As we have said, the form of lung disease from which miners typically suffer, and which is due to the peculiar risks of their occupation, is a chronic one. It is characterized by a progressive fibroid consolidation of the lung tissue with accompanying catarrhal processes, and, while its onset is extremely insidious, its termination is often painfully rapid. It is to this condition, then, that the name "miners' phthisis," is applied, and personally we think the term is both suitable and useful. But it must be thoroughly understood that this term is primarily a clinical one, and carries with it no presuppositions as to its causation or its pathological nature. The chronic lung diseases which one meets with among miners, and which one includes under the term miners' phthisis, have in common the clinical features which we have mentioned. But even in clinical type they present several varieties, which are due to the preponderance in individual cases of one or other of the main causative factors, which contribute to the pathology of the disease. And, therefore, if we may usefully group the chronic lung affections of miners, which are characterized by these common features, and which are due to causes incident to their occupation, under the one name "miners' phthisis," we must at the same time admit that the term does not describe a specific disease due to a single causative factor, but is a name carrying implications which are primarily clinical and which does not exclude the possibility of there being more than one agent concerned in the production of the pathology and symptomatology of the disease. If this is thoroughly understood, the use of such a general, and, pathologically speaking, indefinite term as miners' phthisis is not only defensible but useful, if only to emphasize the fact that few cases of chronic lung disease occurring in miners who have spent many years underground are of quite unmixed causation, or are the manifestations of a single uncomplicated pathological process.

The prevention of "miners' phthisis" is one of the most serious public health problems with which we in this country have to deal, for the mining community it is the most serious health problem. And, therefore, we propose to take up each of these contributory factors which we have named seriatim, and to discuss what may in each case be done in the way of preventing or mimimizing their effects.

The first factor is the dust produced in the drilling of rock by machine or by hand, in blasting, and in shovelling or handling the broken rock. The dust produced by drilling by machines is of the first importance, since rock-drill miners are the heaviest although not the only sufferers from lung disease.



ALONG THE G.T.P.
On River Crôche, a tributary of the St. Maurice.

ALONG THE G.T.P.
Lake Coocoocache, where the Hudson's Bay Company have a fort.

Some time ago we concurred in the opinion of the Chamber of Mines Committee, that in principle the water-drill, a drill, that is, which delivers water as part of its ordinary operation at the end of the drill, was the best means of laying the dust so caused. The trouble is that no such rock-drill is yet on the market which can be recommended for general use. The Leyner drill is the nearest approach to the successful application of the principle, and it does good work, we believe, in rises, but it requires a high pressure and it is costly in maintenance. This being the case, the Committee gave the first prize to Mr. Britten's atomizer. But there are objections to the atomizer in the supersaturation of the air which it causes; a supersaturation which, while somewhat objectionable even if the water employed were pure, is decidedly so when impure water is used. A jet, delivering water into the hole while successful in laying the dust, is apt to give trouble in working by causing the dust to cake and the drill to jam. We are inclined to think that the most generally useful device, which depends upon water, is a coarse spray kept playing at the mouth of the hole. It lays the dust, if a little care be used in occasionally cleaning the mouth of the hole it does not choke, it consumes less water than the jet, and while it may increase the local humidity of the air it does not supersaturate it. For such a spray as for the atomizer, the power can be obtained from the compressed air, as in the case of the atomizer also it is desirable that a supply of water free from organic contamination should be employed. The nozzle of the spray may be usefully of a type to give a rotatory movement to the water.

In hand-drilling it is more easy to control the vitiation of the air by dust. The amount produced is very much less, and the spaces in which work is done are much less confined. If water is used, the amount of dust produced, once the hole is well started, is slight. But one's observation does not go to show that a sufficient supply of water to allay the dust is consistently used in this process. And, further, it is seldom remembered that a considerable quantity of dust is produced in starting the holes, before these are deep enough to hold water. Thomas and McQueen found that as much as 4 mgrm. of dust per litre of air was present in the air at the turner's mouth at the starting of a hole, which is as high as the average of dry holes drilled by rock drill. They recommend that a wet sponge squeezed against the drill in holding it should be employed at the start, and as sponges are expensive no doubt a simpler substitute could be found.

The dust produced by blasting is also a matter of great moment. To allay this, probably no better device can be used than the James' "water blast," the principle of which is to employ the pressure of the compressed air to project into the face immediately after blasting a quantity of water. The mechanism is simple, and its use and effects are thus described in Haldane, Martin, and Thomas's "Report on the Health of Cornish Miners."

"We find that the following plan, devised by Mr. William James, underground agent at Dolcoath, is very effective in quickly laying the dust and diluting the gases. At the mouth of the level a piece of 6 in. iron pipe or a small cylinder, provided with a side tap, is let into the ordinary 2 in. pipe for carrying the compressed air for the drill. Before the blast this is filled with water through the side tap from a cistern, after the compressed air has been turned off. Immediately after the blast the compressed air is suddenly turned full on. The water is thus driven along the pipe with great velocity, and a mixture of finely divided water and air is discharged from the open end, which is directed towards the face which has just been blasted. By this means the dust is entirely cleaned from the last 30 or 40 ft. back from the blast, the air leaving quite clear immediately after. If a ventilating pipe is carried forward about as far as the compressed air pipe, any dust which has been driven out beyond the reach of the jet can be rapidly carried off. This plan has the great merit that it requires scarcely any trouble, and no extra apparatus except the 6 in. pipe and the tap for filling it. The rock blasted is also thoroughly wetted so that no dust is produced in shoveling it. The water partially washes out from the air any nitrous fumes which may be present, but, of course, not carbonic oxide, and for this reason, if no other, a ventilating pipe is desirable in cases where the level or rise has been carried a few fathoms beyond the air current."

The water blast, as this statement shows, not only allays the dust most effectually, but is in addition very useful in diluting and removing nitrous fumes; it reduces the percentage of carbon monoxide also, "partly owing to the fresh air thrown in with the water and partly to the effect produced in mixing the air of the level or rise with the products of combustion." We believe that this mechanism has been already used in isolated cases on the Rand. It is very desirable that its use should be greatly extended in drives, rises and winzes, since it is through stagnation of air in these places that "gassing" accidents commonly occur, for the prevention of which the general method of turning on the compressed air in the ordinary way is clearly not always effectual. The use of the water blast should be supplemented, as we have said, by that of the air-jet.

The dust caused by shovelling and handling the broken rock is also considerable. Where the water blast is applicable, no further means is necessary, where it is not, means should be taken to wet the rock.

Pace Mr. Heymann we may grant we think that in all true cases of miners' phthisis, dust with its direct consequence in silicosis is the primary causative factor; silicosis is the feature common to them all. Of the secondary factors there comes first what we may term the infective factor. The chief infective process which complicates these cases is of course tuberculosis. When shortly after the recommencement of work upon the mines after the war, we first systematically investigated this question, we came to the conclusion that tuberculosis was present only in a minority of cases of miners' phthisis. At that time we certainly saw a much greater proportion than we do now, or we think, than we did before the war, of the pure "dry" form of miners' phthisis, which is typical of silicosis uncomplicated by superimposed infection. This experience was not in harmony with that of Dr. Haldane and his colleagues, who recently reported on the causation of the high mortality from lung disease amongst Cornish miners. They concluded that of the cases of lung disease in miners "probably at least two-thirds, including all cases of so-called miners' phthisis, were to be looked upon as in reality of a tubercular nature," and a considerable proportion of these cases were men who had worked in the Transvaal. We believe that this conclusion was to sweeping to represent accurately the conditions on the Rand at the time, although our present experience approximates more closely to it than did that of three years ago. We believe that at present on the Rand the majority of cases of miners' phthisis do end up with tubercular infection, although we still, undoubtedly, meet with a minority of cases of the pure "dry" type, which appear to be from first to last non-tubercular in character. Given a certain development of silicosis, some intercurrent illness, pleurisy, pneumonia, influenza, or a severe "cold," may be the starting point of the infective process, or it may develop more insidiously. Some cases, no doubt, are tubercular from the beginning, but the mining life of those so affected is a short one. These are not cases of miners' phthisis but of ordinary phthisis in a miner. Pneumonia is characteristically slow to clear up, to "resolve," as we call it, where silicosis is present, it is very apt to persist in the form of a chronic catarrh, which may eventually become tubercular. And, apart from this, localized areas of catarrh, apparently so far as clinical and bacteriological observation goes, non-tubercular in character are commonly met with; they often clear up satisfactorily under treatment. Under ordinary working conditions then we believe that the majority of cases of miners' phthisis do in the end become tubercular. If they do so, the downward progress of the case is usually rapid. Now in this qualification under ordinary working conditions we have, we believe, the explanation of our past experience. The condition of affairs, when we first came to investigate the subject, was not ordinary. The war had caused an interruption of mining work for the miners of two or three years' duration, and it is very likely that many men, in whom fibrosis of the lung was already well developed, escaped as a consequence of this interruption the terminal infection which they might otherwise have contracted. Nothing was more striking than the manner in which in many instances men who had served in the field with good health during the war quite suddenly began to go down hill on resumption of mining work. Their lungs were so far crippled that, although under the favorable conditions of service on the veldt, their health was well maintained, the balance tipped fatally against them on renewed exposure to the irritant effects of the vitiated underground air. And many of these men died without any clinical or bacteriological signs suggestive of tuberculosis.

Perhaps many of you may think that this point is of merely medical interest. But the heavy incidence of tubercular and fibroid phthisis amongst our natives and the signs of a recent increase of the infection amongst whites, suggests a "safety measure" of much importance, namely, strict examination for cases of tubercular phthisis before the natives enter the country, in the detention compounds, and on the mines. To a large extent this is done already; what we should urge is that this process should be carried out with the utmost degree of thoroughness, and that every native proved to be suffering from tubercular phthisis should be absolutely prohibited thereafter from working underground.

The same question arises with regard to white workers. The West Australian Commission definitely lay it down as a recommendation that no white worker proved to be suffering from tuberculosis of the lungs should be allowed to go underground. For the affected man to continue underground work is merely suicidal, and for his mates the risk of working in close places in company with anyone affected by tuberculosis is certainly a definite one. We would urge therefore that the Government should seriously consider whether it would not be wise in the interests of all concerned to follow the recommendation of the Australian commissioners. The proved necessities of public health must override individual interests, and in these cases the interest of the individual, so far as his health is concerned, coincides with the public interest. No doubt, it must be regarded as a hardship to compulsorily debar a man from following his occupation, but the step would only anticipate by a few months, or at the most by a year or two, the final irrevocable compulsion of the disease itself, should the affected man persist in following his

occupation. That this measure would greatly prolong the lives of those already affected by advanced tuberculosis we do not asert, but in early cases of tuberculosis when a slight or moderate degree of silicosis was present, it might certainly do so. But if this step be taken the community must see to it as an equally necessary condition that the conditions of underground work are made such as to reduce to a minimum the occupational risks to health and life. In the meantime, it would be well, in order to obtain data for the deliberate consideration of this serious question, to make tuberculosis in underground workers a notifiable disease.

Gold mining in this country is admittedly an unhealthy occupation; it has been proved that six to nine years' work, and sometimes a considerably shorter period, will inevitably impair or exhaust the working efficiency of a rock-drill miner. Of 47 fatal cases of lung disease among rock-drill miners who had worked in the Transvaal alone, Dr. Haldane and his colleagues found that the average period spent in rock-drill work was 4.7 years. And, in remembering the white miner, we must never forget the much larger number of sufferers amongst the native workers.

But are we to be content to sit down before this situation and look at it? We have looked at it long enough and it does not improve in the looking. Rather must we set to work as a community to alter it. And while it rests with the Government and the mining companies to provide adequate ventilation, adequate means of dust prevention, adequate sanitation, adequate change houses and quarters, and a judicious arrangement of working hours, a very great deal rests with the miner himself. Of some matters relating to the former aspect of the question we shall speak presently; on the latter, the private aspect affecting the individual miner, we wish to say something now.

In the matter of the incidence of lung disease amongst miners the initial physique of the man counts for very much. We always, although not as a rule with any marked success, seek to dissuade any man from becoming a miner whose chest development is poor. It is very close to the truth to say that, so far as occupational lung disease is concerned, the chest expansion of a man is the index of the length of his life as a miner. And further the condition of the chest can be improved and maintained by suitable chest exercises, which stimulate circulation in and excretion from the lungs. We have found the adoption of this treatment to produce marked amelioration even in established cases of miners' phthisis. Light dumb bells, Indian clubs, Sandow's developer, even simple breathing exercises, or a short sprint after the shift is over, are all or any of them useful in this respect. For, apart from infection, miners' phthisis is really mainly a mechanical disability, and it is of the utmost importance to prevent this disability from developing by maintaining the highest functional and excretory activity of the lungs.

The avoidance of risk of chills is another important point, in regard to which the regular use of change houses is all important. The West Australian Commission lay down most detailed provisions regarding the construction and the use of change houses, of which we most cordially approve. In these it is also provided that no man should go to his room in his working clothes. These must be left in the drying-house in his particular locker. The working clothes must be changed at least once a week, if they are left in the lockers over the week end they are to be confiscated and destroyed. The object aimed at is to prevent the living rooms of the men being rendered unclean and unhealthy by the presence of wet, dirty and perhaps faecally contaminated working clothes.

Another point is the individual's responsibility and duty regarding mine sanitation. Where adequate sanitary conveniences are provided, no white man should permit himself, or, so far as he can prevent it, the colored laborers under his control, to foul the underground workings with faecal deposits.

And, lastly, if dust preventives are provided, it is for the miners to use them.

Of course, whatever devices are recommended, it is certain that the men will object to use them. This experience is universal. But, should it be made legally compulsory, as it is now by the new regulations regarding dust prevention, to use some means of allaying dust by water, and the compulsion enforced by supervision and penalty, it would, we fancy, be remarkable how soon the traditional inertia of the miners in a matter so vitally affecting their own health would be overcome, when they really saw that the security of their occupation and of their pockets was involved in addition to the security of their health. And when we remember that not merely the health of the white miners is concerned, but that the health of the mass of our army of unskilled workers is also directly involved, there should be no hesitation in enforcing the use of these preventive measures.

And here we may say a word on the use of respirators. We have never regarded these as anything other than as a second, and unreliable, line of defence. The first consideration is to prevent the formation of dust and noxious fumes, or to remove them when formed. To rely solely on preventing the inhalation of dust is to occupy a weak and secondary defensive position. And to hammer again on the old nail: Respirators do not help the native. Nevertheless, respirators intelligently employed are useful for the specific purpose of preventing the inhalation of dust, and for all engaged in rock-drill work their use, when there is exposure to a very

dusty atmosphere, is certainly advisable until better preventives are generally adopted. No doubt, they are a trouble to use and to keep clean, they are apt to get sat on in the skip, their valves get out of order; they get dirty, they are uncomfortable and hot; you can't smoke with them on or talk. But, in spite of all these inconveniences, they have been used to advantage by those who take them seriously and use them properly. Probably the light aluminum respirators are the best on the market. If they are going to be used, pin down the valve or it will get jammed half open in time, and replace the cotton wool with two layers of flannel cut to shape, the outer layer being removed at each shift.

But respirators are only tolerable to those whose breathing capacity is comparatively unimpaired, those who are already "short of breath" may not be able to bear the slight added disability .ney occasion. Their use, therefore, cannot be made compulsory.

III.

Dust and infective processes, as we have said, are two of the three factors mainly concerned in producing the high respiratory mortality amongst underground workers. The third is the vitiation of the general body of mine air by gaseous impurities. This vitiation may arise from several sources. In many mining areas abroad, chemical changes in the rock account for a large percentage of the total of carbon dioxide present. In Cornish mines, for example, Dr. Haldane and his colleagues found that the carbon dioxide in the mine air was almost entirely due to the slow oxidation of minerals and timber. On the Rand this is not the case, owing to the general absence of carbonates from the rock, and this source of contamination of the underground air is, under local conditions, practically negligible. Analyses have shown that the air in dead ends, where no work has been done for considerable periods, may show little excess of carbon dioxide over the outside air. The main sources of vitiation are, therefore, the respiration of the white and colored workers, the combustion of candles, and the gases produced by explosives.

One other alleged source of contamination we may dismiss as in general unimportant. In the Report of the Transvaal Miners' Phthisis Commission, a series of eleven analyses of "Air supplied by the Compressor" was published. In nine of these carbon monoxide was either absent or present only in small traces. But in two it was stated to be present in quantities which would render it quite impossible to carry on work, and since the local ventilation of many working places in the mines is dependent to a large extent on the exhaust from the rock-drills, the indictment against the use of compressor air was a grave one. Elsewhere these results were severely criticised. Dr. Haldane, in Cornwall, found that the compressor air was free from appreciable quantities of CO, and Mr. Mann, in the analyses published in the Western Australian Commission's Report, makes the same statement.

Dr. Moir, indeed, has recently stated his belief that these particular samples cannot really be taken as representative. Not being responsible for the taking of the samples, he was not responsible for the conclusions to which the analytical results appeared to point. That firing may occur in compressors, especially if oils of too low a flash point are used for lubrication, is, of course, undoubted, and that this has been the cause of fatal accidents is well known. Quite recently, at the end of February of this year, a native was fatally "gassed" on one of the mines of the Rand through the inhalation of gases, due to an explosion in the compressor cylinder. It appears that this was the third occasion within six years that a similar occurrence had taken place with this particular compressor. On the two previous occasions there had been no loss of life. In both of these the character of the oil had been suspected. In this last instance, however, the explosion was found to be due to the fact that a leakage had taken place in the air delivery valve, which allowed communication between the high pressure discharged air chamber and the cylinder, the high pressure air being thus allowed to return to the cylinder for re-compression. The result was that the temperature was at once greatly increased, probably to something in the neighborhood of 630 deg. F., and the oil in the cylinder and the receiver was vaporized and ignited. Underground it was noticed at once, at practically all the machines, that gas was escaping, and the men left the working places immediately. No fatality, indeed, would have occurred if one native had not characteristically gone back to fetch his coat from near the face of a drive. He was overcome, and although rescued alive, died within an hour afterwards. This accident was due to a mechanical defect, the displacement of a set pin in the high pressure air delivery valve. Similar leakages are a well known cause of accidents of this nature. Apart from occasional occurrences of this sort, the use of oils of a high flash point as lubricants, frequent cleaning, and the provision that the intake should be from the outside air, should suffice to prevent any general danger of vitiation of the underground atmosphere by compressor air. To avoid offensiveness from foul water stagnating in the pipes, water traps should be provided, which shall automatically blow themselves off when full of water.

This alleged source of vitiation being excluded, we are left, as we said, with the impurities due to respiration, to combustion of candles, and to explosives, as the main factors.

The six analyses published by the Miners' Phthisis Commission of "Normal mine air under ordinary working conditions" were certainly

strangely labelled. All the samples taken were in "bad places," and even the average of carbon monoxide stated to be present, namely, 0.13 per cent., was so high as to be immediately dangerous to any worker who might be exposed to it. Such a quantity would produce symptoms of poisoning in half an hour or more. If this were a usual composition of the air, even in dead ends, serious gassing would inevitably be very much more common than it is. One was forced to the conclusion either that the estimates of carbon monoxide in these samples were incorrect, which we hesitate to assert, or that the samples were very far from being representative, on which point we have no doubt at all. One may be pardoned, therefore, for setting them aside as indicative of the composition of mine air in ordinary working places.

More recently Dr. Moir has provided us with an admirable series of analyses representative of the composition of mine air. They refer to one mine only, one of the deep level mines of the central group.

Dr. Moir's results are extremely interesting as an illustration of the practical working of natural ventilation in a deep level mine. There are two shafts, one acting as downcast, the other as upcast. Four levels of the mine had been developed, and in three of these stoping was fairly well advanced. Both shafts had been sunk below the fourth level, and some driving had been done from them, but stoping had not been commenced.

The total quantity of air supplied had an average of 75 cub. ft. per man per minute, but it varied between the wide limits of from 35 to 50 cub. ft. in summer, to as much as 140 cub. ft. in winter. Further, it was badly distributed, the main reef workings were well ventilated, considerable portions of the south reef workings were also satisfactory, others were not so either as to quantity or quality of air. The CO_2 rose from 0.35 per 1,000 in the downcast shaft to 1.0 per 1,000 in the upcast, but locally where the air current was poor it rose to 2.0 or even in one instance 4.0 parts per 1,000.

Two sets of observations are of particular interest. First.—Two analyses of the air close to the downcast shaft at the fifth and sixth levels, below the portion of the mine, which had been opened up, gave respectively

CO_2 1.79 per 1,000	CO 0.13 per 1,000
CO_2 1.39 "	CO 0.22 "

This vitiation was due to the previous day's blasting, and it goes to show the unsatisfactory nature of ventilation under these circumstances, when only compressed air is relied on. There were about five men and two machine drills in each of the places.

Second.—An analysis of the return air of the mine, on a level, in a locality where a shift was working an hour after blasting, gave

CO_2 4.0 per 1,000 CO 0.38 per 1,000,

again pointing strongly to the necessity in these conditions of removing noxious fumes by mechanical ventilation before work is resumed. In this portion of the mine the air supply was insufficient, and a specially large quantity of explosives was employed.

Determinations were also made of the temperature and humidity in the shafts and workings. The air of the upcast shaft had a constant humidity of 100 per cent., and a practically constant temperature all the year round of 69.6 deg. F. The air of the workings was similarly almost constant in these respects, humidity being always over 95 per cent., and the temperature in open places practically constant at 69 deg. This was at a depth of 1,200 ft. In the downcast shaft, temperature and humidity varied, naturally, with season and state of weather, but the average humidity at the bottom of the shaft was 97 per cent. in an extended series of observations. The temperature ranged from 54 deg. F to 67 deg. F., according to season.

These results show very clearly the risks of reliance on what one may call haphazard natural ventilation—variable supply of air, unequal distribution, good ventilation in parts of the mine, a considerable degree of local vitiation in other parts. The exhaust from the rock-drills during working, and the use of compressed air from the mains to blow out the smoke after blasting, are the only supplementary factors commonly operative, and while the exhaust from the drills is usually sufficient to keep the air in their vicinity fairly good, it may be quite inadequate to secure the general purity of the air further back. Even where the drills are running there may be places where the condition of the air in their immediate neighborhood is very far from perfect.

Extended detailed analyses of this sort are very necessary to enable us to arrive at a satisfactory knowledge of the actual condition of the underground air in the mines of the Rand, and at a satisfactory judgment as to how far, and in what way, natural ventilation, particularly in deep level mines, should be supplemented by mechanical means. Probably the condition of this mine is fairly representative of that of many others, although we anticipate that the ventilation of the outcrop mines will be found to be, on the whole, satisfactory. The Government Mining Engineer is at present having a systematic series of quantitative determinations made in a considerable number of the mines, with a view to obtaining the extended data necessary. We have already stated our opinion that it is very desirable to supplement the present method of ventilation of drives, rises and winzes, by mechanical means, such as the water blast and ventilating pipes fitted with a reversible air jet, measures which should go a good way to meet the special difficulties of development. To adhere solely to a standard

quantity of air supply is clearly inadequate if the proper distribution of that supply is not secured. For this we must supplement the standard minimum datum of quantity with a standard minimum datum of quality, which should apply to all the parts of a mine where work is being actually carried on.

We cannot, perhaps, do better than quote here the specific conditions laid down in the Western Australian Commission's Report to define what is pure air.

"The air in any part of a mine where men are working or passing shall be deemed to be pure air, and in a fit state for working and passing therein if

(1) The total quantity of carbon dioxide present does not exceed .15 per cent. of the air by volume; but at any point where firing has taken place such test shall not be taken until at least half-an-hour has elapsed since the firing, unless the men have returned to work; and

(2) The temperature does not exceed 85 deg. F.; but, nevertheless, a higher temperature may be allowed by the Minister on the recommendation of the Mines Regulation Board in cases where it may be shown to be impracticable to maintain a lower temperature; and

(3) The percentage of humidity does not exceed the amounts set out for the relative dry bulb thermometer readings in the table previously quoted (this is the standard laid down in the Cotton Cloth Factories Act, 1889); and

(4) That the temperature at the place where the test is taken is not more than 5 deg. F. above that of the air in the principal intake of air into the main level from which the said place derives its supply; and

(5) That there is a perceptible current of air passing the place tested sufficient to distinctly deflect the flame of a candle, but such test shall not be taken within 10 ft. from the face of a drive or crosscut, nor from the top of a rise or bottom of a shaft or winze, nor when rock-drills are working so close to the testing point as to cause agitation of the air.

The air shall be deemed inadequate and unfit for working or passing therein, if any one of these requirements be not complied with."

Adequate ventilation is the first "safety measure" in mining; it means efficient work and efficient health; inadequate ventilation just as certainly means inefficient work and impaired health. And the analyses we have quoted certainly show that, quite apart from dust, amounts of carbon dioxide and carbon monoxide may be present locally in the air of working places, not sufficient, perhaps to cause acute symptoms, but sufficient, if repeatedly inhaled, to deteriorate the health of the workers. And, in our experience, clinical observation confirms this view. We agree with Mr. Heymann in the opinion, which Dr. Black expresses in the Western Australian Commission's Report, "that chronic carbon monoxide poisoning is probably much more common than is generally supposed." As a matter of fact, it not infrequently happens, that a miner tells one that, when he was working in a rise or an ill-ventilated drive continually for three or six months, he felt during that time he was out of sorts, that he was steadily getting weaker, less able to do his work, more short of breath, suffering also, perhaps, from dyspepsia, until, finally, he stopped his work, or went to another part of the mine. Then he will tell one he began to get better again. Such cases as these are not uncommon, and we have little doubt that in them we may have what we may call a sub-acute or chronic carbon monoxide poisoning of a degree sufficient to cause symptoms of itself and certain to aggravate any pre-existing silicosis. It may be, indeed, that account must be taken of this factor in explaining why miners' phthisis is more fatal here than in other mining centres. It is quite likely that some and even much of the anaemia from which miners suffer is traceable to this cause, and the general anaemia and lowered vitality also necessarily imply a local lowering of vitality on the part of the lung, rendering it more susceptible to the action of irritants and the invasion of infective processes.

There are three reasons then why miners' phthisis is apparently more prevalent and more fatal on the Rand than in other mining communities. First, that the rock is hard, and the mines are relatively dry. Second, that the number of rock-drills used is proportionately great. Third, that the quantity of explosives used is also proportionately large.

And there are two main preventives—water for the dust, ventilation for the gases.

The Western Australian Commission do not advise the use of water for the prevention of dust, for the specific reason that the increase of water in the mines would increase the risk of the introduction and spread of ankylostomiasis. They would prefer some method of dust extraction, although they admit that no satisfactory method of doing this has yet been devised.

The same risk may, perhaps, be held to exist in our own mines. During the last few years cases of ankylostomiasis, and even occasional deaths from the disease, have been reported as occurring amongst the native workers. We have not as yet, however, seen any cases clinically pointing to the existence of "miners' worm" in whites, although at Kimberley the disease is not uncommon. Nevertheless, ankylostomiasis is, undoubtedly, liable to occur amongst the natives, and particularly amongst those from the tropical coast districts. It should, therefore, always be looked for, and when found it should be dealt with, in the detention compound and on the mines, and no native who is known to

suffer from the disease should be allowed to go underground without previous thorough treatment. Ankylostomiasis is already a notifiable disease. Whether the general acidity of the underground water, as has been suggested, has hitherto been a safeguard against the dissemination of the worm underground or not, the increased use of water might, by making the working places locally more muddy, tend to add to the risk of its spread. It is in warm faecally contaminated mud that the ova and larvae of the worm develop.

The question is which is the greater risk—dust or the worm. Unquestionably dust. Ankylostomiasis when recognized, and it should always be looked for, is infinitely more amenable to treatment than are the lung diseases of miners. Nor do we consider, judging from the experience of the past few years, when the worm has undoubtedly been present amongst certain tribes of natives, that the future danger to the industry from this source is likely to be serious, provided reasonable precautions are taken. Nevertheless, in spite of recent great improvements, we doubt whether underground sanitation is everywhere regarded with quite the seriousness which the circumstances warrant. Its supervision should be held to be the particular duty of an adequate staff of special inspectors. The native, of course, does not regard it as serious at all, and as he is apt to act in that belief, he is the main source of danger. In all cases where the compounds are at a distance from the shaft heads, additional latrines should be provided within a reasonable distance of the latter, and in any case pressure should be put upon the boys to make use of the latrines before going underground. Further, the use of underground water for drinking purposes should be prohibited. The native and colored workers should be supplied with water bottles which should be filled from a pure source.

Dr. Haldane and his colleagues conclude their "Report on the Health of Cornish Miners" with these remarkable words:—

"We venture to express our conviction that there is no reason why work underground, in whatever kind of mines, should not be a perfectly healthy employment; the work itself is thoroughly wholesome both to body and mind, and the special dangers, whether to health or to life associated with different varieties of mining are such as if recognized and faced can be avoided, provided that both employers and employed will co-operate in bringing this end about."

To many these words may appear to convey a mere counsel of perfection. But we are not justified in treating them so until we are sure that everything practicable has been done both by employers and employed to realize them as far as may be in practice. The mines of the Rand have gained an unenviable reputation with regard to the mortality and sickness which occur amongst both the white and the native workers. Everyone must recognize the many economic difficulties which the mining industry has to face. Everyone must recognize that climatic more than occupational influences are largely responsible for the high death-rate amongst our native workers, and that very much has been done within the past few years to make life and work upon the mines both more attractive and more healthy. Knowing this, we can afford to ignore the ridiculous statements which have been so freely made in England regarding the treatment of the workers by those responsible for the direction of the mines. But at the same time it is our conviction that more is needed. The adoption of the measures we have outlined would no doubt lead at the outset to increased expenditure and higher costs, but we are convinced that it would be an expenditure which would yield a rapid return by directly decreasing the wastage which now occurs in health and life—a wastage which in view of the restricted nature of our supply of unskilled labor in South Africa constitutes a most serious economic drain.

THE EARTH'S TEMPERATURE.*

(By Hugh F. Marriott.)

The country in the immediate vicinity of the Main Reef series consists chiefly of evenly-deposited sandstones and shales which have been faulted and intersected by dykes only to a very moderate extent, and have not been subjected to any great disturbing earth movements. The country rock does not contain constituents to any appreciable extent which are liable to decomposition on exposure to air and water. Iron pyrites is present only in a proportionately small degree, and, so far as yet noted, occurs only in isolated crystals. These facts render the locality suitable for the further establishment of the theory of regular and systematic increase of temperature in direct proportion to the depth from the surface.

The Witwatersrand area possesses peculiar advantages for the estimation of deep-level temperatures, having within its more central limits an extensively-worked closely-allied series of outcrop mines, flanked by a deep level row of mine workings, which in their turn are outlain by still deeper shafts and mine works, and by bore-holes which penetrate the strata to great depths.

The various mines and bore-holes in which the temperature observations were taken, are grouped together within an area of eleven miles along the strike of the country by one and a half miles to the dip of the reef deposit. The positions of the various

*Read before the Institution of Mining and Metallurgy, March, 1906.

places noted are easily ascertainable in any of the published maps of the district and need not be further detailed here.

The depths at which the observations were taken are recorded hereunder. They are as follows:—

Name.	Mine or Bore-hole.	Range of Observations, in Feet, Vertically Below the Surface.
Robinson G.M. Co..	Mine	Between 497 and 784 ft.
Crown Reef G.M.Co.	Mine	Between 547 and 914 ft.
Geldenhuis Deep ...	Mine	Between 500 and 1000 ft.
Ferreira G.M.Co. ...	Mine	Between 500 and 1142 ft.
Ferreira Deep	Mine	At 1158 and 1175 ft.
City & Suburban G.M. Co.	Mine	Between 495 and 1201 ft.
Jumpers Deep	Mine	Between 348 and 1235 ft.
Village M.R.G.M.Co..	Mine	Between 518 and 1242 ft.
Crown Deep	Mine	Between 590 and 1253 ft.
Durban Deep	Mine	Between 500 and 1420 ft.
Nourse Deep	Mine	Between 530 and 1500 ft.
Simmer East	Mine	At 1700 and 1800 ft.
Robinson Deep	Mine	Between 500 and 2400 ft.
Bezuidenville	Bore-hole	Between 1000 and 2930 ft.
Turf Mines	Bore-hole	At 3400 ft.
Simmer West	Mine and Bore-hole	Between 3358 and 3473 ft.
Jupiter G.M. Co. ..	Mine and Bore-hole	Between 3906 and 3916 ft.

The following mines also were included in the observations of relative air and rock temperatures on the fields:—Geldenhuis Deep, Ferreira Deep, Langlaagte Deep, French Rand, Durban Roodeport, Robinson Central Deep, Jumpers Deep.

The thermometers used were made in each case to suit the particular class of work required, and included the following designs:—

1. Slow-registering maximum thermometers, in which the mercury index is separated from the main column and is left in the highest registered position when the column recedes on cooling. The thermometer proper is encased in an outer glass tube containing alcohol in liquid and vapor form, and it is thus effectually protected from any exterior changes of pressure, and is only slowly susceptible to changes of temperature.

2. Quick-acting maximum thermometers with a separate mercury index. Except as regards the detached index, these were made on the pattern of the ordinary clinical thermometer, and are extremely rapid in their recording properties.

3. Quick-acting themometers of design exactly similar to the ordinary clinical thermometer, in which the mercury column passes from the bulb into the stem through a restricted neck, and remains in position as an index of the maximum temperature recorded.

This last type of instrument has proved itself universally reliable throughout the various classes of experiments, and is the best and handiest design for work of this description.

Several other types of thermometers were made for this work, and were tested for efficiency under the varying conditions. One of these, a variation of Walferdin's thermometer, is interesting from the theoretical point of view. In this instrument the bulb and stem were fully charged with mercury at the commencement of the experiment, and on being heated the mercury flowed out through the nozzle in the top of the stem into the bulb or cup, which was so designed that, when used in any position except that approaching the horizontal, the discharged mercury was imprisoned in the cup and could not return down the stem on cooling. The method of reading the record obtained was by re-heating the thermometer in an air or water bath, in conjunction with a standard thermometer, until the mercury again reached the overflow point. The temperature recorded by the standard thermometer was then noted. Another method was to have the stem graduated in an inverted order of degrees, which were calibrated at a given standard temperature. The thermometer was thus placed in a bath at the standard temperature, and the previously-recorded temperature was then read directly off the top of the mercury column standing in the stem.

For use in mine work the design mentioned as No. 1 was encased in a copper tube perforated at both ends to allow the free passage of water. The remaining designs were used enclosed in water and air-tight iron tubes, which were lined with wood to render the thermometers less susceptible to temporary changes of temperature.

In making experiments down the mines, wherever possible, the system of preparing the ground for observation was as follows:—A spot was chosen in a drive, cross-cut, or pump-station as nearly at the required depth from the surface as convenient, and as far removed from the main air-way as possible. A 5-ft. hand-drill hole was then put into the wall near the floor, inclined downwards at an angle of about 30° from the horizontal. This hole was then filled with water and the mouth plugged with clay, after which it was left untouched for at least twenty-four hours. This procedure ensured the obtaining of the true rock temperature at the point of observation.

Wherever feasible, two thermometers of different makes were placed in the bottom of each hole thus prepared, and in some cases another thermometer was placed at the mouth of the hole as a check on the main results. The hole was again sealed up with clay and the instruments left in position for at least half-an-hour. The thermometers were then withdrawn, the readings taken, and the variation, if any, of the upper instrument from the lower was noted.

At intervals during the complete series of experiments, the thermometers used were all checked at different temperatures within the range required against a standard thermometer, and the corrections were noted and applied to the readings. In every case the extreme variations of the air temperatures

at the time and point of observation were recorded by a maximum and minimum thermometer with iron indices, and these readings proved valuable in checking the reliable results obtained, and eliminating readings of doubtful veracity.

For bore-hole work various types of thermometers were tried; but the clinical type with the completely cut-off column described under No. 3 was finally exclusively adopted as giving the only consistently reliable results.

These thermometers were enclosed in a watertight case in a set of four, two being placed upright and two inverted. The case was then lowered, by means of a wire passing over the measuring drum, down the hole to the depth at which records were required.

The bore-holes experimented upon were continued to great depths and were invariably almost full of water, and thus enormous external pressure had to be contended against as it was essential that the thermometer readings should not be complicated by varying pressures during the experiments. The type of case specially designed for this work has proved so successful in practice that it is worthy of a short description.

A solid steel cylinder, of diameter suitable to the requirements of the bore-hole, is drilled longitudinally in four blind holes, each just large enough to take a thermometer of the size required. These four holes open into an upper circular chamber which is closed by means of a screw plug containing a square keyway sunk in its head. The wall of this chamber is made as thin as possible, consistently with having sufficient strength to carry the outer cap, which is of the same diameter as the cylinder and is screwed down over the chamber containing the plug. The top of the outer cap and the bottom of the cylinder are each cut to take a hexagonal spanner.

An absolute lock against the transference of external pressure to the thermometer chambers is produced as follows: any leakage through the joint of the outer cap must pass up along the outside of the thin chamber wall and into the hollow keyway of the plug. This pressure acting primarily on the outside of the chamber wall causes the screw plug joint to become tighter. Any access of pressure within the keyway of the screw plug also serves to further tighten the joints of both sides of the chamber wall, and this action is intensified indefinitely with increase of pressure. The tightening effect is also assisted by expansion due to the rise of temperature encountered.

In practice, the total leakage has never amounted to more than a single drop of water introduced into the keyway, and the plug and cap are never more tightly screwed up than can be easily accomplished by a small hand spanner.

In case any extreme jarring were to falsify the results of the thermometers, the two upright instruments would give lower records than those in an inverted position, and the error would be thus immediately discovered.

To ensure the thermometers being introduced at a temperature lower than that to be recorded, the cases are prepared for the reception of the cooled thermometers by being placed in a freezing mixture such as ice and salt. Where light transport is a consideration, a convenient method is to surround the cases with cotton waste, and, having saturated this with ether, to place it in a current of air. Care must, however, be taken that the thermometers themselves when lowered are free from any continuous disturbing influence of this nature.

Details of the readings taken in the Mines, are as follows:*—

Robinson, G. M, Co.—At 497 ft. vertical, the reading was taken in a 5 ft. machine hole which was located in sandstone 10 ft. from the wall of a dyke. It gave 68.5°.

At 784 ft. vertical, the reading was taken in a heading the air in which registered over 70° of temperature; the result was 68.25°.

Crown Reef Gold Mining Co.—At 574 ft. vertical the reading yas taken in a hole in sandstone 184 ft. distant from a large dyke; the result was 67°.

At 914 ft. vertical the reading was taken in sandstone in a hole in the cross-cut which connects this mine with the Crown Deep, and the rock here has been subjected to a continual draught of cold air; the result was 65.5°, and the water in the launder coming down from the higher levels was 67°.

Geldenhuis Deep.—At 500 ft. vertical the reading was taken in sandstone in a dry 5 ft. hole sunk in the footwall of a stope lately opened; the result was 68°.

At 1000 ft. vertical in No. 1 Shaft the reading was taken in sandstone in a 5 ft. hole, one thermometer being in water and the other in air; the result was 67.75°, the air temperature here being 70°.

At 1000 ft. vertical in No. 2 Shaft the reading was taken in sandstone in a wet hole and gave a result of 70°.

Ferreira Gold Mining Co.—At 500 ft. vertical the reading was taken in a 5 ft. hole in the sandstone and gave a very reliable result of 67.5°.

At 1000 ft. vertical, the reading was taken in a 5 ft. hole sunk in the sandstone footwall of the shaft, down which water was continually flowing; the result was 69.5°.

At 1142 ft. vertical, a similarly located hole gave 71°.

Ferreira Deep.—At 1175 ft. vertical, a 5 ft. hole in sandstone in the cross-cut in No. 1 Shaft gave 62.9°, the air temperature during the experiment fluctuating between 74° and 81°.

At 1158 ft. vertical, in No. 2 Shaft, a 5 ft. hole in sandstone gave 71°, thus checking very nearly the results obtained in the bottom of the Ferreira Mine only a short distance away from this point.

City and Suburban Gold Mining Co.—At 495 ft. vertical, a 5 ft. hole located in the sandstone, in a situation at the side of the shaft, gave 58°.

At 1021 ft. vertical, a dry 5 ft. hole gave 67.5°, and at the bottom of the shaft 1201 ft. vertical, a hole placed in the reef in a locality subject to frequent blasting operations gave 70.5°.

Jumpers Deep.—At 878 ft. vertical, in No. 1 shaft, in sandstone, a hole in a heading gave 69°, the surrounding air registering 68°.

At 848 ft. vertical in No. 2 shaft the result was 68°.

At 1076 ft. vertical, a hole placed in the wall of a dyke gave 68.5°; at 1148 ft. vertical, a hole also in a dyke wall gave 69°, and at 1235 ft. vertical, the reading was 69.5° in sandstone.

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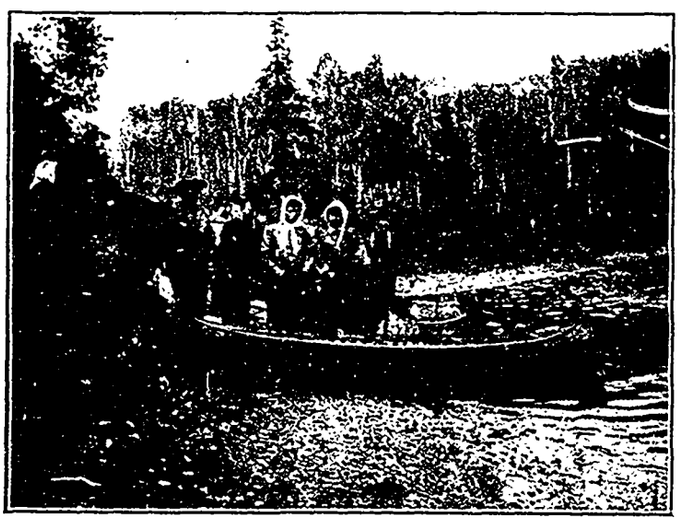
*[Note.—All readings are given in degrees Fahrenheit.]

ALONG THE G.T.P.
Moving "house" on the height of land.



ALONG THE G.T.P.
William Laloche, a Tête de Boule Indian, and his family.

Village Main Reef Gold Mining Co.—At 518 ft. vertical, a 4 ft. hole put in the side of a level in the older workings of the mine gave 65°.

Another hole, 2 ft. deep only, gave 66° and the surrounding air registered 68°.

At 1026 ft. vertical, a 4 ft. hole gave 63°, and at 1242 ft. vertical, 2 holes each 4 ft. in depth, one wet and the other dry, gave 65.5°, the air temperature here being 66.5°, and the water standing in the level 64.5°.

Crown Deep.—At 590 ft. vertical, a hole in the sandstone in the shaft near a fault gave 67.°.

At 1026 ft. vertical, a hole in the side of a stope gave 70°.

At 1253 ft. vertical, a hole in the side of a drive gave 70°.

Durban Roodepoort Deep.—At 500 ft. in the side of the vertical shaft the reading was 56°.

At 1000 ft. vertical in the same shaft the reading was 61.6°.

At 1420 ft. vertical, in the incline of the same shaft, the reading was 65°, the air here being over 70°.

Nourse Deep.—At 530 ft. vertical, a hole in the shaft gave 68°.

At 1000 ft. vertical, a hole in a cross-cut gave 70°.

At 1500 ft. vertical, a hole in the incline shaft gave 73°.

All these holes were located near dykes and gave reliable results as to the temperature of the rock under these conditions.

Simmer East.—At 1700 ft. vertical a long machine drill hole gave 72.5°, the surrounding air registering the same temperature, and at 1800 ft. vertical the reading was 72.5°.

These holes were open and not previously prepared for the experiments; their results, though corroborative, cannot be taken as primary evidence.

Robinson Deep.—This mine was subjected to a series of exhaustive tests. A first series of shallow holes was taken in pump stations down No. 1 shaft.

500 ft. vertical in sandstone gave 62.5°.
1060 ft. " in dyke " 66.5°.
1500 ft. " in dyke " 63° and 67.5°.
1950 ft. " in sandstone " 66.25°, the air here being 63.5°.

At 2400 ft. vertical a hole placed near the shaft in the main air-way of the mine gave 67°, the air here being 66.25°, the water in a dam 67.5°, and the water flowing into the same from the shaft being 66.5°.

Second Series of 5 ft. Holes.

500 ft. vertical in sandstone gave 57.5°
(Extra checks taken)
air temperature " 56.0° (do.)
1060 ft. " in dyke " 60.25°
air temperature " 56.0°
1500 ft. " in dyke " 62.5°
1950 ft. " in sandstone " 68.0°
2200 ft. " in sandstone " 73.5°
(A very reliable reading)
air temperature " 76.0°
2400 ft. " in a hole drilled in a hot stope drive, in which the air registered over 80°, the reading was 76.5°.

Bezuidenville Bore-hole.—Readings taken before closing the hole at 2930 ft.

At 1000 ft. vertical .....69.0°
1500 " .....71.75°
2000 " .....75.0°
2500 " .....75.5°
2925 " .....78.0°

Another reading taken after the hole had become blocked up gave at this last point 75° only.

Howard Shaft, Simmer West.—At the 3358 ft. level in the cross-cut north, at a distance of 205 ft. from the shaft, a drill hole was put in on the west side of the cross-cut 6 ft. in length and inclined slightly downwards. The mean result of four readings and two observations gave for this depth a temperature of 80.4° F.

At the same level=3358 ft. deep, a bore-hole had been sunk in the floor of the cross-cut, at a distance of 90 ft. from the shaft, its dip being 55° north. The thermometers were lowered a distance of 140 ft. on the incline, or 115 ft. vertically below the level of the cross-cut, thus making a total depth from the surface of 3,473 ft. The mean result from the readings of four thermometers used for this observation gave for this depth a temperature of 81.5°F. This may be taken as a particularly reliable result, as the readings from the thermometers of various makes checked one another to within half a degree.

Catlin Shaft, Jupiter G. M. Co.—At the 3906 ft. level in the cross-cut north at a distance of 137 ft. from the shaft, a drill-hole was put in on the west side of the cross-cut 6 ft. in length and inclined slightly downward. The results obtained from the readings at this point gave for this depth a temperature of 82.4° F.

At the same level=3906 ft. deep, a bore-hole had been sunk in the floor of the cross-cut at a distance of 105 ft. from the shaft, its dip being 43° north. This hole was found to be blocked at a depth of 14 ft. on the incline, or 10 ft. vertically below the level. Readings were taken, therefore, at this depth=3916 ft. from surface, and the average result gave a temperature of 83.25° F.

This last experiment, however, cannot be considered as conclusive, owing to the water in the bore-hole having been in communication with that flowing along the level immediately previous to the time of making the experiment.

Turf Mines.—West Bore-hole.—Readings taken at the surveyed depth of 3400 ft., gave a temperature result of 80° F. These readings were consistent throughout, and were subjected to severe tests for accuracy. At the time they were made the bore-hole was unsurveyed, and the apparent result did not coincide with the already established mean line of temperature. The subsequent survey, however, enabled the reading to be allotted the correct position on the scale of depth, and this record, the final piece of evidence obtained from an isolated position in undisturbed country, constitutes a convincing corroboration of the general tenor of the now established mine results.

The results recorded at a depth of over 3,000 feet from the surface were obtained at a considerably later date than those upon which the line of mean temperature was first estimated. They were found to comform in a remarkable manner to the results of the previous work.

An inspection of a plotting of these borings shows many recorded points of divergence from the accepted mean line of temperature. These variations are attributable to several causes, some of which can be readily ascertained, while others are more obscure. For example, the Bezuidenville bore-hole reading at 2,000 feet is more than a degree higher than that indicated by the mean line; and the geological records show that the rock passed through at this point consists chiefly of dyke matter.

In several observations taken in the mines also, it has been noticed that a higher temperature of varying degree prevails in the vicinity of dykes and disturbed ground.

The marked deviation from the normal of the complete series of observations taken down the Robinson Deep shaft demonstrates very clearly the cooling effect of the air introduced by natural ventilation in the mines. At the 1,500 feet level, for instance, three readings taken in holes drilled in dyke within a few feet of the shaft give results 3½°, 8° and 8½° below the normal, and this difference was

maintained in the readings taken in the upper stations of the shaft.

The position of the Durban Roodepoort Deep in the diagram is probably due to the fact that the readings were taken in the side of a very wet vertical shaft, in which the cooling effect would be more rapid than would be the case if air were the only conductor.

The City and Suburban records, and some of those of the Village Main Reef also, give remarkable instances of the rapid secondary cooling which has taken place. It is worthy of note that these two mines are situated in adjoining ground.

The records of the number of feet of depth for each degree Fahr. of rise in temperature, as observed in various deep bore-holes, are given in "Earth Temperatures" by E. Dunker, as follows:

	English Ft. per 1° F.
Neuffen Bore-hole	20.5
Rosebridge Mine	47.6
South Hetton Bore-hole	50.0
Preguy Bore-hole	53.4
Sperenberg Bore-hole	61.5
Kentish Town Bore-hole	64.0
Schladebach Bore-hole	72.3
Schladebach Bore-hole	65.0
Grenelle Bore-hole	75.75
St. Gotthard Tunnel	84.5
Adalbert Mine, Przibram	105.0
Bootle Waterworks, Liverpool	234.0

These records show that the proportionate increase of temperature at depth varies very greatly in different localities, but the details of the observations prove conclusively that the increase of temperature is in direct proportion to the depth.

It is upon this law that the following estimate of mean earth temperatures for the deeper levels of the Witwatersrand Gold Fields is based, and the mean rate of increase as deduced from the above detailed record is—

1° Fahr. for each 208 ft. increase in depth,
or
48° Fahr. increase per 100 ft. of depth.

Thus starting from the mean temperature of 1,000 feet depth = 68.75°, the following table is obtained:

Depth Ft.		Degrees Fahr.
1000	=	68.75
2000	=	73.55
3000	=	78.35
4000	=	83.15
5000	=	87.95
6000	=	92.75
7000	=	97.55
8000	=	102.35

The experiments have shown that the natural ventilation of the mines decreases the rock temperature in the vicinity of the workings from 5° to 10°F.

This action will tend to become more marked in the deeper levels opened up, where the contrast between the temperature of the entering air and that of the surrounding rock walls will be more accentuated.

The establishment of air communication between the deeper level mines and those adjoining them towards the outcrop will also tend to still further reduce the working temperature, as, unless special conditions intervene, the natural pull of the ventilation will cause all the deepest shafts to act as downcasts, and as such they will introduce the colder air directly in those portions of the mines where it will have the greatest cooling effect.

The heating effect of the decomposition of dyke matter in the locality has been shown to be so light as to be negligible, and it is not clear that the instances of increases of temperature noted are, as a body, due to the result of chemical action.

The whole evidence obtained goes to prove an extraordinary uniform and moderate rate of increase of temperature in depth at this interesting portion of the earth's surface. The practical deductions to be made therefrom are of special gratification to the miner, in that every change from the normal state, resulting from his work, will, where controlled alone by the laws of nature, take place invariably to his advantage.

POWDER TESTING.

A useful paper on the "Testing of Explosives" appeared in the *Mining Magazine* recently. It was written by Mr. J. B. Porter, who, it will be remembered read a paper before the Mining Section of the Canadian Society of Civil Engineers in November, 1905. An abstract of this paper follows:—

The testing of explosives for mining use is usually accomplished in the so-called lead bombs, namely, cylinders of cast lead originally designed by Trauzl. The lead cylinder is 8 in. in diameter and 8 in. high, with a hole 4-5 in. in diameter and 4 2-5 in. long cored axially from one end to just beyond the centre of the cylinder. The tests are carried out by placing a weighted quantity, usually 20 grams, of explosive in the cylinder, inserting a standard detonator with a fuse, tamping lightly with dry sand and firing. The enlargement of the hole is then measured and the strength of the explosive calculated by that means. The correction for the detonator can be made by firing a second identical cap alone in a second cylinder.

The author, in a paper read before the Mining Section of the Canadian Society of Civil Engineers, November 30th, 1905, describes some modifications which he introduced in order to obtain results more closely approximating the practical conditions. He states that the most serious fault with the Trauzl test is that the proportions are not those of an ordinary blast, as the hole is too short, the fuse is disproportionately large and the tamping is very ineffective. Therefore, a very considerable part of the explosion is wasted, and as this loss is greater for slow than for quick powders, the test is unfair to powders which require substantial tamping.

A few months ago, the author had occasion to compare a number of powders, and as he was convinced that the proportions of the Traulz cylinder could be changed with advantage he calculated from the theoretical considerations the shape of a lead cylinder in which shots could be fired without undue loss of force through the charging hole. It was undesirable to make the cylinders longer than necessary, as they are expensive and can be used but once, but it was also important to make them long enough to hold a reasonable amount of tamping and to confine the gases until the work was accomplished. He, therefore, decided after a number of experiments upon cylinders 125 mm. (5 in.) in diameter and 200 mm. (8 in.) in height. The bore hole was made 12 mm. (15-32 in.) in diameter and 135 mm. (5½ in.) in depth.

Cylinders of cast lead are often unequal in quality and therefore the cylinders were cut from a solid cylinder of compressed lead. When the cylinder was then cut into the required lengths and bored it was found to be perfectly homogeneous. Charges of various size were used, but 8 grams was found most satisfactory for high explosives. The experiments were made with detonators fired by electricity, as the use of a fuse with the Trauzl cylinders seemed always to lessen the efficiency of the tamping. The small wires leading to these caps were found to interfere scarcely at all with the tamping of dry sharp sand, which was run in on top of the charge and shaken down as compactly as possible. As the bore hole was yet much shorter than in practice the sand tamping was further compressed by placing a lead weight of about 100 lbs. on top of it. The cylinders were placed for firing upon an anvil weighing half a ton.

The author states that a large number of tests were made in these cylinders, and the results were most satisfactory. Duplicates, which with ordinary Traulz cylinders seldom agree within many per cent., were found to agree remarkably well with the new cylinders. Differences over one per cent. are stated to have been very rare, while in most instances the checks were so exact as to be practically identical. The cavities were measured by running in water from an accurate burette, correction having been made for the volume of the original bore hole and for the effect of the cap.

In the author's opinion the tests described above are still far from being identical in character with actual blasting operations, as lead yields slowly to rupture, whereas blasts in the rock always rupture the material and afford the gas an almost free means of escape. He believes, however, that tests made in cylinders proportioned as those he has described will be more fairly comparable with actual blasts than tests made in other apparatus. Probably the cylinders still give somewhat higher results for quick powders, such as dynamite, when compared with slow powders, such as common blasting gunpowder. This difficulty can, however, probably be largely corrected by further changes in the dimensions of the apparatus and by increasing the weight used to confine the tamping.

The most important thing, however, in the opinion of the author, which remains to be done, is to compare tests in the cylinders with the results of actual blasting operations on a large scale. For this purpose he wants to interest practising engineers in this matter so that they will keep careful records of the results obtained by the use of different makes and grades of powder, and will provide him with samples of the powder used so that he can make the tests in the lead cylinders. By cooperation of this kind it is probable that some definite comparable relation can be proved between practical blasting in different classes of rock under different conditions of work and the testing experiments on a small scale. It will then be possible to determine in advance the approximate working strength of different powders and to tell which one will be most suitable for any particular work to be done.

CORRESPONDENCE.

THE YUKON NOT DEAD.

956 Nicola Street,
Vancouver, B.C.
July 27th, 1906.

The Editor Canadian Mining Review:

Dear Sir,—

Your esteemed favor received.

My journey North was a successful one, and the Klondike and Yukon have a big future.

From personal observations I would judge that that country will be one of the greatest dredging fields in the world. Vast deposits of auriferous gravels exist, of low value, it is true, 15 cents to 20 cents per cubic yard, but which as facilities improve will be worked. The overburden of peat and moss which one hears so much about, is not such a serious obstacle as one would imagine, when water facilities are at hand and the bedrock has a decent grade.

I should judge 80 per cent. is water frozen.

The White River channel is another proposition which will be worked in the near future, whether by hydraulic method, or free milling process remains to be seen, but if the latter, then the power question crops up, and as wood fuel is too expensive, other means must be found, and which fortunately exist, in my opinion, on the Indian River, bordering the great Klondike District on the south. Coal croppings are there, and, I believe, with proper development, a coal basin will be proved of great importance, as electric power could be generated at the pitmouth, and transmitted to the different operators around Dawson.

The northern country has great chances for capital well directed.

Yours very truly,

ARTHUR E. HEPBURN.

956 Nicola Street,
Vancouver, B.C.

We are in receipt of the Calendar of Dalhousie College and University of Halifax, N.S., for 1906-07. The Faculty of Engineering is conducted by Professors Ebenezer Mackay, Daniel Murray, Joseph Edmund Woodman, A. Stanley MacKenzie. The next term will begin Sept. 13th, the last day for receiving applications for the autumn preliminary examinations being August 16th.

CUSTODIANS OF GREAT WEALTH.

In the course of his presidential address, delivered before the Institution of Mining and Metallurgy at the last annual meeting, Mr. Arthur C. Claudet made the following remarks:—

"Everyone will agree that our special profession—that is all mining and metallurgy, apart from coal and iron—should have a strong and powerful institution to raise the standard of science and practice within our sphere of influence, and not only to protect and advance our own professional status and interests, but in every way in our power to further the wellbeing of the great industries we represent. As many of you are aware, those industries produce for the British Empire alone a sum of no less than £70,000,000 sterling per annum, to say nothing of the colossal extent to which British capital is employed in them.

"After two or three ineffectual attempts to found a society such as ours, this Institution came into existence in 1892, and I will quote the remarks that the late George Seymour, Assoc. R.S.M., our first and greatly esteemed President, made at the first general meeting, which was held in the Lecture Theatre of the old Royal School of Mines in Jermyn Street. Mr. Seymour said:

"'Whilst the members of other branches of mining and of practical science and applied science have, for many years past, had frequent opportunities of meeting and conferring together upon subjects of technical and mutual interest, it is, to say the least, curious that the metalliferous and metallurgical engineers of the greatest mining and commercial empire which the world has ever seen, should have taken no serious measures to found some central Institution, for the consideration of subjects of such common and absorbing interest.'"

"In concluding his address, he said:

"'I was anxious to impress upon you, and, through you, possibly upon others, the magnitude of those interests with which we are associated as mining and metallurgical engineers, which have extended beyond all historic times, and which now spread over almost every quarter of the globe. It is upon us, gentlemen, and upon our brethren abroad, that the custody and exploitation of these inexhaustible stores of mineral wealth der a good and faithful account of our stewardship. The founders of this Institution have been guided by the hope that the best and highest interests of the profession would be advanced by its efforts, and that in process of time, by adopting all that is good, and, so far as is possible, avoiding all that is unprofitable, it would become at once both a benefit and a safeguard to its members. Such I believe and hope will be the case.'"

NEW USE FOR TANTALUM.

The use of tantalum for the manufacture of writing pens, as a substitute for gold pens, is described in a British patent granted to Siemens & Halske, Berlin, Germany.

Steel pens have the advantage of great hardness and elasticity, but they do not resist the action of chemicals and in particular, of that of atmosphere and of ink. Gold pens, on the other hand, offer great resistance to chemical action, but their mechanical properties are relatively inferior. According to the present invention pens are made of metallic tantalum, a metal that is exceedingly resistant to chemical action and at the same time possesses a high degree of elasticity and hardness. On account of the great hardness of pens made in this metal they have also a much greater resistance to wear than steel.

The pens can be made either of pure metallic tantalum or of alloys thereof, with other metal, and the tantalum can also contain small quantities of other substances such as carbon, silicon, boron, serving to impart greater hardness thereto.

For the sake of economy, parts of the pens may be made of other materials, such as steel, and only the points or parts subject to wear or strain, be made of tantalum.

WATER-SPRAYED AIR.

A paper on the effect of water-sprayed or damped air in coal mines was prepared by Mr. James Ashworth, M.E., Chaddesden, Derby, England, and read before a general meeting of the North of England Institute of Mining and Mechanical Engineers at their last general meeting at Newcastle-on-Tyne.

The author propounds the following questions: (a) Shall we attempt by spraying, the impossible task of limiting a possible explosion? or (b) shall we give attention to the comfort and health of underground labor, and reduce spraying to a sanitary point?

Seeing that dust is constantly being produced during the transit of coal, there is always fine dust floating in the air mixed with moisture, much too small in quantity to produce the most explosive condition, and yet this dust is the most dangerous of any, and may be said to correspond with the dust which, having been left in pit for upwards of three-quarters of an hour after being thrown in, was exploded by Mr. H. Hall in more than one experiment. No percentage of moisture, under 5 per cent., can offer any restraint against the extension of a coal-dust explosion and it is not surprising, therefore, that in the disasters at Tylorstown, Universal and MacLaren collieries, the flame swept along the watered parts of the roads as if they were charged with gas. Experiments made in Germany, entirely support these facts, as it was there proved that water had no restraining influence on an explosion of coal-dust, unless the dust was so wet, that water could be squeezed out of it by the hand. It is useless, therefore, to depend on water-sprays for restraining the extension of an explosion after it has once been initiated.

Water-sprays are to some extent a sanitary requirement, but even from this standpoint can be overdone, and may become the means of extending the horrible disease known as ankylostomiasis. This is not a "bogey" to be lightly considered, but a serious matter: thus Dr. J. S. Haldane states that "it is evident that the spread of the disease may be entirely checked by preventing the pollution of mines by human excrement. Unless this is effected, as it certainly can be, the disease will probably spread gradually throughout the mines of England, wherever the temperature and moisture are favourable to the growth of the larvae. As damp and warm air is favourable to the propagation of ankylostomiasis, the writer would ask Dr. Haldane, or any other authority, what weight of moisture is permissible per cubic foot of air at certain temperatures, to enable colliers to work under the most favourable sanitary conditions. In 1899, there were 94 cases of ankylostomiasis reported in the Westphalian coal-field; in 1900, when water-spraying was made compulsory, the numbers increased; in 1901 there were 1,030 cases, up to October, 1902, 1,355 cases; and the increase continued, until at three collieries, 90 per cent. of the men were said to have been affected; but the disease was checked in 1903, and the percentage of men affected commenced to decrease. One means used for checking its extension was drier air, and, therefore, the Government Mining Board of Dortmund has sanctioned the temporary suspension of compulsory water-spraying. A Royal order in the Dortmund district also directs that, if the pit-water is not taken direct from the marl, it must not be used for spraying coal-dust.

The necessity for a full and dispassionate discussion of this subject is evidenced in other ways; thus it has

been proved, in evidence given before the Royal Commission on coal supplies, that in the deep and hot collieries of this country, in Lancashire and Staffordshire, and in Scotland, water-spraying or other means of damping the air has had to be entirely abandoned, because warm damp air is so enervating that the colliers cannot do their work with any degree of comfort. Here, then, those who hold that watering of some sort is a necessary condition to ensure safety in dusty mines are confronted with a problem, for which at present there is no practical solution. Not only so, but owners, agents and managers of mines are placed in a serious position, for if an explosion occurs in a deep pit, where no watering is practised, H.M. inspectors of mines may, at once, assert that the colliery was not fitted with watering apparatus, and, therefore, that the management had been culpably negligent. And if the opposite extreme be taken, namely, of a colliery so situated that there is a great difficulty in keeping down the formation of ice on the main haulageways (No. 3 colliery of Tables I and II), and where watering is therefore an impossibility in winter, and even if it were possible, the grains of water that would bring it up to the point of saturation are so few (say 2.6), that although this mine has been described as a dusty and gaseous one, 2.6 grains of water would have to represent the factor of safety. Comparing this case with a deep pit, or say with the Universal colliery, where the air was carrying 4.4 grains of water at or near the pit-bottom, the time seems to have arrived when it ought to be authoritatively stated (1) what is the point of saturation to which air ought to be brought, and (2) how that saturation may be attained.

THE WINDY ARM DISTRICT.

A few months ago, Mr. R. G. McConnell, of the Geological Survey, wrote a short report on the Windy Arm district just north of the British Columbia boundary, where rich strikes of silver and copper are being worked. This season, Mr. D. D. Cairnes, of the same department, has been commisioned to survey the district, and his preliminary notes make interesting reading:

Mr. Cairnes says: "In the district north of the boundary, south of Carcross and between Windy Arm and Lake Bennett (an area of about 14 by 8 or 9 miles), over 260 claims are being held and a great deal of development is going on. The Conrad Consolidated Company own a great many of these properties and are pushing forward operations at seven of their camps. Machine drills are used at the Venus mine. The power is generated by a 50 horse-power gasoline engine. But, as there is enormous water-power on many of the creeks, piping etc., has arrived to establish water-power to replace gasoline engines. A double-cable tramway is in operation from the Montana mines to the beach at Conrad City, 3,400 feet below. Four other tramways, it is reported, are to be erected.

Conrad City was practically started this spring and is quite a little town; it is built on the west shore of Windy Arm and already boasts three hotels, three stores, a drug store, restaurant, etc.

The Anglo-American Consolidated Company have a number of promising-looking properties working to the south of Conrad, on Windy Arm. The leads are quartz, carrying high gold and silver values and can, in most cases, be traced for considerable distances. Though the leads are generally narrow, from a few inches up to two feet, they are high grade.

The mineralized rock of the Venus Mine is exceptionally wide, sometimes as much as 32 feet, and averaging, for considerable distances, over 20 feet: it can be traced over 3,000 feet. It is interbanded quartz and porphyrite and will average about $25 per ton.

A tunnel over 700 feet long has been run on the Montana lead, proving it to be from 2 to 4½ feet wide. About 14 inches will average $80 and the rest will go over $20 per ton. Wherever galena is present in these quartz veins, the returns are invariably high, on account of associated minerals—silver chloride, ruby silver, silver glance, stephanite, etc. Assays running into the hundreds and even thousands of dollars per ton are rather common from picked samples, rich stringers, etc. On the whole, the camp looks quite promising and, no doubt, will continue to go ahead rapidly.

Native copper is found in a number of places on the east side of Windy Arm, distributed through the rock, which is a slate and chert series, near contact with old peridotite intrusions. No leads have, as yet, been found, but scarcely any work or prospecting has been done.

Some rich copper ores carrying nickel and cobalt values, as yet rather low, have been, however, found on Marsh lake near here, and I am thinking of taking two or three days to look at the properties, as they are quite close, and are very interesting.

A recent free-gold strike has been made up the Wheaton river, about fifteen miles west of Robson. As this has just started, reports vary, but some very rich rock is coming down. This is in my district and I will see it soon.

All interested parties are very anxious to have more work done than I can possibly do this season, but I will work as late as possible and can cover a good-sized area.

WORK OF GEOLOGICAL SURVEY STAFF.

Communications received by the Directors from several of the field parties of the Geological Survey show that the work is everywhere progressing favorably.

From Dawson word has come that the work of estimating the volume and value of the gold-bearing bench gravels is well under way.

In British Columbia, Mr. LeRoy has finished the examination of the coast section from the international boundary to Burrard Inlet and is now continuing it in Howe Sound. He has traced out the rocks on the coast containing economic minerals and will carefully study the more important areas of Howe Sound.

Mr. Camsell in the Similkameen has finished the mapping of the Princeton coal basin, and has left to examine the Roche river, Kennedy and Copper Mountain camps along the South Similkameen from the international boundary northward.

Mr. Brock reports good progress in the detailed study and mapping of Rossland camp and sees no difficulty in completing the work before the end of the season. He has sent for analysis specimens of sands from Little Sheep Creek, which he suspects contain platinum, along with a considerable amount of gold.

No word has been received from Mr. Leach, in the Bulkley valley, nor from Mr. Dowling who is tracing northward the anthracite coal area on the eastern slopes of the mountains.

From the plains Prof. Macoun writes frequently and enthusiastically concerning the soil and crops of the country along the line of the Grand Trunk Pacific Railway to the west of Manitoba, while Mr. Chalmers has been employed giving advice as to the clays and the boring prospects in the same region.

The parties of Mr. McInnes and Mr. O'Sullivan who are exploring the country between the Saskatchewan river and Hudson Bay have not been heard from nor has word been received from Mr. Collins nor Mr. Wilson in Northern Ontario and Quebec.

Dr. Barlow, whose party is working in Quebec to the east of Cobalt, reports fair indications of minerals in the district, but owing to a thick covering of clay, discoveries are slow and difficult to make.

Mr. W. A. Johnston has nearly completed the work on the Peterborough map sheet and will soon move to the area of the Prince Edward map sheet which a few more surveys will complete.

The International Committee on the classification of the older rock formations is at work in Northern New

York and will transfer their field of investigation to Eastern Ontario towards the end of July. Dr. Barlow is official representative of the Survey on this commission.

In New Brunswick, Dr. Ellis is making considerable change in the classification of the rocks of the southern part of the province, and is also visiting the various mining centres with a view to the publication of a revised edition of the report on the minerals of New Brunswick.

Mr. Fletcher, after starting his party in the field, rendered assistance to Prof. Woodman who is closely investigating the iron resources of Nova Scotia for the Mines Branch of the Department of the Interior. Recently he has visited the lately opened seam of coal on the property of the Eastern Coal Company, Limited, at Maccan; the section in the face of the working gives ten feet of coal in a thickness of fifteen feet, the working coal being four feet thick, and apparently of good quality.

Mr. Faribault is busy revising work on the Nova Scotia goldfields with a view to writing a complete report on this important area during the coming winter.

LE ROI SHIPMENTS AND EXPENSES.

We have been favored by the Consolidated Mining and Smelting Company, Ltd., with the following statement:

1905	Shipments to Trail tons.	Containing			Expenditure on Development	Estimated profit, after deducting Cost of Mining, Smelting, Realization and Depreciation.
		Gold, ozs.	Silver, ozs.	Copper, lbs.		
Sept. ..	6,965	3,079	3,050	172,850	$10,000	$17,000
To N,port	1,185					
To Trail						
	8,150					
Oct. ...	2,150	2,950	3,750	187,500	11,000	19,500
To N,port	8,075					
To Trail						
	8,225					
Nov. ..	8,000	2,550	4,350	187,600	9,000	17,000
Dec. ..	6,925	2,772	5,300	205,700	8,000	32,500
1906.						
Jan. ...	8,000	3,250	5,800	224,500	9,500	39,000
Feb. ..	7,500	2,721	4,700	180,691	9,500	24,000
March .	10,465	4,672	7,030	246,500	12,000	43,000
April ..	10,860	4,350	6,400	233,700	12,000	43,000
May ...	12,017	4,887	6,734	270,000	13,500	50,000
June ..	12,215	4,868	6,282	259,100	16,000	47,000
July ...	12,000	4,220	5,470	238,500	13,250	33,000

THE GEOLOGICAL SURVEY.

Mr. A. P. Low has been in Victoria, on his way to Mexico, and was interviewed by the Colonist, with the following result:

"The geological survey under Mr. Templeman's direction will probably get much more consideration from the government than it formerly did under the the Ministry of the Interior. Being now a minister of department he will undoubtedly see that British Columbia shall get its due share of the services of the staff of the geological survey and with that as a nucleus a department of mines will probably be formed with Mr. Templeman at its head, larger, more efficient and practical than at present and the study of the mining industry, in the matters of advice, reports on special minerals, maps, statistics, etc., will be made more of a specialty and with this practical phase of the question I identify myself with hearty sympathy. From here I go to Mexico City to attend the International Geological Congress to be held there in September, which meets every three years, usually in Europe, and comprises amongst its members all the chief geologists of the world. I leave to-night and am sincerely sorry that pressure of time and business has prevented my seeing more of the mining interests of this country now. I regret to say I am not even able to visit Nanaimo, Crofton, and the mines of Vancouver Island this time but I nevertheless hope to do so next year."

In relation to the work of the survey and its aims he said that ordinary surface maps showing only the streams, etc., were of little utility, even if absolutely correct, and it was the intention of the government to issue sheet maps in connection with its reports from which a better idea of the surface could be obtained. He hoped to have the survey work extended to such a degree that the topography of the country could be shown with some degree of accuracy, together with the contour and geological formation as was done in many parts of the United States. On taking stock of the official reports of the department he had been astonished at the accumulation of volumes from which the public are deriving no benefit. He had succeeded in having this system abolished and these reports were now being supplied to all Canadian applicants free of charge, on applications from the United States a charge was made for these reports but this was only because Canadians were charged by the United States geological survey for any reports procured from them. It was also the intention to publish preliminary reports each year from all points instead of keeping the public waiting until a full report can be compiled for each section traversed.

BOOK REVIEWS.

Receipt is acknowledged of:—

The Mechanical Engineering of Collieries, by T. Campbell Futers. Part II. Published by the Chichester Press, 30 and 31 Furnival St., Holborn, London, E.C.

Mica and the Mica Industry, by George Wetmore Colle, M.E., M.Sc. Published by the Franklin Institute, Philadelphia.

The Cyanide Process, an introduction to the. By Alfred S. Miller. Published by John Wiley & Sons, New York.

The following bulletins issued by the U. S. Geological Survey, Charles D. Walcott, Director:—

The Cement Industry of the United States. Edwin C. Eckel.

The Production of Steel-Hardening Metals. Joseph Hyde Pratt.

The Production of Tin. Frank L. Hess.

The Production of Mineral Waters. Myron L. Fuller.

Peat in the United States.—Miruis R. Campbell.

The Production of Zinc. Charles Kirchhoff.

The Production of Carbon Dioxide. Myron L. Fuller.

The Production of Magnesite. Charles G. Yale.

The Production of Phosphate Rock. Edmund Otis Hovey.

The Production of Salt. Edmund Otis Hovey.

The Production of Abrasive Materials. Joseph Hyde Pratt.

The Production of Quicksilver. F. W. Horton.

PERSONALS.

L. W. Stabler, a Butte mining engineer, visited Franklin camp recently for the purpose of inspecting work done on the McKinley group, now under bond to the F. A. Heinze interests.

Mr. E. T. Hannam, the inventor of the Atlas Water Tube Boiler, died at Chicago, at 4 p.m. Saturday, August 18th, just as he was entering a train. His death was due to heart disease.

J. M. Broucher, of the Brownell Company, Dayton, Ohio, has resigned his connection with that Company to accept the position of Assistant General Managership of Sales for the Atlas Engine Works of Indianapolis.

Col. W. J. Sutherland, president of the Alaska-Perseverance Mining Company of New York, and Mr. P. P. Pope, one of the directors, have been in Juneau, Alaska, and inspected the company's properties near that city.

Prof. Clement D. Child, Ph.D., of Colgate University, Hamilton, N.Y., has been selected to fill the chair of Professor Physics in the School of Mining, Kingston, and which carries with it the appointment of Professor of Physics in Queen's University.

Messrs. C. H. Macnutt and E. C. Vigeon are accepting the management of the Sociedad Minas de Cobre de Cutter Cove in the Straits of Magellan on leaving their present positions with the Societe des Mines de Cuivre de Catemu, Chile. They will also do consulting work.

Mr. Hubert Carmichael, Provincial Assayer, is visiting Alberni, Gardner and Observatory inlets, and, if time permits, the Queen Charlotte Islands. Mr. Carmichael visited the Queen Charlotte group in 1901, but there have been several promising discoveries made on the island since that day.

Howard E. Troutman, for over ten years connected with the Buckeye Engine Company and for several years manager of its Chicago office, has resigned to accept the sales management, Corliss and High Speed Engine Department of the Atlas Engine Works, Indianapolis. Mr. Troutman's headquarters wil be at the home office.

J. P. Johnston, for several years past the General Sales Manager for the Weber Steel Concrete Chimney Co., Chicago, has resigned to become Sales Manager, Water Tube Boiler Department of the Atlas Engine Works, Indianapolis. Mr. Johnston's offices will be at the Company's plant in Indianapolis.

Mr. W. H. Whiteside, President of the Allis-Chalmers Company, Milwaukee, represented in Canada by the Allis-Chalmers-Bullock, Ltd., returned on August 22nd, from a two months' combined business and pleasure tour of England, France, Germany, and Switzerland. Mr. Whiteside inspected various large manufacturing industries of England and on the continent, among others he visited the plants of the leading English steam turbine builders, whose American rights for building Parsons steam turbines for marine and land use, are enjoyed by the Allis-Chalmers Company.

Freight Traffic Manager Wm. Sproule of the Southern Pacific, has accepted the traffic management of the American Smelting Refinery, the American Smelting Securities Company, the Smelters' Steamship Company and a score of smaller corporations, including railways in Nevada and Alaska, and smelters and mines both in North and South America. On the Pacific Coast alone these companies own smelters at Tacoma, Everett, San Francisco and Selby. Their properties in Utah, Colorado, Nevada, Mexico, and South America are immense. Sproule entered the service of the Southern Pacific as a clerk in the freight department, in 1882, and leaves his high traffic position in the West after twenty-four years of continuous service.

MINING NOTES.

The investigations into the commercial possibilities of electric smelting of iron ore which were published by Dr. Haanel some time ago, are bearing fruit.

It is understood that a big steel firm of Pittsburg is preparing to put up an electric smelting plant at some point in Canada where the water power and ore are available.

Six months hence an electric smelting plant capable of turning out twenty tons of pig iron a day will be in operation in California. It is being installed by Dr. Herault, of France, who erected the experimental station at Sault Ste. Marie, under arrangement with Dr. Haanel. The California plant is to be eventually enlarged to an output of six to eight hundred tons a day.

The Michigan copper country possesses the world's three deepest vertical mining shafts.

The deepest of these is the No. 3 at the North Tamarack property, its measurement being 5,200 feet—eighty feet less than a mile. To the south, at a distance of 4,000 feet, is the No. 5 shaft of the same company. This ranks as the second deepest vertical shaft on the globe, its measurement being 5,080 feet from the collar to the bottom level.

Second only to these great openings is the Red Jacket, of the Calumet and Hecla Company, which is down 4,900 feet, and in which the copper lode was not encountered until a depth of 3,300 feet had been attained.

The deepest incline shaft in the world is the No. 4 of the Calumet and Hecla. This shaft itself, from the collar to the lowest level, is sunk on the plane of the lode for a distance of 8,100 feet, while from a drift at the bottom a winze extends downward 190 feet to the boundary of the property, giving a measurement of 8,290 feet from the surface. No. 4 shaft passes by the Red Jacket shaft at the fifty-sixth level.

The iron and steel bounty payments paid by the Dominion Government for the financial year up to July 1st amount to $2,004,339, as compared with $1,540,203 in 1905. The payments indicate a very large increase in the output of the Canadian iron and steel industries.

Bounty amounting to $687,631 was paid on a total output of 581,858 tons of pig iron; of this, 86,523 tons was made from Canadian ore. The bounty on this was at the rate of $1.65, and totalled $142,263. 495,335 tons were made from foreign ore. The bounty on this was at the rate of $1.10, and totalled $544,868.

Last year's output of pig iron was 386,719 tons, of which 327,267 tons were made from foreign and 59,452 from Canadian ore. The rates of bounty were higher; however, last year, viz., $1.50 on foreign and $2.25 on Canadian ore, so the total amount paid as pig iron bounty, was $624,167, of which $490,401 was on foreign and $133,766 on Canadian ore.

Of steel ingots, 569,237 tons were made in the Canadian mills during the past year, as compared with 272,916 tons in 1905. The bounty in 1906 at the rate of $1.65 per ton, was $941,000. In 1905, at the rate of $2.25 per ton, it was $614,433. Of puddled bars, 3,560 tons were made in 1906, as compared with 3,509 tons the year before. The bounty, at $1.65 per ton, this year, was $5,875. The payments last year at $2.25 per ton were $7,895.

The Government paid a bounty in 1906 of $369,832 on 72,875 tons of rolled angles, wire rods, plates, etc. In 1905 the payments were $293,208, and the output 59,842 tons.

These iron and steel bounties expire next year unless they are renewed by Parliament. The bounty rate on pig iron from Canadian ore and on puddled bars and steel ingots this year is $1.05 per ton. The rate on pig made from foreign ore is 70 cents a ton.

BOUNTY ON LEAD.

The lead bounty in 1906 totalled $90,197, as compared with $330,645, the year before, the rate of bounty being much lower on account of the higher price of lead in the world's markets.

The petroleum bounty, at the rate of 1½ cents per gallon, showed payments amounting to $291,157, as compared with $350,047 in 1905.

QUEBEC.

The latest mineral find to be added to the Province of Quebec's already long list of economic ores is red hematite. This metal has been discovered in the southern part of the province, near Dunham, and mines are already being opened up. The belt in which the mineral appears most freely is about eight miles long, and consists of a strip of land encircling the base of Little Pinnacle mountain.

The Little Pinnacle is just on the boundary between Vermont and Canada, and the find is distributed between the two countries, although Canada has by far the larger share.

ONTARIO.

The ratepayers of Sturgeon Falls have approved of a bonus to the Northern Ontario Smelting and Refining Company by a vote of 330 to 1. Such a practically unanimous vote shows the faith the townspeople have in the proposed undertaking.

The pyrite mine at Bogart, being operated by the American Madoc Mining Company, is to be operated on an extensive scale in the near future, and a plant will be erected for the treatment of the ores. The Baskin Bros., of Norwood, have taken the contract of building a siding to the mine from the main line of the C.P.R.

Gold has, it is reported, been discovered in Playfair township, in New Ontario, north of the height of land, by a miner from Lexington, Kentucky. The find was made 85 miles north of New Liskeard, and three miles from the Government railway. The samples were at once forwarded to the Government offices for analysis, and the result is said to be most satisfactory.

The mines branch of the Department of Interior will shortly be installed in the Thistle building on Wellington street, Ottawa. It will occupy the first, third and fourth floors, the second floor being tenanted by the United States consul-general. On the fourth flat there will be installed an assay office, and there the staff will be instructed by Dr. Haanel in the magnetic method of locating ore bodies.

It is said that the experiments in refining ores from Cobalt, which are being made in Hamilton, have been satisfactory, and the result is that a large establishment will be built there.

Seven or eight of the best mining companies at Cobalt are interested. A sample of ore recently assayed showed the following results per ton: Silver, $1,800; cobalt, $175; nickel, $40; total, $2,015.

The Cobalt Refining Company is using a portion of the old Hoepfries refinery, but it has an option on five acres of land adjoining this property.

Work has been re-commenced at the big steel plant of the Northern Iron and Steel Co., at Collingwood, after being idle for about two years. The company has been successfully financed, and will be turning out finished iron and steel shapes and bars shortly. The company will start with a large volume of orders on its books. Gangs of men are at work going over and fitting up the machinery ready for rolling and making steel. The superintendent of one of the big American steel plants has been employed to take charge of the mills.

COBALT.

There is a popular idea that the Cobalt boom is over because some five thousand green prospectors were chased out of the district this spring by a combination of lack of success, and black flies. Up to the latter part of July the black flies, mosquitoes and sand flies were so rife that they made prospecting in the thick brush almost impossible. Added to this the new prospectors instead of spreading out over the country confined their operations principally to the area around Cobalt which has already been prospected on the surface. Those who hope to make strikes in that vicinity now must trench for discoveries. Any surface indications were all located last summer.

Another feature which tended to dull the interest in the camp was the determination of the shipping mine owners not to ship any more ore to the States. Last year they were forced to ship in order to realize enough money to declare dividends and provide for development. But they recognized that it was robbing their mines to send ore to Jersey City because the monopoly smelter paid only for their silver and kept all the rich by-products. This summer all the large mines are storing their ore and waiting for the completion of the Hamilton smelter. Last month one well-known property had 200 tons stored that would run from $1,000 to $1,500 to the ton, and another was reported to have $1,000,000 worth of ore either bagged or blocked out. Meantime most of the mines are clearing off the surface of their properties and finding rich veins under the surface earth.

Semi-official corroboration of the story of the rich gold find in the township of Playfair has been received at the Department of Mines, but the department has heard nothing official of the five-foot strip of solid silver said to have been found on the Nipissing Company's property.

The miscellaneous floating population of the early spring, consisting largely of amateur prospectors and investors, has departed almost without exception, leaving only a law-abiding assemblage of miners and of those in legitimate trade, so that only the constantly recurring blasts from the surrounding mines show that Cobalt differs from the prosaic character of an ordinary new village of Ontario. The only cause for trouble at present is due to several parties prospecting on the same mining lot, all trenching for discovery veins, with equal right in the eyes of the law. In those cases the party that has been at work for weeks digging unsuccessfully but hopefully, feels naturally sore at the intrusion of others, and threatened violence has been expressed in a number of instances of this description; luckily, whisky is absent and "guns" are few, so that to date these bickerings have all ended in words.

The older claims are beginning to be systematically worked—almost every mine has a shaft with the necessary steam hoisting and drilling plants. Shafts are being sunk and tunnels run, to block out and prove the mines, and a start is being made to recover from last season's dumps much of the valuable ore thrown aside in the hurry for rich returns. Milling plants are being introduced and the time will soon be passed when ore valued at hundreds of dollars a ton will be cast aside as of no consequence.

The future of Cobalt camp looks bright for several years to come, and there appears to be little doubt that continued development will lead to the discovery of many new veins while the sinking shafts will show a continuation of values in depth.—Ottawa Citizen.

ALBERTA.

The MacDonnell Dominion Government survey party has returned to Edmonton from the Peace River country. They believe they have discovered gold in paying amount, within 15 miles of the British Columbia boundary.

Mr. T. C. Denis, who is attached to the mines section of the Geological Survey, has just returned from a short trip to Pelican Portage on the Athabasca River some hundred and twenty miles below Athabasca Landing. He has been investigating the mineral reserves of Alberta, on behalf of the department, and the object of his visit to Pelican Rapids was to report on the present state of the hole sunk at that place some eight years ago, from which there has been a tremendous rush of natural gas.

Farther north in the vicinity of Fort McMurray boring operations for oil are being actively proceeded with. Two drilling rigs equipped to reach a depth of three thousand feet are now in this district.

BRITISH COLUMBIA.

Advices from Quatsimo say that a big strike of bog iron has just been made to the north of the West Arm of Quatsimo Sound.

A forest fire completely destroyed the aerial tramway connecting the Hunter V. mine, near Ymir, with the Great Northern Railway, entailing a loss of some $30,000.

Work at the Hosmer mines is progressing satisfactorily. The main tunnel, 5,000 feet in length, is to be an exceptionally large one, twenty-two feet wide and ten feet high.

There is much mining activity reported in the vicinity of Cowichan Lake, Vancouver Island. The recent finds of copper-gold ores have stimulated further prospecting. As a result several claims have been recorded.

After a year's shut-down, the Stemwinder mine at Fairview, is preparing for extensive development, and a gang of men is engaged in excavating the rock on the south side of the 46-stamp mill for a foundation for an air compressor.

In the second quarter of the current year, ended June 30, the British Columbia Mining Company showed net earnings of $117,000. Owing to changes carried out at the plant production has been curtailed for about a month, and earnings will exhibit considerably under the $40,000 average of the preceding three months.

What is said to be the richest gold stake in Cariboo, B.C., within the past twenty-five years, has been made at Peter's Creek, near Stanley, by an old miner named Mathers. Mathers' discovery is the result of persistent prospecting and deep diggings. At the depth of 100 feet he is reported to have struck dirt that yielded thirty ounces of gold to the set of ten feet.

An eight-hour day is now in force at the St. Eugene concentrator. The request of the mill men was acceded to, and they will be paid at the rate of an eight-hour day. Therefore the men will be paid for a shift and a-half's work as long as they have to work twelve hours. But three eight-hour shifts will be worked as soon as possible. The "bull-cooks," or roustabouts, will work ten hours.

On August 21 the initial shipment of ore from the Dominion Copper Co.'s Idaho mine was sent to the company's smelter at Boundary Falls. It was also the first shipment to go out over the Great Northern and be transferred to the C.P.R. at Denoro, eight miles from Phoenix by either line. The shipment consisted of ten cars, or 600 tons of ore, and will be followed by others at regular intervals, somewhat relieving the other mines of the company from contributing their regular quota until the new furnace is received and installed at the smelter. This ore came from the tunnel level of the Idaho.

The most important developments of the past week have been in the Sandon-Slocan district, On Slocan Lake the record is one of steady development and gratifying results at Silverton, near Slocan City and on Ten-Mile Creek. The long-looked for strike in the big Rambler-Cariboo has rehabilitated Sandon camp. The lead has been struck in an up-raise and the long tunnel has still to be driven 400 feet, which will give it a total length of nearly a mile and a quarter. The mine contains a large body of comparatively high-grade ore, and it is now a matter of a few months only, until shipments shall be resumed on a bigger scale than ever.

Stockholders of the Granby Consolidated Mining, Smelting and Power Company will receive with their dividend cheques notice of the company's annual meeting in New York on October 2. The company's fiscal year ended June 30, and during that period net earnings were between $1,800,000 and $1,900,000. Copper production was just under 25,000,000 pounds. Next year's production is expected to show a still further material increase. A director thinks the production will be eventually considerably over the 50,00,000 pounds mark. The shares are in the hands of between 2,500 and 3,000 persons, as compared with about 900 in December, 1903, the time of the first dividend payment.

A dividend of 3 per cent. is payable September 15 on Granby Consolidated.

This is the third dividend of the Granby Consolidated made payable this year, each amounting to $405,000, each at the rate of three per cent. on the issued stock, there being 13,500,000 shares outstanding. This makes a total of $1,215,000 in dividends by this company thus far made payable in 1906, which is at the rate of nine per cent. per annum.

The dividend record of the Granby shows that thus far four declarations of this character have been made, the first being in December, 1903. The following shows the dates of payments of the dividends and amounts of each, the total of the four amounting to $1,348,630: December 19th, 1903, $133,630; January, 1906, $405,000; May, 1906, $405,000, and September, 1906, $405,000. Total declared $1,348,630.

Mr. Le Roy, the Dominion Geologist, is making a thorough examination of Texada Island, for the purpose of arriving at a conclusion in regard to the continuity, location and direction of the mineral veins of the island. Mr. Le Roy started to work at once in the vicinity of the Marble Bay mine. He stated that the Government noticed that large shipments of copper ore had been coming from British Columbia, and decided to send him to the different camps in the province to report on the geological formation of the ore zones, to prepare maps and plans, and to get full information for the benefit of the mining industry. Mr. Le Roy is now working on two large dykes which seem to carry the ore which is running parallel with them.

The Canadian Consolidated Mining Co. is still expanding, its latest purchase being the Iron Mask Mine, which will be operated on an extensive scale from the War Eagle workings, which are not far from the ore shoots in the Iron Mask Connections are already completed between the War Eagle and the Centre Star. The Iron Mask was operated in the early days of the Rossland Camp by the Iron Mask Gold Mining Co., which was organized Feb. 19, 1896. The development consisted of about 7,000 feet of horizontal and vertical working, and the main shaft has a depth of 450 feet. The ledges are not very wide, but the ore ran from $30 to $40 to the ton, carrying gold, copper and silver. The mine for a time paid profits, and accumulated $50,000 in its treasury, when it became involved in litigation with the Centre Star Mining Company.

From all parts of the province there continue to come reports of progress in mining, indicating such an output as will surpass the record of 1905, when the present year is completed. One gratifying feature is the continued extension of the smelting industry, says the Victoria Daily Colonist. In this connection there is a report that the Le Roi smelter at Northport, Washington, which has been lying idle for some time, is likely to be placed in operation again. If this is done, however, there seems a possibility of a renewal of the objection against the export of British Columbia ore to be smelted in a foreign country. The feeling that natural products should be manufactured at home, caused the recent legislation against the export of logs in the lumber industry. Still we are not in a position to say what effect the objection would have in regard to ore exported from British Columbia to be smelted in Washington.

It is announced that the Northport smelter is to be re-opened and operated on ore shipped from the Le Roi mine. The Le Roi Company has been anxious to have its smelting plant in operation for several months past, and after considerable negotiations an amicable agreement was reached between it and the Consolidated Mining and Smelting Company. By the terms of this agreement the contract entered into last year under which the entire output of the Le Roi was to go to Trail for a period of three years, is cancelled. Since then the Consolidated Company has secured the Snowshoe mine at Phoenix and the Iron Mask in this camp, and owing to the discovery of new shoots of high grade ore in the Centre Star and War Eagle and a large increase in the quantity of custom ore from outside mines, there was no particular necessity for the Le Roi ore. Under the circumstances, the Consolidated was willing to cancel the contract. It is provided, however, that the Le Roi shall furnish about 75,000 tons of ore to the Trail smelter within the next seven months. It is said that there are such large reserves of ore in Le Roi that it will be able to keep the Northport plant in operation and at the same time furnish the 75,000 tons to Trail within the stipulated time.

A short time since announcement was made that a consolidation of several important mining claims in Phoenix would be made, including the War Eagle group, the new corporation to be called the Phoenix Amalgamated Copper Mines, Ltd. Information has now been received here that the consolidation has been carried into effect and takes in the War Eagle, Red Rock, Lulu, Bald Eagle, Dandy Fraction, Missing Link No. 2, Pinhook and World's Fair Fraction, continguous claims, that immediately adjoin the Granby Consolidated group on the south. The area of the properties is 210.30 acres, and comprises mineral territory that is favorably thought of by many who are familiar with the ground.

The Phoenix Amalgamated Copper Mines, Ltd., has been incorporated under the laws of British Columbia, with a capital of $5,000,000, having 500,000 shares of $10 par value each. Of this number 200,000 shares have been placed in the treasury of the company, the executive office of which is at Sherbrooke, Que., and the mine office at Phoenix.

The first board of directors of the new company is as follows: N. P. Buck, C. H. Fletcher, and C. A. French, of Sherbrooke, Quebec; George Vandyke, Boston; H. P. Buck, New York; W. J. C. Wakefield, Spokane, Wash.; George R. Naden, Greenwood; Charles Riordan, St. Catharines, Ont.; R. Bence Jones, Lisselan, Clonakilty, Ireland. The officers are: — F. P. Buck, president; C. H. Fletcher, vice-president; A. F. Fraser, secretary.

YUKON.

It is expected that the recent introduction of dredges will greatly increase the output of gold in the Klondike. In 1905 this was reduced to about $7,500,000 against $10,350,000 in 1904, $18,000,000 in 1901 and and $22,275,000 in 1900. Speculations are already rife as to whether this enlarged supply from the Yukon, coupled with Alaska's growing yield of new gold, will not perceptibly affect the general economic conditions in America as a whole. During 1906 Alaska will probably furnish some $20,000,000 of gold, as against $14,500,000 for 1905, $9,000,000 for 1904, and $6,350,000 for 1903.

Supt. Snyder, of the mounted police at White Horse, reports that "the month has witnessed a continuous boom in quartz mining, discovery after discovery being located and samples of ore are being brought in which are claimed to run from $200 to $600 to the ton. These discoveries were made in Watson and Wheaton River districts, at points from fifteen to twenty-five miles southwest of Robinson Siding, on White Pass and Yukon Railway.

"Although rich float has been found in these districts, since 1898, it is only this year that anyone has claimed to have discovered any ledge. Claims are purchased as soon as staked, there being good demand for them at prices ranging from $250 up."

Applications have been made for two town sites, one at the mines and one at Robinson Siding, at a point where the railway leaves to go to them. Work is being actively carried on in the neighborhood of Conrad, development work being carried on in about forty claims, employing in all about five hundred men.

Encouraging reports are received from various placer fields in the district, 1,025 ounces of gold being taken to town from Livingstone Creek in one week.

An application for 60,000 inches of water from Twelve-Mile River, one mile above its mouth, has been filed at the Gold Office in Dawson by L. S. Robe, H. G. Wilson, and F. J. Stackpoole.

The applicants state in their notice of application as posted in the Gold Office that they desire the water for the purpose of generating electrical power for distribution in Yukon Territory and Alaska. They also state that they plan to spend not less than $100,000 on the enterprise by the first of the year, and agree, if the grant is given, to have the plant working by October 15th of the second year after the grant is issued.

L. S. Robe, one of the applicants, was formerly mining engineer for the N. A. T. & T. Messrs. Wilson and Stackpoole are Dawson lawyers and solicitors for the N. A. T. & T. Robe is now in the Tanana.

The water to be asked for is to be taken from the stream some distance below the point of diversion by the Yukon Consolidated Goldfields Company, which is backed by the Guggenheims.

This is one of the largest applications ever filed in the Yukon for water. It is as great, if not greater, than that already issued by the Government to the Consolidated Company.

COAL NOTES.

NOVA SCOTIA.

The 20-year lease of the Port Hood Coal Company having been allowed to expire, others stepped in, and on August 27, took up the Minudie and Strathcona areas and five square miles at Port Hood. The matter has caused a lively sensation throughout Nova Scotia.

The output of the Dominion Coal Company's mines for month of August was:—No. 1, 45,825 tons; No. 2, 54,941 tons; No. 3, 38,464 tons; No. 4, 50,886 tons; No. 5, 59,251 tons; No. 6, 9,933 tons; No. 7, 11,891 tons; No. 8, 24,566 tons; No. 9, 35,959 tons; total, 331,716 tons. Shipments amounted to 343,788 tons during the same month.

It is said the management of the Nova Scotia Steel and Coal Company are now about to enlarge their working areas. It was for this purpose the three heads of the company visited Boularderie. Since the day the Nova Scotia Steel and Coal Company first surveyed the proposed line of railway from No. 3 to Point Aconi in 1901, the matter has always been in the minds of Messrs. Cantley and Brown. They were aware of the fact that in these areas they had more coal than the company possesses elsewhere, and that some day they would be called upon to develop them. With the unprecedented demand for the output of their collieries at No. 3 and Sydney Mines, a demand which will be increased largely in a short time, the company have decided to again resume active operations at Point Aconi.

A report was current that a number of Canadian capitalists had made overtures to the Scotia Steel and Coal Company for the purchase of the Boularderie Island areas. There is little likelihood, however, of the deal going through just at present, as the company are firm in their intention of connecting their properties with their present railway system at No. 3.

BRITISH COLUMBIA.

Work at the Hosmer coal mines is progressing satisfactorily. The main tunnel, 5,000 feet in length, is to be an exceptionally large one—22 feet wide and 10 feet high.

THE MINING AND INDUSTRIAL SHARE MARKET.

(Specially reported for the CANADIAN MINING REVIEW by ROBERT MERREDITH & Co., Mining Brokers, 57 St. François Xavier St., Montreal.)

There has been very little of interest to note in the markets, during the past month.

In mining stocks, prices have remained firm, but the active trading in International Coal has quieted down, and more has been doing in some of the lower-priced stocks.

The industrial stocks remain stationary, and there has been practically no speculation in them.

News from the different mining camps is satisfactory, and is drawing public attention more and more to the industry.

In Rossland, especially, some fine veins of ore have been opened up.

There is practically nothing doing in the Cobalt stocks, with the exception of Nipissing, which is actively traded in on the New York "curb," and has scored an advance of some $3.00 per share.

The latest quotations are as follows:—

	Bid.	Asked.
Consolidated Mines	125	130
Can. Gold Fields	6	7
Granby Consolidated	12	12¼
Rambler Cariboo	30	32½
North Star	11	13
Monte Cristo	3	3½
White Bear	9	10
California	2	2½
Virginia	5	6
Deer Trail	..	1½
International Coal	64	65
Sullivan	7	9
Jumbo	15	18
Cariboo-McKinney	2½	3½
Denoro	7	8
Diamond Vale Coal	12½	18
Dominion Copper	3¾	4
Dominion Coal (common)	74	77
Dominion Coal (pref.)	..	..
Dominion Iron and Steel (common)	28¼	28¾
Dominion Iron and Steel (pref)	77	78
Intercolonial Coal (common)	..	..
Intercolonial Coal (pref.)	..	..
Nova Scotia Steel and Coal	67½	68
Nova Scotia Steel and Coal (pref.)	..	..

COMPANY NOTES.

The Salt Lake City district office of the Westinghouse Electric and Mfg. Company was removed on July 2nd, 1906, to 212-214 South West Temple Street, Salt Lake City, Utah. The Dallas district office was also removed on the same date to 418 Main street, Dallas, Texas.

INDUSTRIAL NOTES.

The Cobalt "Silver Queen" has purchased from Allis-Chalmers-Bullock, Limited, Montreal, through the Toronto office, an electric lighting outfit, including a "Bullock" generator driven by a high speed automatic engine, and additional boiler equipment.

Two 165 r.m.p. producer gas engines, manufactured by the Canadian Westinghouse Co., are to be installed in the plant of the Calgary Milling Company, at Calgary, Alberta, Canada. The engines operate at an altitude of 3,000 feet, using authracite coal for fuel, with possibility of a change to natural gas as soon as a supply is obtained.

The University Mine, Cobalt, has purchased from Allis-Chalmers-Bullock, Limited, Montreal, through the Toronto office, mining equipment including one-half of a duplex compound "Ingersoll" air compressor, "Ingersoll" rock drills, mountings, etc., two horizontal return tubular boilers and a "Bullock" generator driven by a high-speed automatic engine for lighting the mine, buildings, and camp generally. The contract included piping and connections for the complete outfit.

The Boundary iron works at Grand Forks was destroyed by fire. The origin of the fire is not known. The bulk of the patterns, valued at $8,000, were in a separate building and were saved. The buildings and machinery destroyed are valued between $15,000 and $18,000; insurance, $7,000. Managing Director Charles Brown announces his intention of rebuilding at once.

Strong and reliable, "Ingersoll-Sergeant" air compressors have just added one more good mark to their credit. The Tacoma Steel Works, of Tacoma, Washington, have ordered a large size compressor of the duplex steam and compound air class from Allis-Chalmers-Bullock, Limited, Montreal, through the Vancouver office, for their Marble Bay Mines, on Texada Island, about 80 miles north of Vancouver. This is to replace a smaller compressor built by the same firm which has been in constant and severe service for the past seven years. For one period of five months this smaller compressor worked continuously night and day.

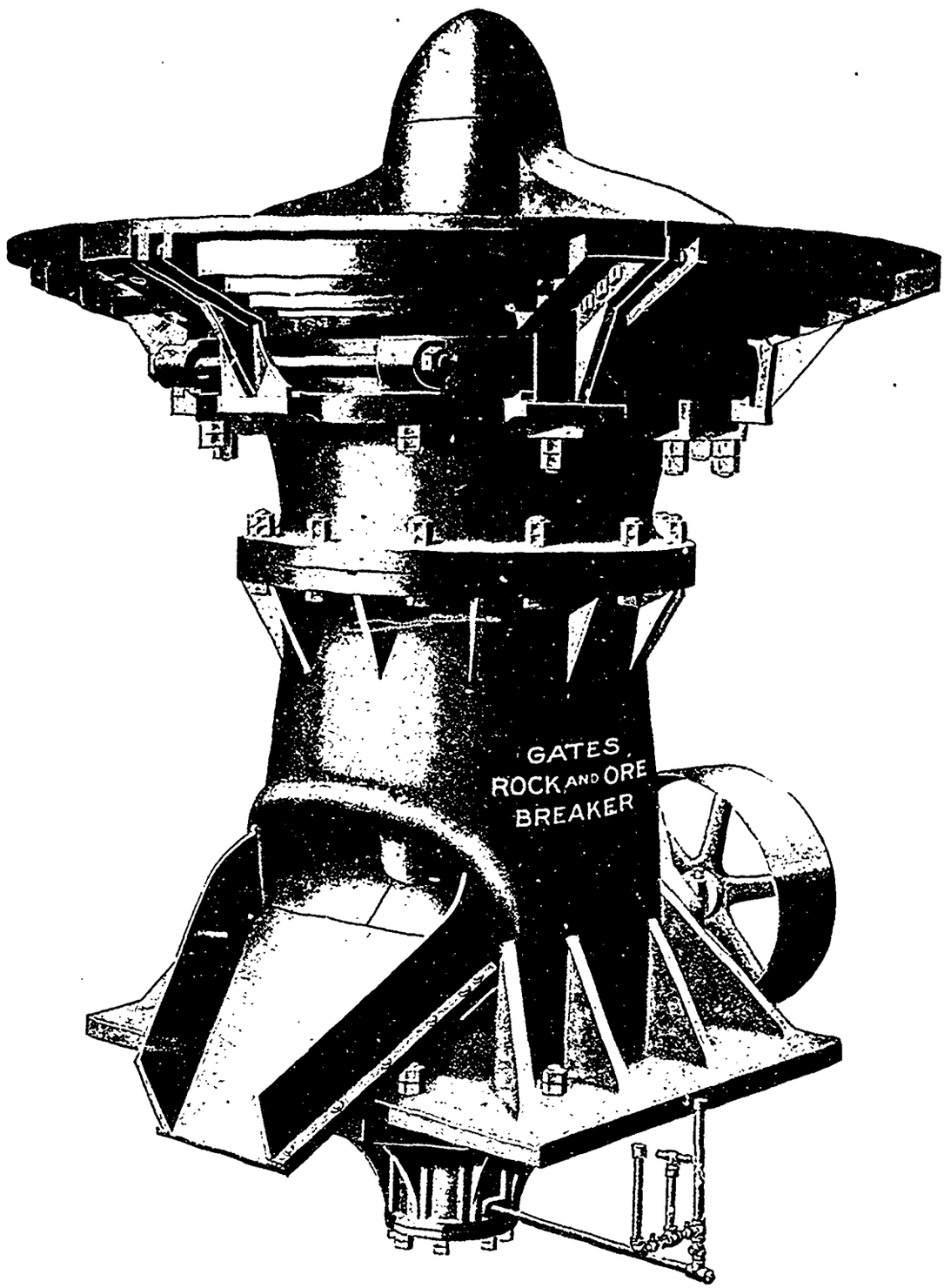
The Canadian Westinghouse Company, Ltd., are doing a large business in steam turbo-generator equipments. The Northern Electric & Mfg. Company, of Montreal, duplicated an order recently for a 300 k.w., Westinghouse-Parsons turbo-generator unit, to be installed in their power house alongside of one of the same capacity now in service. The generator is a 220 volt, thre phase, 7,200 alternation machine, operating at 3,600 r.p.m.. and will be of the latest enclosed type, while the turbine will operate at 150 pounds steam pressure with 100 degrees superheat. Their present turbine is operating part of the year condensing, and through the winter non-condensing, the exhaust steam being used during the winter for heating purposes. It was the splendid operation of this steam turbine generating unit which led the company to order the one about to be installed.

A mammoth gold dredge for service on the "Forty Mile" in the Yukon was built this summer at White Horse and floated down the river to its destination. The timbers and machinery for this dredge were dispatched north from Vancouver, and the work of assembling it at White Horse commenced early in the season, so that the completed dredge was started down the river as soon as possible after the ice went out.

The mechanical equipment was ordered by the Forty-Mile Gold Dredging Co., of Toronto, Canada, through the Allis-Chalmers-Bullock Co., Ltd., Montreal.

The dredge equipment which was furnished complete is special in nature and adapted to the particularly heavy service of the Forty-Mile. The dredge proper will be equipped with 5 1-3 cu. ft. buckets. The accessory machinery, ready for operation, was shipped from the various works of the Allis-Chalmers Company. It consists of engines, pumps, boilers, concentrating machinery and a small electric light plant.

The largest generator ever made in this country has just been made ready for shipment to British Columbia from the works of the Canadian Westinghouse Company, of Hamilton. The purchaser is the British Columbia Electric Railway Company, of Vancouver, The generator is 2,000 horse power, 3 phase, 7,200 alternations, 200 revolutions per minute, engine type for direct connection with the water wheel. The order also includes one rotary converter of 1,350 horse power, 550 volts, 3 phase, 7,200 alternations, 400 revolutions per minute, and eight air blast transformers each of 733 horse power, 2,200 volts to 24,200 volts, 7,200 alternations. The necessary switch boards and regulating and controlling devices were also manufactured in this plant and will be shipped with the balance of the order in the course of a day or two.



The Gates Rock and Ore Breaker.

The new machinery is required by the Vancouver company to provide added power to meet the ever-increasing demand of Vancouver and vicinity. It is the fourth generator of the size ordered by the Vancouver company, but the other three were supplied by the Westinghouse company from its Pittsburg works previous to the building of the Hamilton works. The one now ready for shipment is by long odds the largest ever manufactured in Canad.

A recent appointment at the hands of Governor McInnes, acting for the Dominion of Canada, confers the title of consulting engineer to the Canadian Government upon Mr. Chas. T. Arkins, mining expert attached to the Seattle office of the Allis-Chalmers Company, represented in Canada by the Allis-Chalmers-Bullock Co., Ltd., Montreal. Mr. Arkins will act with the chief of the Geological Survey of Canada and the Government Mining Department in an investigation of the merits of the extensive deposits of "white channel gravels," so called, of Yukon Territory; and to report on the relative advantage of the mining and milling process over the sluicing treatment of these gravels for gold, which is the present method used. Water is scarce in that district and when used for sluicing purposes, it can be procured only through elaborate and expensive pumping and conveying schemes, involving an expenditure of approximately ten million dollars. The Government, with a view to avoiding this expense, has ordered this mining and metallurgical examination in order to determine upon the best mode of procedure.

Mr. Arkins is charged particularly with the metallurgical side of the investigation. The appointment, while it is temporay in character, comes as a personal honor and acknowledgment of Mr. Arkins' abilities as an expert as well as a tribute to the Allis-Chalmers Company, with whom he is associated. Mr. Arkins is now in Dawson, Y.T., where he will make the necessary preparations for undertaking his new work.

MINING INCORPORATIONS.

ONTARIO.

Verona Mining Company. Capital, $1,000. Head office, Toronto, Ont. George Herbert Smythe, attorney.

The Boston Mines, Limited. Capital, $50,000, divided into 50,000 shares of $1 each. Head office, Toronto, Ont. Provisional directors to be Frederick Rielly, George Verney, John Ross, Elmer Eugene Wallace and Arthur Roger Clute.

The American Silver King Mining Company, Limited. Share capital, $500,000, divided into 500,000 shares of $1 each. Head office, Haileybury, Ont. Provisional directors, Harvey Driffill Graham, George Aaron Bagshaw and Frederick Nasseau Hughes.

Right of Way Mining Company, Limited. Share capital, $500,000, divided into 500,000 shares of $1 each. Head office, Ottawa, Ont. Provisional directors to be George Patterson Murphy, James Barnet MacLaren, John Proctor Dickson and Edwin Septimus Leetham.

Cobalt Nugget Silver, Limited. Capital, $40,000, divided into 1,600 shares of 25c each. Head office, Haileybury, Ont. Provisional directors to be Arthur English Whitby, Vivian Reynolds Oliver, Cyril Thomas Young, Duran Fernando Hulbert, and Peter Stewart Hairston.

BRITISH COLUMBIA.

The Elk Valley Coal Company. Capital: $200,000, divided into 200,000 shares of $1 each. Head office, Victoria, B.C.

Empress Mining Company, Limited. Capital, $250,000, divided into 2,500 shares of $100 each. Head office, Victoria, B.C.

Recobond Mining Company, Limited. Capital, $10,000. divided into 10,000 shares of $1 each. Head office, Victoria, B.C.

Pacific Slate Company, Limited. Capital, $125,000, divided into 125,000 shares of $1 each. Head office, Victoria, B.C.

British Columbia Mining Exchange, Limited. Capital, $25,000, divided into 250 shares of $100 each. Head office, Victoria, B.C.

Northern Exploration Company. Capital, $500,000, divided into 500,000 shares. Wm. Ernest Burns, barrister-at-law, attorney. Head office, Vancouver, B.C.

CATALOGUES.

Round copper furnaces are dealt with in Bulletin M—106 published by the Wellman-Seaver-Morgan Company, Cleveland, Ohio.

The Atlas Engine Works of Indianapolis have published Bulletin No. 131, dealing with throttling and automatic single valve engines; a handsome publication of sixteen pages.

Conveying and Transmission, are covered in a monthly publication published by the Stephens-Adamson Mnfg. Co. of Aurora, Ill., whose Canadian sales agents are W. H. C. Mussen & Co., Montreal.

The Wellman-Seaver-Morgan Co. of Cleveland, O., has issued Bulletin M—105, on silver-lead blast furnaces, which shows the latest design of silver-lead blast furnaces that the company is prepared to build in all standard sizes, from 30 x 60 inches to 42 x 160 inches.

The Sullivan Machinery Company have managed to work a vast amount of useful information concerning their machinery into the August number of Mine and Quarry. Mining men who have long adits to drive should be particularly interested in the description of the Gunnison Tunnel.

W. H. C. Mussen & Company, Montreal, are often asked the question, "What do you handle?" In order to give a comprehensive answer the house has brought out, for the use of purchasing agents and others, a reference list of machinery and supplies for railways, mines, contractors and municipalities.

PROVINCE OF QUEBEC

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

GREAT MINERAL TERRITORY

Open for Investment in the Province of Quebec.

Gold, Silver, Copper, Iron, Asbestos, Mica, Plumbago, Phosphate, Chromic Iron, Galena, Etc.

ORNAMENTAL AND STRUCTURAL MATERIALS IN ABUNDANT VARIETY.

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

All mines belong to the government of the Province on all unsold lands and on all those sold since the 24th of July, 1880, but gold and silver are always reserved, whatever may be the date when the land was sold, unless it be otherwise mentioned in the patent.

The government grants PROSPECTING LICENSES for lands on which the mines belong to it, giving the holders of such licenses the first right to purchase the mines. In the case of lands where the surface alone is sold, the owner of the surface may be expropriated if he refuses an amicable settlement.

The price of prospecting licenses is $5.00 per 100 acres on surveyed lands and per square mile on unsurveyed lands. If the surface has already been sold, the price is only $2.00. They are valid for three months and are renewable at the discretion of the Minister.

When mines are discovered, they can be bought or leased from the government. The purchase price is as follows :

Mining for superior metals on lands situate more than 12 miles from a railway in operation, $5.00 per acre, and on lands situate less than 12 miles from such a railway, $10.00 per acre ;

Mining for inferior metals—the price and the area of the concessions are fixed by the Lieutenant-Governor in council.

The words "superior metals" include the ores of gold, silver, lead, copper, nickel and also graphite, asbestos and phosphate of lime ; and the words "inferior metals" mean and include all the minerals and ores not included in the foregoing definition and which are of appreciable value.

MINING CONCESSIONS are sold in entire lots in surveyed townships or in blocks of not less than 100 acres in unsurveyed territories.

Patents are obtained subject to the following conditions : The full price must be paid in cash : specimens must be produced and accompanied by an affidavit ; a survey at the cost of the applicant must be made on unsurveyed lands ; work must be bona fide begun within the two years.

Mining licenses giving the right to work the mine and dispose of its products, are granted on payment of a fee of $5.00 and a rent of $1.00 per acre per annum. Such licenses are valid for one year and are renewable on payment of the fee and of the same rent. They may cover from 1 to 200 acres for one and the same person and must be marked out on the ground by posts. The description or designation must, however, be made to the satisfaction of the Minister.

Persons working mines must send in yearly reports of their operations to the government.

The attention of the public is specially called to the new territory north of the height of land towards James Bay, which comprises an important mineral belt in which remarkable discoveries of minerals have already been made and through which the New Grand Trunk Pacific Railway will run.

The government has made special arrangements with Mr. Milton L. Hersey, 171 St. James Street, Montreal, for the assay and analysis of minerals at very reduced rates for the benefit of miners and prospectors in the Province of Quebec. Tariffs of assays can be obtained on application to him.

The Bureau of Mines at Quebec, under the direction of the Superintendent of Mines, will give all the information asked for in connection with the mines of the Province of Quebec and will supply maps, pamphlets, copies of the law, tariff of assays, etc., to all who apply for same.

Applications should be addressed to :

THE HON. MINISTER OF COLONIZATION, MINES & FISHERIES,

PARLIAMENT BUILDINGS, QUEBEC

DOMINION OF CANADA

SYNOPSIS OF CANADIAN NORTH-WEST MINING REGULATIONS.

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

A person 18 years of age or over having discovered mineral in place, may locate a claim 1,500 feet x 1,500 feet.

The fee for recording a claim is $5.

At least $100 must be expended on the claim each year, or paid to the mining recorder in lieu thereof. When $500 has been expended or paid, the locator may, upon having a survey, made, and upon complying with other requirements, purchase the land at $1 an acre.

The patent provides for the payment of a royalty of 2½ per cent. on the sales.

Placer mining claims generally are 100 feet square; entry fee $5, renewable yearly.

A free miner may obtain two leases to dredge for gold of five miles each for a term of twenty years, renewable at the discretion of the Minister of the Interior.

The lessee shall have a dredge in operation within one season from the date of the lease for each five miles. Rental $10 per annum for each mile of river leased. Royalty at the rate of 2½ per cent. collected on the output after it exceeds $10,000.

W. W. CORY,

Deputy of the Minister of the Interior.

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RAILROAD, DOCK, SUBWAY CONSTRUCTION,
DREDGING, LOGGING, HAULING, ERECTING, DRIVING
ELECTRIC HOISTS **BELT HOISTS**

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AND FOR ALL
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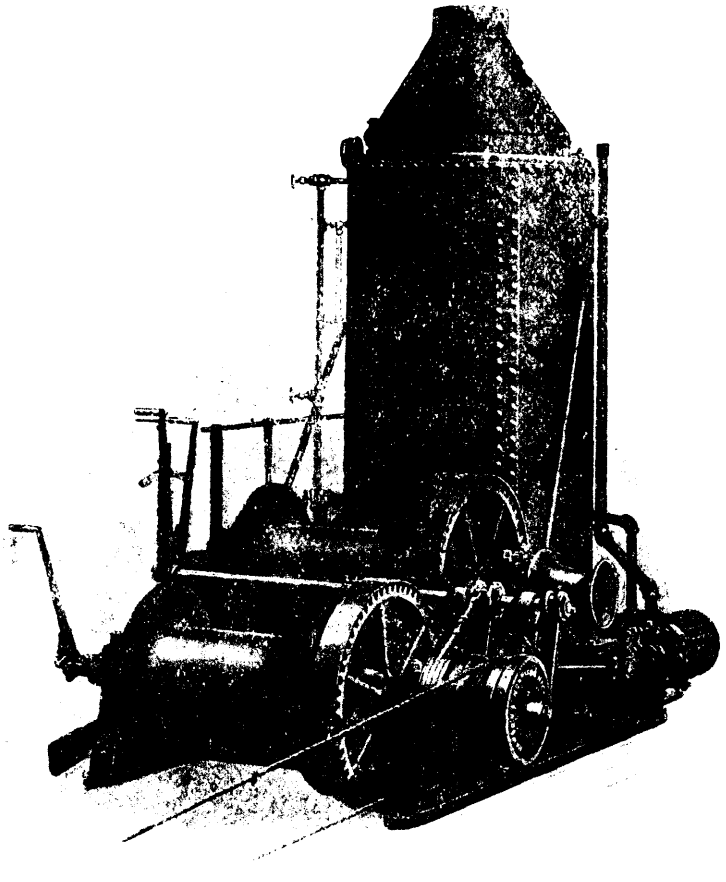

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